Office of Emergency Management

City of Philadelphia

City of Philadelphia
All Hazard Mitigation Plan

Contents

1 Introduction

1.1 Background

The term “hazard mitigation” as defined by the Federal Emergency Management Agency (FEMA) describes sustained actions taken to prevent or minimize long-term risks to life and property from hazards and their effects. Hazard mitigation:

- Identifies and profiles hazards;
- Analyzes risk factors to people, property, and the environment; and
- Develops mitigation actions in response to the above two actions.

Mitigation actions are actions taken in advance of a hazard event and are essential to breaking the disaster cycle of preparedness, response, and recovery. According to a 2005 study by the National Institute of Building Sciences, for every one dollar spent on mitigation, four dollars is saved in post-storm cleanup and rebuilding. Examples of mitigation include:

- Promoting sound land use planning based on known community hazards;
- Adopting and enforcing building codes and standards;
- Using fire-retardant materials in new construction;
- Buying flood insurance to protect personal property and belongings;
- Elevating structures above the floodplain;
- Elevating critical equipment (i.e. computer servers, generators, water heaters, above the base flood elevation); and
- Retrofitting highway overpasses to withstand earthquakes.

The City and County of Philadelphia (hereinafter referred to as Philadelphia or the City) has developed this Hazard Mitigation Plan (hereinafter referred to as the HMP) to assess risks posed by natural and human caused hazards, and to develop mitigation strategies for reducing the risks of these hazards. The City has prepared the HMP in accordance with the requirements of the Disaster Mitigation Act of 2000 (DMA 2000). The Office of Emergency Management (OEM) has coordinated the preparations of the HMP in cooperation with other City agencies and departments, as well as private agency representatives and members of the public.

1.2 Purpose and Scope

1.2.1 Premise

As a condition of receiving federal disaster mitigation funds, Section 322 of the DMA 2000 requires that local governments have a mitigation plan. The HMP describes the process for identifying hazards, creating a risk assessment and vulnerability analysis, identifying and prioritizing mitigation strategies, and developing an implementation schedule.

In order to satisfy this requirement OEM has prepared the HMP with the following objectives in mind:

- Provide guidance for reducing property damage and saving lives from the effects of natural disasters within Philadelphia County;
- Qualify Philadelphia for applicable pre-disaster and post-disaster grant funding;
- Comply with state and federal legislative requirements related to local hazard mitigation planning;
- Demonstrate a firm local commitment to hazard mitigation principles; and
- Improve community resiliency following a disaster event.

1.2.1.1 Grant Programs with Mitigation Plan Requirements

Hazard Mitigation Grant Program (HMGP)

The HMGP provides grants to state, local, and tribal entities to implement long-term hazard mitigation measures after declaration of a major disaster. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. Projects must provide a long-term solution to a problem (for example, elevation of a home to reduce the risk of flood damage rather than buying sandbags and pumps in response to flooding conditions). In addition, a project’s potential savings must be more than the cost of implementing the project. Funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. The amount of funding available for the HMGP under a particular disaster declaration is limited. Under the program, the federal government may provide a state or tribe with up to 20 percent of the total disaster grants awarded by FEMA; and may provide up to 75 percent of the cost of projects approved under the program.

Pre-Disaster Mitigation (PDM) Program

The PDM Program provides funds to state, local, and tribal entities for hazard mitigation planning and the implementation of mitigation projects before a disaster event. PDM grants are awarded on a nationally competitive basis. Like HMGP funding, the potential savings of a PDM project must be more than the cost of implementing the project. Funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. Congress appropriates the total amount of PDM funding available on an annual basis. The federal government provides up to 75 percent of the cost of projects approved under the program.

Flood Mitigation Assistance (FMA) Grant Program

The goal of the FMA Grant Program is to reduce or eliminate flood insurance claims under the National Flood Insurance Program (NFIP). This program places particular emphasis on mitigating repetitive loss (RL) properties. The primary source of funding for this program is the National Flood Insurance Fund. Grant funding is available for three types of grants: Planning, Project, and Technical Assistance. Project grants, which use the majority of the program's total funding, are awarded to local entities to apply mitigation measures to reduce flood losses to properties insured under the NFIP. The cost-share for this grant is 75 percent federal/25 percent nonfederal. However, a cost-share of 90 percent federal/10 percent nonfederal is available in certain situations to mitigate severe repetitive loss (SRL) properties.

Repetitive Flood Claims (RFC) Program

The RFC Program provides funding to reduce or eliminate the long-term risk of flood damage to residential and non-residential structures insured under the NFIP. Structures considered for mitigation must have had one or more claim payments for flood damages. All RFC grants are eligible for up to100 percent federal assistance.

Severe Repetitive Loss (SRL) Program

The SRL Program provides funding to reduce or eliminate the long-term risk of flood damage to residential structures insured under the NFIP. Structures considered for mitigation must have had:

- At least four NFIP claim payments over $5,000 each, when at least two such claims have occurred within any 10-year period, and the cumulative amount of such claim payments exceeds $20,000; or
- At least two separate claims payments have been made with the cumulative amount of the building portion of such claims exceeding the value of the property, when two such claims have occurred within any 10- year period.

The cost-share for this grant is 75 percent federal/25 percent nonfederal. However, a cost-share of 90 percent federal/10 percent nonfederal is available to mitigate SRL properties when the state or tribal plan addresses ways to mitigate existing and future SRL properties.

1.2.2 __Purpose of the Plan__

The Philadelphia HMP represents the City's approach to mitigate the adverse impacts of natural and human caused disasters. The 2017 HMP is organized into the following sections:

Introduction

The Introduction provides a brief overview of the background and purpose, the legal authority for the plan, as well as the grant programs available to Philadelphia once the plan has been adopted.

Community Profile

The Community Profile provides a general overview of Philadelphia by summarizing demographics, economic characteristics, the City's natural environment including its climate and waterways, growth trends, land use and more. To accomplish these goals, the profile is divided into three components:

- Physical Environment: the physical setting of Philadelphia, including
  - Geography;
  - Hydrography and hydrology;
  - Topography and geology; and
  - Climate information.

- Social Environment: the City of Philadelphia's history and population information, including
  - Social characteristics;
  - Demographic estimates;
  - Economic characteristics; and
  - Housing characteristics.

- Built Environment: land use and infrastructure within Philadelphia's boundaries

Planning Process

This section outlines the process in which Philadelphia developed the HMP. It identifies the 18 Philadelphia, Commonwealth, federal, and private organizations that were involved in planning process. The section also details the strategies employed to obtain public feedback.

Risk Assessment

The Risk Assessment provides an analysis of the hazards and risks facing Philadelphia. It contains detailed profiles of each natural hazard addressed in the plan, and estimates losses in Philadelphia in a realistic worst-case scenario for each hazard.

Capability Assessment

The Capability Assessment reviews and analyzes Philadelphia's authority, policies, plans, programs, and resources that are currently available to accomplish mitigation and reduce long-term vulnerability to hazards. The assessment includes overviews of the following capabilities:

- Planning and regulatory capabilities to guide or manage growth and development in the City;
- Administrative and technical capabilities to plan for and implement mitigation actions;
- Financial capabilities to access resources to fund mitigation actions; and
- Education and outreach capabilities to implement mitigation activities and communicate hazard and risk related information to the public.

Mitigation Strategy

The Mitigation Strategy section describes how Philadelphia intends to reduce losses identified in the Risk Assessment. The section contains a prioritized list of cost-effective, environmentally sound, and technically feasible mitigation actions broken down by hazard and by the agency or agencies responsible for implementing each strategy. It identifies current and potential sources of funding and other resources needed to implement mitigation actions. Finally, it includes Philadelphia policies and programs that will assist in administering the identified mitigation actions.

Plan Adoption

This section states how Philadelphia will formally adopt the Plan, ensuring a citywide commitment to mitigation planning and program management.

Plan Maintenance

The Plan Maintenance section describes how Philadelphia will monitor, evaluate and update its HMP on an annual basis, or following major disasters or incidents, in consultation with key stakeholders.

1.3 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 programs aided the preparation of this document:

- Local Mitigation Planning Handbook, March 2013
- Local Mitigation Plan Review Guide, October 2011
- Understanding Your Risks: Identifying Hazards and Estimating Losses, August 2001
- Plan Integration: Linking Local Planning Efforts, July 2015
- Using Benefit-Cost Review in Mitigation Planning, May 2007
- Using the Hazard Mitigation Plan to Prepare Successful Mitigation Projects, August 2008
- Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards, January 2013
- Hazard Mitigation Grant Program under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act 42 U.S.C., Section 322, as amended.
- Pre-Disaster Mitigation Grant Program under Section 203 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act 42 U.S.C. 5133.
- Flood Mitigation Assistance Program under the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101).
- Severe Repetitive Loss Program under section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a.
- Repetitive Flood Claims Grant Program under Flood Insurance Reform Act of 2004 (P.L. 108–264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al).

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

- Mitigation Strategy Action Evaluation: PA STEEL
- Flood Plain Management Regulations, July 2010
- Pennsylvania Pre-Disaster Mitigation Program: Project and Planning Funding Assistance, October 2010
- Plan Integration Guide, July 2014

The following guidance document produced by the National Fire Protection Association (NFPA) assisted in the creation of this plan:

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

2 Community Profile

Philadelphia:

- *Is the fifth most populous city in the United States with 1.5 million people*
- *Has the 26th largest metropolitan GDP in the world*
- *Encompasses 134.1 square miles of land*

Philadelphia is home to over 1.5 million people and ranks as the fifth most-populous city in the United States.[1] The City is located at the confluence of the Delaware and Schuylkill Rivers, and has a diverse and growing population. With numerous universities and colleges, the City is an international study and education destination. Philadelphia's gross domestic product (GDP) of $346 billion ranks the City as the 26th largest metropolitan GDP in the world.[2] Rich history abounds, with 67 National Historic Landmarks located throughout the City.[3] In 2015, Philadelphia became the first U.S. World Heritage City. These cultural strengths, along with increasing development, position Philadelphia for growth in residents, businesses, and industry.

2.1 Physical Environment

2.1.1 Geography

Philadelphia, as originally laid out by William Penn, initially encompassed the area between South and Vine Streets, ending at the Delaware and Schuylkill Rivers.[4] Settlements sprang up outside the city's borders, with Southwark and Moyamensing south of the city, and Northern Liberties, Kensington, Spring Garden and Penn District to the north, and West Philadelphia to the west.[5] In 1854, citizens voted to pass a bill that consolidated these areas and numerous more into what would today be the county 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).

---

[1] United States Census. American Community Survey: Philadelphia.
[2] Brookings Institute. Global MetroMonitor 2014. Retrieved November 20, 2015.
[3] National Park Service. National Historic Landmarks Program: List of National Historic Landmarks by State.
[4] "Philadelphia History". Independence Hall Association. Retrieved November 18, 2015.
[5] Ibid.

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 as the urban center of a four-state "Greater Philadelphia" region, otherwise known as the Delaware Valley, which is comprised of the 12 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 fifth-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 of the major bodies of water within Philadelphia are part of seven primary and secondary watersheds. The Environmental Protection Agency (EPA) defines a watershed as the area of land where all of the water that is under it or drains from it goes into the same place. Within Philadelphia's watersheds, 54 percent of the surfaces are impervious, leading much of the City prone to flash flooding. Over 24,170 linear miles of streams contribute to the extensive waterways crossing and bordering Philadelphia.

2.1.2.1 Primary Watersheds

2.1.2.1.1 Delaware River Watershed

Philadelphia contributes approximately 40 square miles to 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, 530,652 of which live in Philadelphia. The land use composition for this watershed is estimated at roughly 55 percent forest, 26 percent agriculture, and 15 percent developed. The area within Philadelphia is densely developed and estimated to be 72 percent impervious surface and therefore highly susceptible to flash flooding. The Delaware River watershed encompasses areas of four states, 42 counties, and all or parts of 838 municipalities in the Mid-Atlantic region. [6]

---

[6] "Delaware". Philadelphia Water. Retrieved November 18, 2015.

2.1.2.1.2 Schuylkill River Watershed

The Schuylkill River Watershed drains approximately 2000 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. There is approximately 10 percent impervious cover in this area. The area is susceptible to flash flooding due to the amount of impervious coverage and other contributing factors. [7]

2.1.2.2 Secondary Watersheds

2.1.2.2.1 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, with all or parts of 15 municipalities. Approximately 48,441 Philadelphia residents currently live within the watershed. About 24 percent 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 decades causing strain on

---

[7] "Schuylkill". Philadelphia Water. Retrieved November 18, 2015.

the water resources, mostly from increased storm water runoff and discharge of treated wastewater.[8]

2.1.2.2.2 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. Philadelphia contributes 17.9 miles to the watershed. Pennypack Creek Watershed includes 137,010 Philadelphia residents. Roughly 33 percent of the watershed in the City limits is impervious, and therefore may be prone to flash floods.[9]

2.1.2.2.3 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

---

[8] "Wissahickon". Philadelphia Water. Retrieved November 18, 2015.

[9] "Pennypack". Philadelphia Water. Retrieved November 18, 2015.

residents, 75,550 of whom reside in Philadelphia. The watershed has 38 percent impervious cover within the City's borders, increasing the area's risk of flash flooding. [10]

2.1.2.2.4 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 percent of the area is covered by impervious cover, making almost half of the watershed prone to flash flooding. [11]

2.1.2.2.5 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.[12] An estimated 44 percent of the surfaces located within the watershed in Philadelphia are impervious.[13]

---

[10] "Poquessing". Philadelphia Water. Retrieved November 18, 2015.

[11] "Tookany/Tacony/Frankford". Philadelphia Water. Retrieved November 18, 2015.

[12] "Darby Cobbs". Philadelphia Water. Retrieved November 18, 2015.

[13] Ibid.

2.1.3 Topography and Geology

Philadelphia resides 39 feet above sea level on average[14], with the lowest point occurring at 10 feet above sea level, and the highest point occurring in the neighborhood of Chestnut Hill at about 445 feet above sea level.[15]

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 because of having undergone environmental processes such as weathering and erosion over a period of time. 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). The image on the following page 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. The Southern Piedmont contains schist, metagraywacke, amphibolite, and associated ultramafic rocks of the Wissahickon Formation overlain by unconsolidated Cretaceaous and tertiary sediments.[16]

---

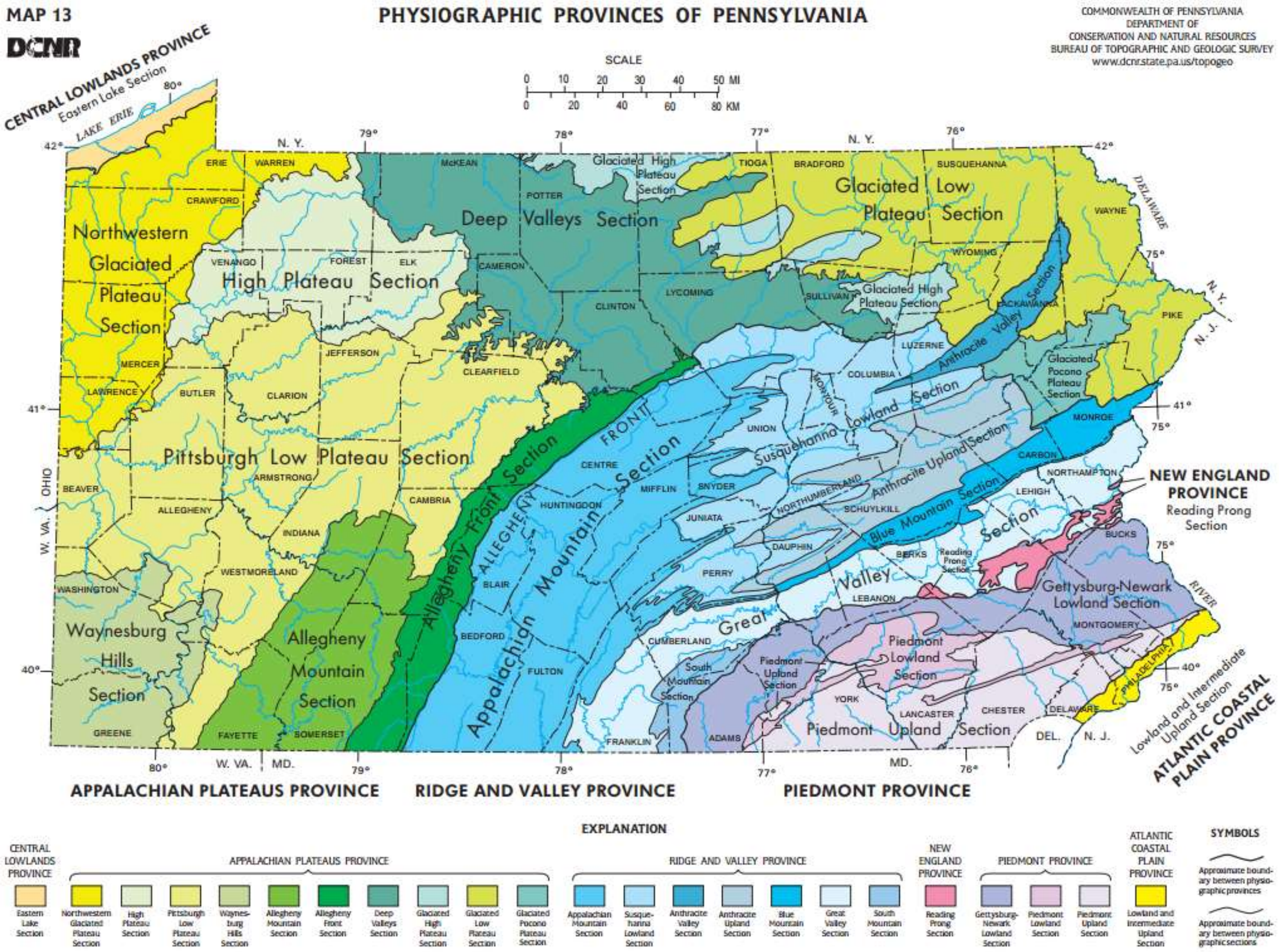
[14] Pennsylvania Spatial Data Access. Philadelphia topographic contours. Retrieved November 20, 2015.

[15] USGS. Map Locator. Retrieved November 20, 2015.

[16] Commonwealth of Pennsylvania Department of Conservation and Natural Resources. Lowland and Intermediate Upland Section, Atlantic Coastal Plain Province. Retrieved November 3, 2011.

MAP 13

PHYSIOGRAPHIC PROVINCES OF PENNSYLVANIA



2.1.4 Climate

The Delaware Valley lies about halfway between the equator and the North Pole. This mid-latitude location puts Philadelphia about equidistant from the reservoirs of cold air to the north and warm air to the south. This location contributes to the diverse types of weather the city sees. Moisture provided by the Atlantic Ocean to the east and the 3,000 miles of land to the west of the City also impacts weather variability. The table below illustrates the annual temperature and precipitation averages from 1981 to 2015 using NOAA's NOWData from Philadelphia International Airport (PHL).

Philadelphia Average Temperatures and Precipitation Averages[17]	
Average Annual Temperature	55.8^{0}F
Change in Average Since 2012	- 0.7^{0}F
Average Maximum Temperature	67.3^{0}F
Average Minimum Temperature	58.2^{0}F
Liquid Precipitation Average	42.6 inches per year
Change in Average Since 2012	+ 1.1 inches
Snowfall Average	23 inches per year
Change in Average Since 2012	+ 2.5 inches

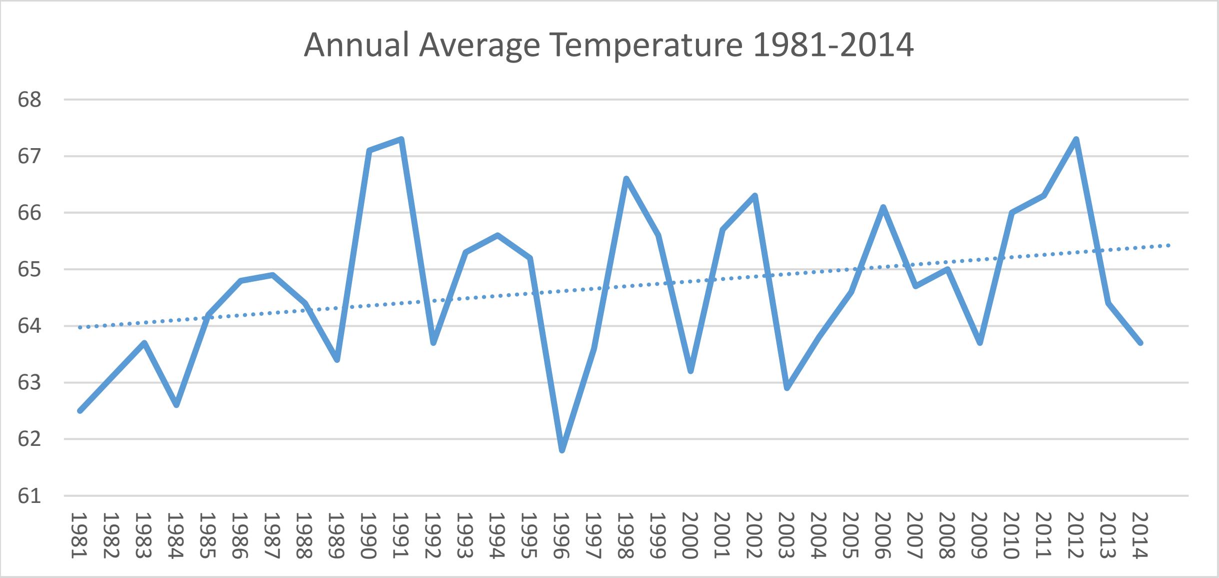
The following sections describe the climate characteristics of the City of Philadelphia, including data on temperature, precipitation, severe weather, and climate change.

---

[17] Philadelphia Weather. NOWData - NOAA Online Weather Data. Retrieved November 3, 2015.

2.1.4.1 Temperature

Philadelphia's average annual temperature is 55.8⁰F, with mean summer temperatures around 75.6⁰F, and mean average winter temperatures around 36.2⁰F.[18] Climatologically, Philadelphia's winters are somewhat mild, with less than 85 days beneath the freezing mark. Days below 0⁰F are also highly infrequent, occurring at a similar rate as those days above 100⁰F, averaging once annually.[19] The graph below depicts the annual average temperature between the years of 1981 and 2014 in Philadelphia. [20]



The global position of Philadelphia does allow for large swings in temperatures from year to year. The temperature between Philadelphia's hottest and coldest years is more than 8⁰F, a dramatic and dynamic range for climatology. The chart below captures the averages and records for winter (December through February) and summer (June through August) temperatures.

Philadelphia Temperature Statistics for Winter and Summer[21]	
Winter Average Temperature	36.2⁰F
Winter Record High Temperature	74⁰F (set February 27, 1997, February 24, 1985)
Winter Record Low Temperature	-11⁰F (set February 9, 1934)
Summer Average Temperature	75.6⁰F
Summer Record High Temperature	106⁰F (set August 7, 1918)

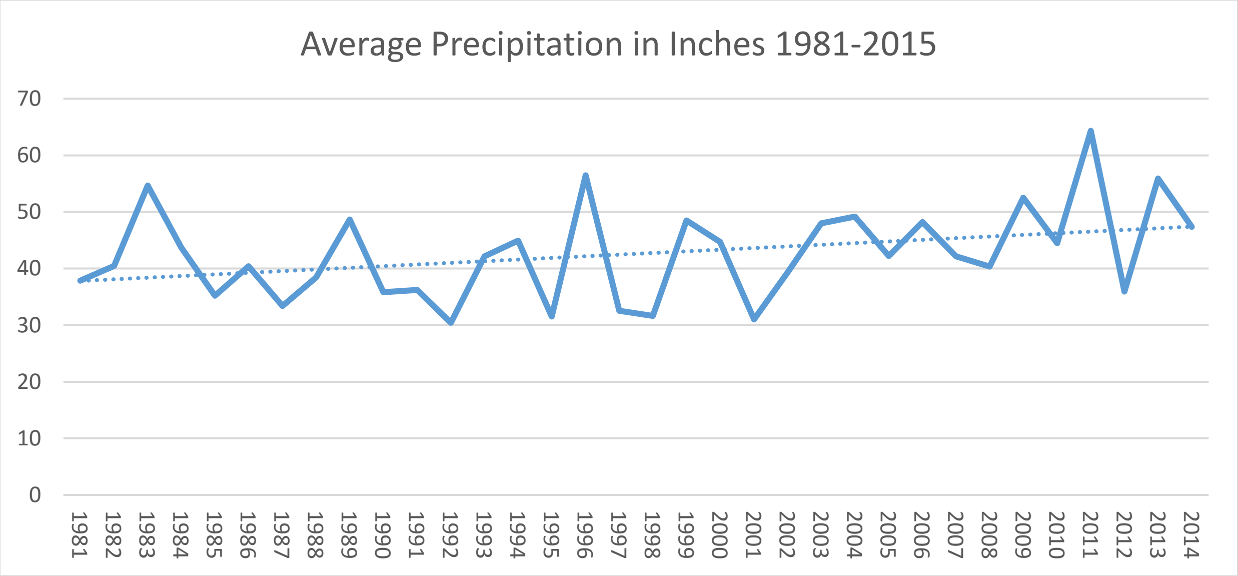
---

[18] Philadelphia Climate. NOAA NOWData. Retrieved November 3, 2015.
[19] Philadelphia Climate. NOAA NOWData. Retrieved November 3, 2015.
[20] Philadelphia Climate. NOAA NOWData. Retrieved November 3, 2015.
[21] Ibid

Summer Record Low Temperature	44⁰F (set August 29, 1986, and seven other times)

2.1.4.2 *Precipitation*[22]

Precipitation in the Philadelphia area is fairly distributed throughout the year. The average annual rainfall is 41.45 inches, and the average snowfall is 23 inches. The greatest amounts of precipitation generally occur during the spring and summer months. Records show July to be the rainiest month, averaging 4.35 inches, while February is the driest, producing 2.64 inches of precipitation on average. [23]



2.1.4.3 *Severe Weather*

Philadelphia Severe Annual Average Weather Statistics[24]
Precipitation: 117 days
Thunderstorms: 20 days
Severe Thunderstorms: 2.3 days
Hail: 1 day

Not only does Philadelphia's geographic location mean greater variability in temperature and precipitation throughout the year, the City's situation ensures a variety of severe weather threats occurring throughout the year. Heavy snow, extreme cold, and ice storms are the main winter threats. Droughts, extreme heat, and thunderstorms, which can bring damaging winds, flash flooding, hail and even tornadoes are the primary natural hazards in late spring and summer.

---

[22] Ibid.

[23] Philadelphia Climate Data 2000 to 2015. National Climatic Data Center. NOAA. Retrieved November 3, 2015.

[24] Ibid

2.1.4.4 Climate Change

With the creation of the Mayor's Office of Sustainability, the City of Philadelphia has committed itself to the analysis of climate-related City data, which has helped shape several strategies, reports, and projects to lead to a more sustainable and climate-ready city.[25] Since 1976, every year has been warmer than the 20th century mean. Philadelphia's climate is no exception. In 2013 and 2014, Philadelphia experienced the rainiest summer and the second snowiest winter on record. Forty-nine daily high temperature records have been set in Philadelphia since the year 2000, 18 of them since the year 2010.[26] The sea level around Philadelphia has been rising at a rate of roughly 0.11 inches per year since 1900, equivalent to an increase of nearly one foot in 100 years.[27] Scientists expect these trends to continue in the future, at an accelerating pace and with increasing severity.

The best available climate information suggests that weather in Philadelphia will become warmer and wetter during all seasons in the years and decades ahead, and that the rate of sea level rise will increase, especially toward the end of this century.[28] Much of that warmth and moisture will be concentrated in the form of heat waves and heavy precipitation events (rain or snow)—posing challenges to infrastructure, City services, businesses, and residents.

Sea level rise is a particularly important risk for the City, even though Philadelphia lies 90 miles from the coast. A four-foot rise in sea level increases the extent and extremity of flooding and storm surge.[29] Both flooding and storm surge occur in hurricanes, a known threat for Philadelphia.

In addition, under this same model, more than 30 city-owned facilities, as well as numerous privately held facilities would be highly or moderately vulnerable to flooding due to sea level rise alone.[30] To learn more about the impacts climate change will have on flooding, see the Flooding section of the Risk Assessment.

---

[25] A full list of reports and projects is available online on the Office of Sustainability's website at www.phila.gov/green. Reports include the *Greenworks* progress reports, which detail the City's status in reaching fifteen measurable targets for sustainability, and *Growing Stronger*, a report that details City-level climate adaptation measures and projects.

[26] Pennsylvania State Climatologist, 2015. Retrieved November 3, 2015.

[27] ICF International, 2014. Retrieved November 3, 2015.

[28] Mayor's Office of Sustainability and ICF International. Growing Stronger: Toward a Climate-Ready Philadelphia. November 2015.

[29] Mayor's Office of Sustainability and ICF International. Growing Stronger: Toward a Climate-Ready Philadelphia. November 2015.

[30] Ibid.

2.2 Social Environment

2.2.1 __History__

Long before the area currently known as Philadelphia was settled by Europeans, it was inhabited by Native American tribes. 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 between the Schuylkill and Delaware Rivers. Penn made numerous treaties with the Delaware Indians compensating them for the acquisition of the land.[31] The future city was named Philadelphia from the Greek words "philos" and 'adelphos'. Philos meaning loving and adelphos meaning brother, together Philadelphia became the City of Brotherly Love.[32] [33]

Philadelphia's current ability to grow stems from Penn's early city design plan. 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.[34] Immigration of the Germans and the Scots-Irish and the growth of the port turned Philadelphia into a major city by the 1750s. During the 1770s Philadelphia quickly 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.

---

[31] Lenni-Lenape (Delaware) Indians' History, Culture and Food. Retrieved November 8, 2011.
[32] Online Etymology Dictionary. Douglas Harper. Retrieved February 24, 2012.
[33] Image: Philadelphia. Free Library. Creative Commons License. Retrieved December 28, 2015.
[34] Philadelphia: A 300 Year History. Weigley, Russell Frank. Retrieved December 28, 2015.

Manufacturing in the United States increased in the late 18th century and early 19th century. As a result, manufacturing plants and foundries were built and Philadelphia became an important center of textiles, paper-related industries, and leather industries. Coal and iron mines, along with the construction of new infrastructure and transportation systems helped Philadelphia's manufacturing power grow. From 1800 to 1897 Philadelphia was the leading manufacturing city in the United States. To work within the factories, immigrants mostly from Germany and Ireland streamed into Philadelphia, increasing the population from 41,220 in 1800 to 565,529 by 1860. The city's growth continued until the early 1950's when Philadelphia's population peaked. As in many cities of the Northeast, a decades-long period of de-industrialization resulted in closed factories, population loss, vacant land and urban decay. By 2010, reinvestment and economic diversification stabilized and reversed the decline of population (increasing by 0.6% from 2000 to 2010). [35]

2.2.2 ***Social Characteristics***

The Social Characteristics section contains information on the population, geographic mobility, ethnicity, nativity and language, individuals with disabilities, and education levels for Philadelphians. The information in this section is pulled from the 2014 census data estimates from the American Community Survey (ACS), except where noted. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses.

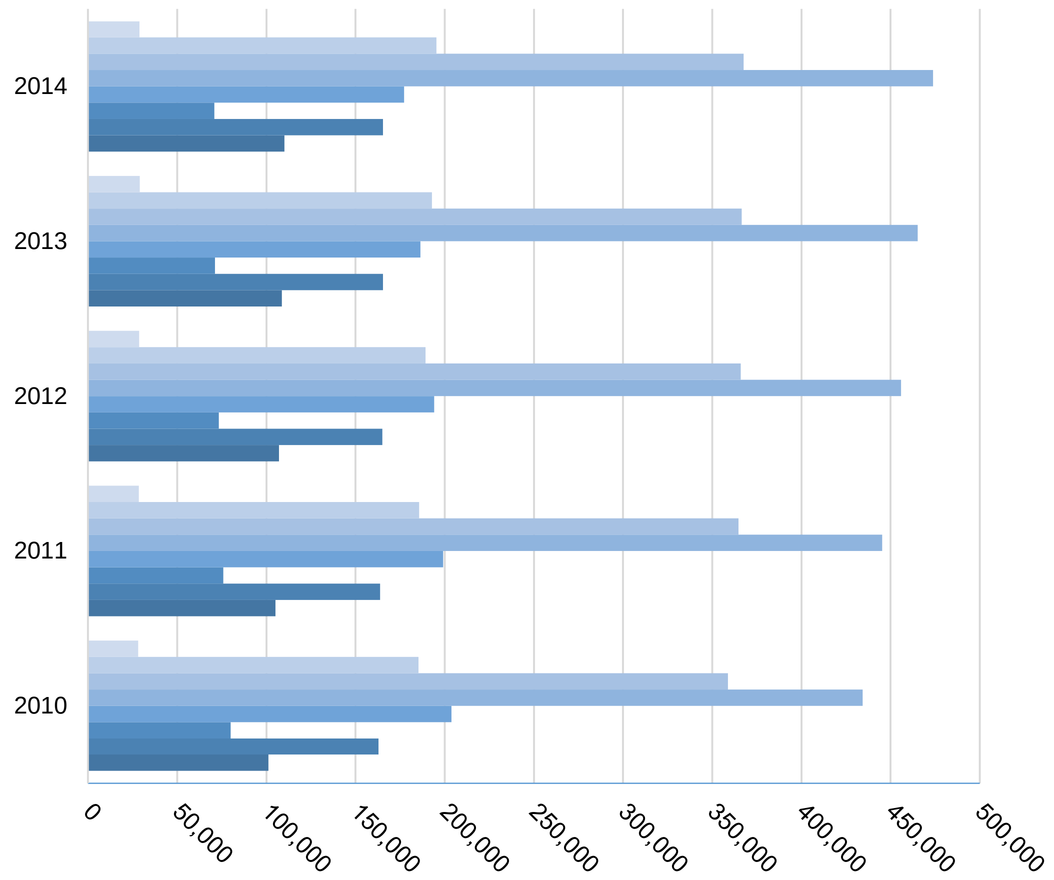
---

[35] Image: Philadelphia. Free Library. Creative Commons License. Retrieved December 28, 2015.

2.2.2.1 *Population*

The city of Philadelphia remains the fifth most populous city in the United States, with an estimated population of 1,560,297 as of 2014[36], up from 1,526,006 in the estimate conducted in 2012. City population continues to grow, and has increased approximately 2.2 percent since 2010, and 0.6 percent since the 2012 Hazard Mitigation Plan.

Annual Population Estimates By Age



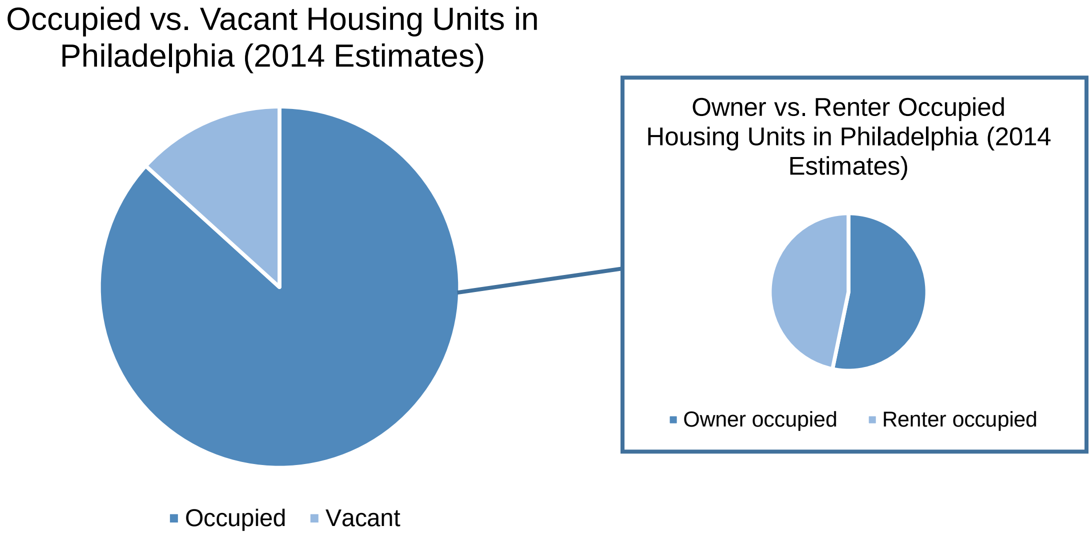
	2010	2011	2012	2013	2014
■ 85 years and over	28,111	28,426	28,710	28,963	28,908
■ 65 years and over	185,309	185,685	189,222	192,772	195,315
■ 45 to 64 years	358,778	364,649	365,996	366,524	367,498
■ 25 to 44 years	434,385	445,308	455,809	465,207	473,857
■ 18 to 24 years	203,697	199,032	194,055	186,393	177,282
■ 14 to 17 years	79,908	75,836	73,314	71,186	70,855
■ 5 to 13 years	162,876	163,737	164,930	165,375	165,364
■ Under 5 years	101,053	105,066	107,070	108,595	110,126

---

[36] Philadelphia. American Community Survey Data. US Census Bureau. Retrieved November 3, 2015.

The median age for Philadelphia residents is 35.3 years according to 2014 estimates, a small increase since the 2012 data. There are an estimated 668,806 housing units in the city, 580,017 of which are estimated to be occupied[37]. Of these units, 308,931 (53 percent) are owner occupied, and 271,086 (47 percent) are renter occupied.[38]

For the purposes of risk management, this division implies a difference in insurance coverage which impacts long-term recovery. Renters insurance coverage exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Vacant homes without insurance can also impact long-term recovery. Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[39] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The charts below illustrates the renter versus owner occupancy breakdown of occupied properties.



Within Philadelphia, 3,347 households (0.5 percent) lack complete plumbing facilities[40], and 22,490 households (3.4 percent) have no telephone (home and/or cell phones) service available. Housing units without sufficient plumbing pose additional challenges to situations that may require sheltering in place. Those households without a phone available also pose a challenge for emergency responders in sending emergency notifications or relaying updated information during an incident.

According to the most recent data, approximately 241,266 people commute into Philadelphia for work, while 149,903 commute from the County for employment

---

[37] American Community Survey: Philadelphia, 2013, 5 Year Summary. United States Census Bureau.
[38] Ibid.
[39] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.
[40] Complete plumbing facilities include: Hot and cold running water; a flush toilet; a bathtub or shower.

elsewhere.[41] This leads to a 91,363 net gain in daytime population, increasing the total population of Philadelphia to approximately 1,652,660 during daytime working hours. The chart below details the inbound and outbound population change by county.

Average Daily Inbound and Outbound Population by County			
County	Inbound to Philadelphia	Outbound from Philadelphia	Population Gain
Bucks County	35,140	28,905	6,235
Montgomery County	64,751	62,574	2,177
Chester County	16,689	10,488	6,201
Delaware County	57,122	26,028	31,094
New Castle County	6,482	2,976	3,506
Gloucester County	14,488	2,701	11,787
Camden County	29,087	10,033	19,054
Burlington County	17,507	6,198	11,309
Total	241,266	149,903	91,363

2.2.2.2 Vulnerable and Disabled Populations

Vulnerable populations are those individuals who are at increased risk for negative impact in the event of an emergency incident due to financial circumstances, health, age (over 65 and under 5), functional status, developmental status, ability to communicate effectively, presence of chronic or terminal illness, or disability.

Philadelphia has an exceptionally high percentage of vulnerable populations, with 26.5 percent of citizens living below the federal poverty line as of the most recent 2013 estimates, which is double the percentage of the state as a whole.[42] This represents a decline of 0.6 percent from 2012 estimates. Philadelphia residents under the age of five make up seven percent of the population, while those over the age of 65 make up 12.4 percent.[43]

There are six disability types reflected in the most recent version of the ACS: hearing, vision, cognitive, ambulatory, self-care, and independent living disability. 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”.[44]

---

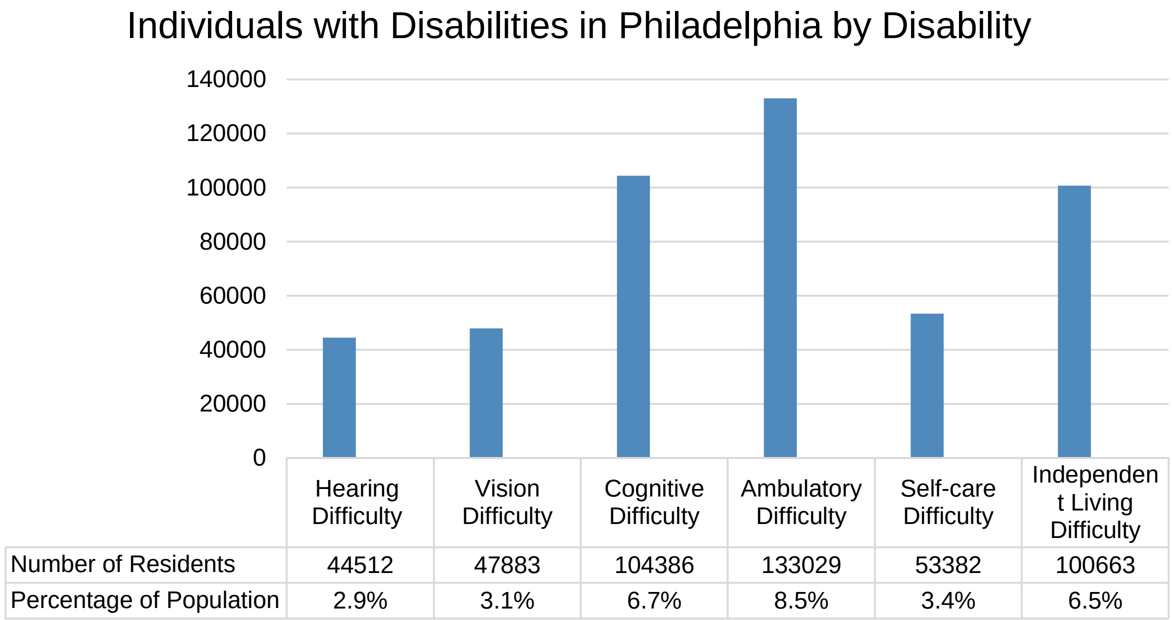
[41] Pew Trusts. State of the City Report: Philadelphia. 2015.

[42] State and County QuickFacts: Philadelphia County, Pennsylvania. Retrieved November 3, 2015.

[43] Ibid.

[44] United States Census Bureau. American Community Survey: Disability. Retrieved November 20, 2015.

The chart below details the number and percentage of Philadelphia residents who reported having one or more disabilities that may require additional assistance in the event of an emergency.[45]


Individuals with Disabilities in Philadelphia by Disability

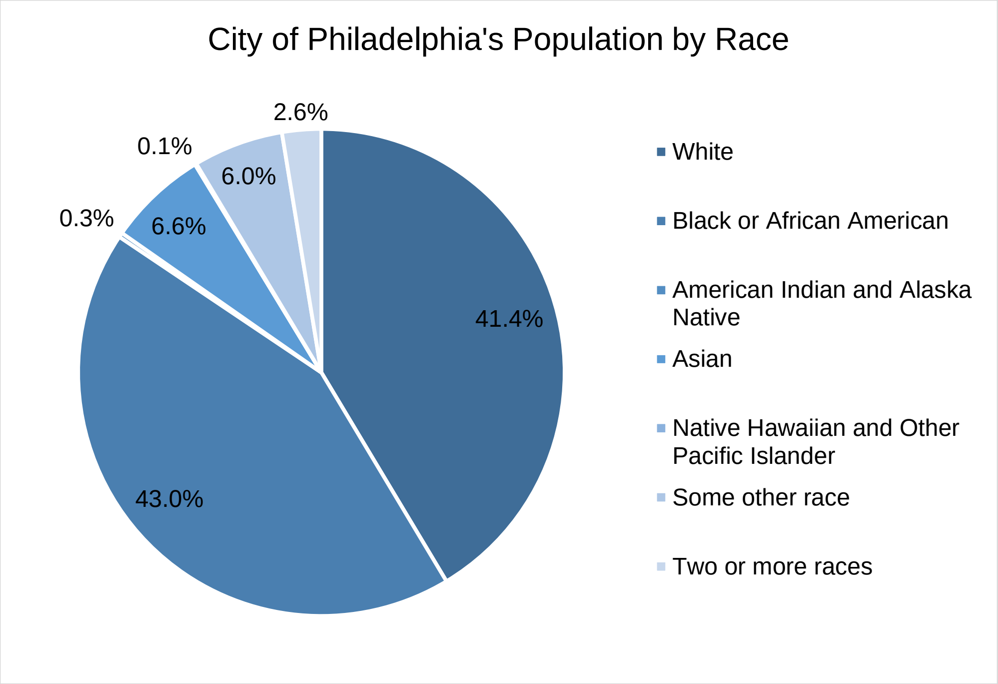
	Hearing Difficulty	Vision Difficulty	Cognitive Difficulty	Ambulatory Difficulty	Self-care Difficulty	Independent Living Difficulty
Number of Residents	44512	47883	104386	133029	53382	100663
Percentage of Population	2.9%	3.1%	6.7%	8.5%	3.4%	6.5%

---

[45] Ibid.

2.2.2.3 *Ethnicity*

Philadelphia is an ethnically and culturally diverse city, with 43.0 percent of the population identifying as Black or African American, 41.4 percent identifying as White, 6.6 percent identifying as Asian, 6.0 percent identifying as another race, and 0.3 percent identifying as American Indian.



2.2.2.4 *Geographic Mobility*

Of the people one year or older residing in Philadelphia:

- 85.8 percent were living in the same residence one year earlier according to the 2013-2014 ACS;
- 9.7 percent had moved during the past year from another residence within Philadelphia,
- 1.6 percent moved to Philadelphia from another county in Pennsylvania,
- 2.1 percent moved from another state, and 0.8 percent moved from abroad.[46]

Compared to the rest of the United States, Philadelphia's geographic mobility is slightly higher for moves within the same county and for moves out of the state; however, the City's moves from Philadelphia to another county within Pennsylvania are slightly lower.[47]

---

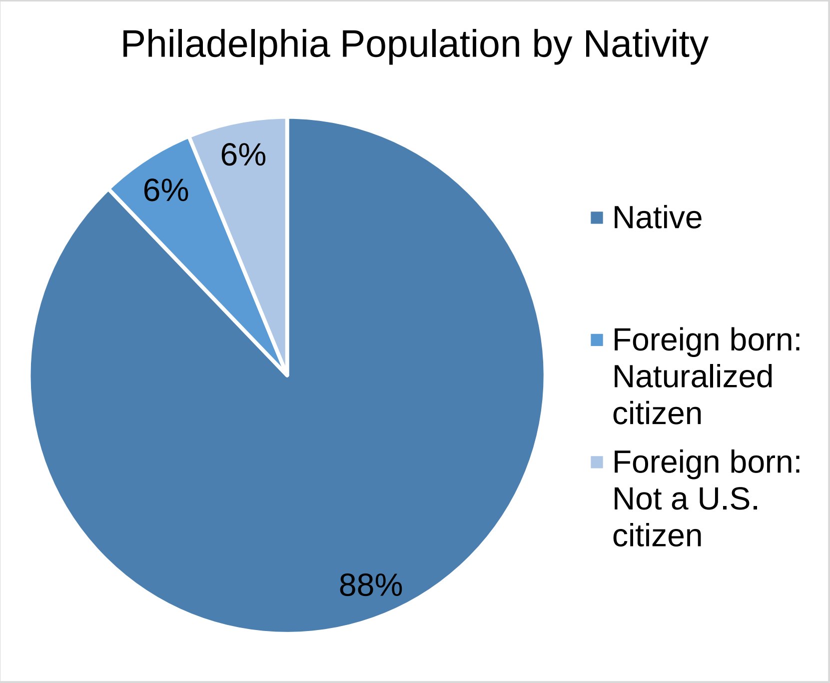
[46] Geographic Mobility. American Community Survey. United States Census 2013-2014. Retrieved November 3, 2015.

[47] Migration/Geographic Mobility. United States. United States Census. Retrieved December 28, 2015.

2.2.2.5 Nativity and Language

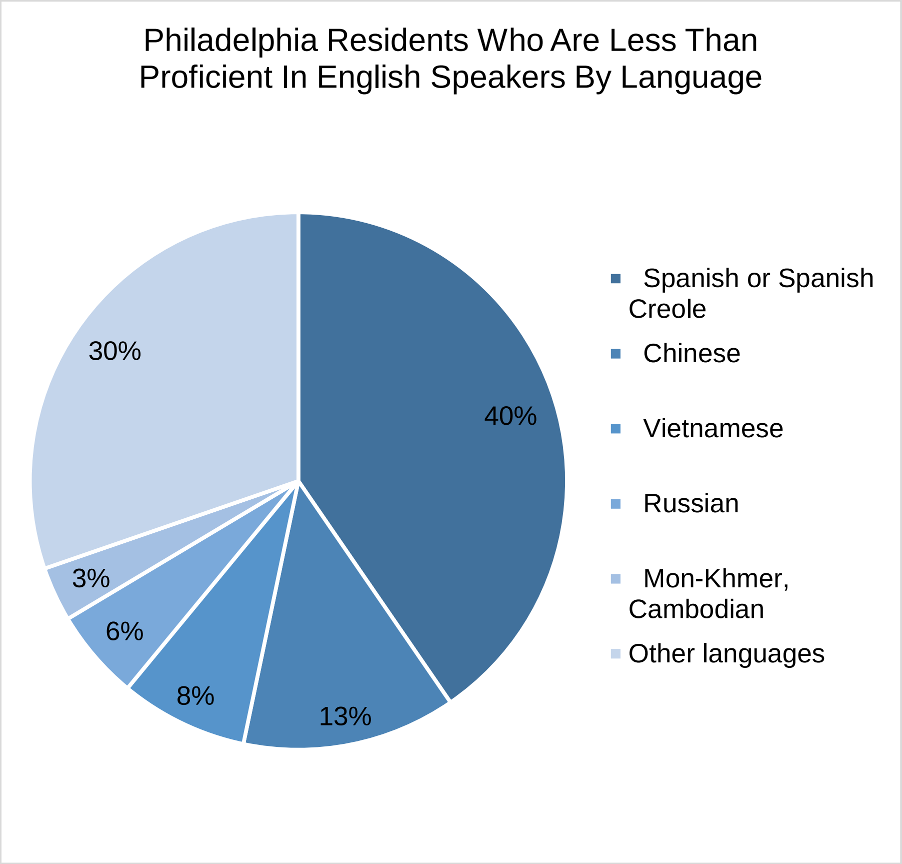
2.2.2.5.1 Nativity

According to the most recent data, 12.2 percent of the people living in Philadelphia are foreign born, and 49.0 percent of those individuals are naturalized citizens. Approximately 88.0 percent of Philadelphia residents are U.S. born. The graph below depicts the population breakdown of Philadelphia by nativity.



2.2.2.5.2 Language

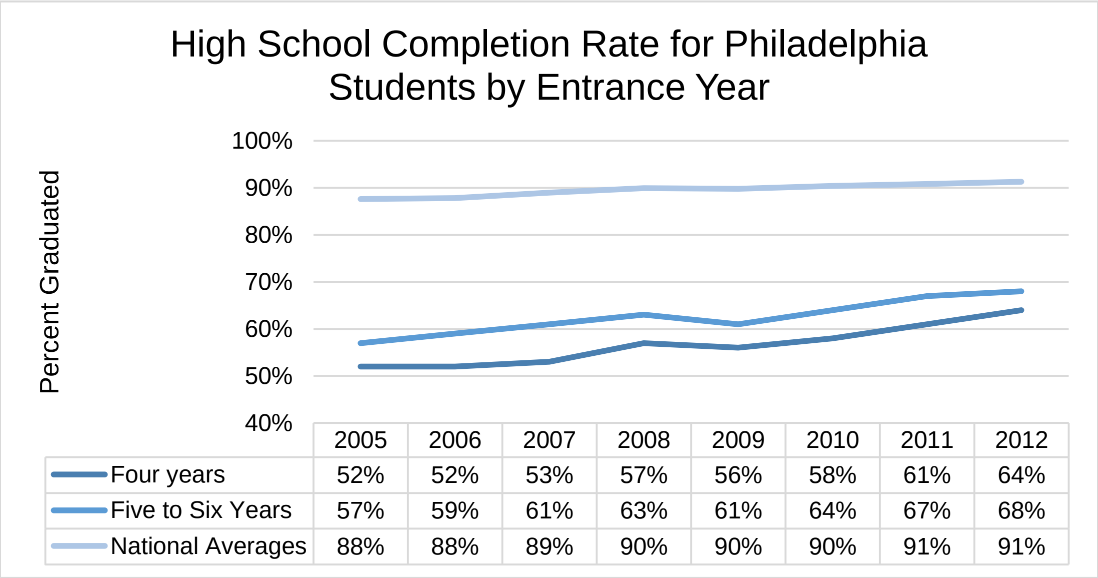
As of 2014, 7.2 percent of the households in Philadelphia are linguistically isolated, meaning all adults in a household have some limitation in communicating in English. If these households include children under the age of 14 who speak English, those children would be considered linguistically isolated. Emergency responders may have difficulty communicating instructions during emergencies to less than proficient English speakers. The chart below details those households in Philadelphia who self-identify as less than proficient in English.



2.2.2.6 Education

According to the 2013 American Community Survey, 81.2 percent of people 25 years and over in Philadelphia had at least graduated from high school, and 23.9 percent had a bachelor's degree or higher. The 2013 ACS identified total school enrollment in Philadelphia for the population ages three years and over as 421,991, with 26,924 enrolled in nursery school or pre-school, 243,054 enrolled in elementary through high school, and 152,013 enrolled in college/graduate school.[48]

The number of high school graduates increased over the past nine years, but still remains well below national and state averages. The chart below shows Philadelphia's graduation rates in comparison to national averages by year.[49] [50]



High School Completion Rate for Philadelphia Students by Entrance Year

	2005	2006	2007	2008	2009	2010	2011	2012
Four years	52%	52%	53%	57%	56%	58%	61%	64%
Five to Six Years	57%	59%	61%	63%	61%	64%	67%	68%
National Averages	88%	88%	89%	90%	90%	90%	91%	91%

---

[48] High School Completion Rate: Philadelphia. 2013 American Community Survey. United States Census. Retrieved December 28, 2015.

[49] High School Completion Rate: Philadelphia. 2013 American Community Survey. United States Census. Retrieved December 28, 2015.

[50] Trends in High School Dropout and Completion Rates in the United States: 1972–2012. U.S. Department of Education. NCES 2015-015. Retrieved December 28, 2015.

2.2.2.7 Colleges and Universities

Philadelphia has a large number of colleges, universities, continuing education institutions, and technical schools within its borders. Schools 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

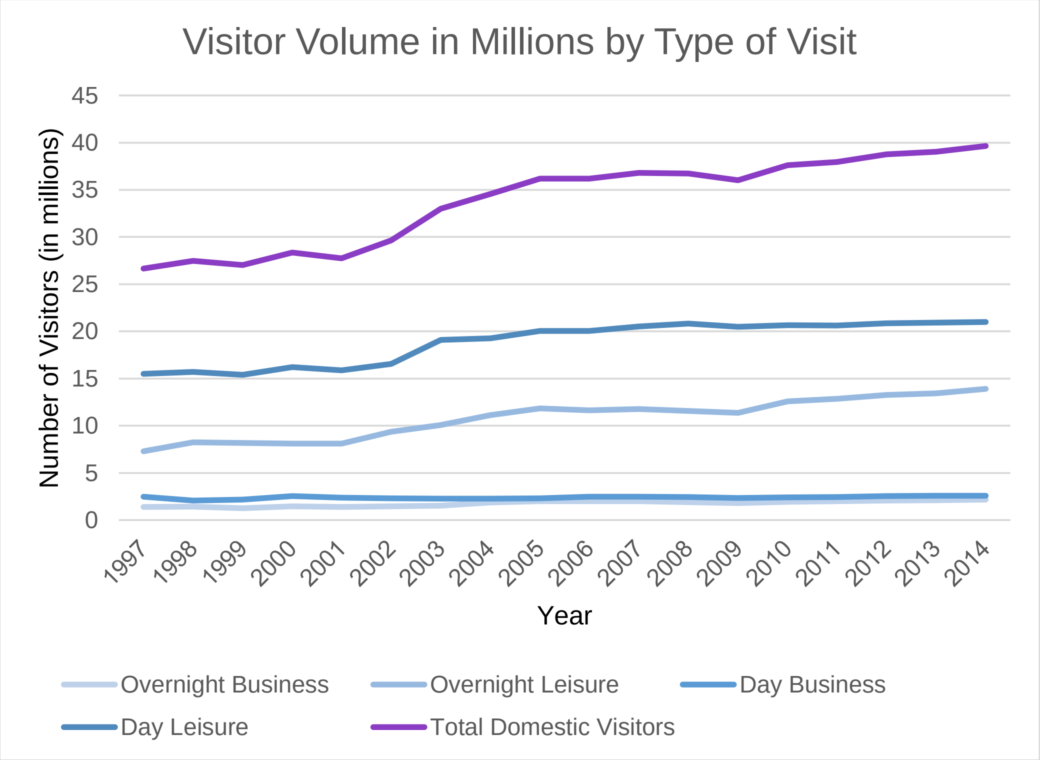
Combined, resident student populations exceed 130,600.[51] College and university students make up nearly nine percent of Philadelphia’s overall residency population.

---

[51] “Philadelphia, Pennsylvania”. City Data. Retrieved November 3, 2015.

2.2.2.8 Tourism

Tourism is the sixth-largest industry in greater Philadelphia, providing $10 billion in economic impact and 90,000 full-time jobs.[52] [53] The city hosts several high profile annual events that draw people to the region, such as the July 4th celebration and the Thanksgiving Day parade. Tourists dynamically affect Philadelphia's population. As a transient population, tourists may have transportation, language, and accessibility needs during a disaster not captured in city-specific Census data. The graph below depicts tourism trends in Philadelphia by type of stay.[54]



> *"Philadelphia continues to see an increasing trend in tourism, with 39.7 million visitors in 2014 alone."*

---

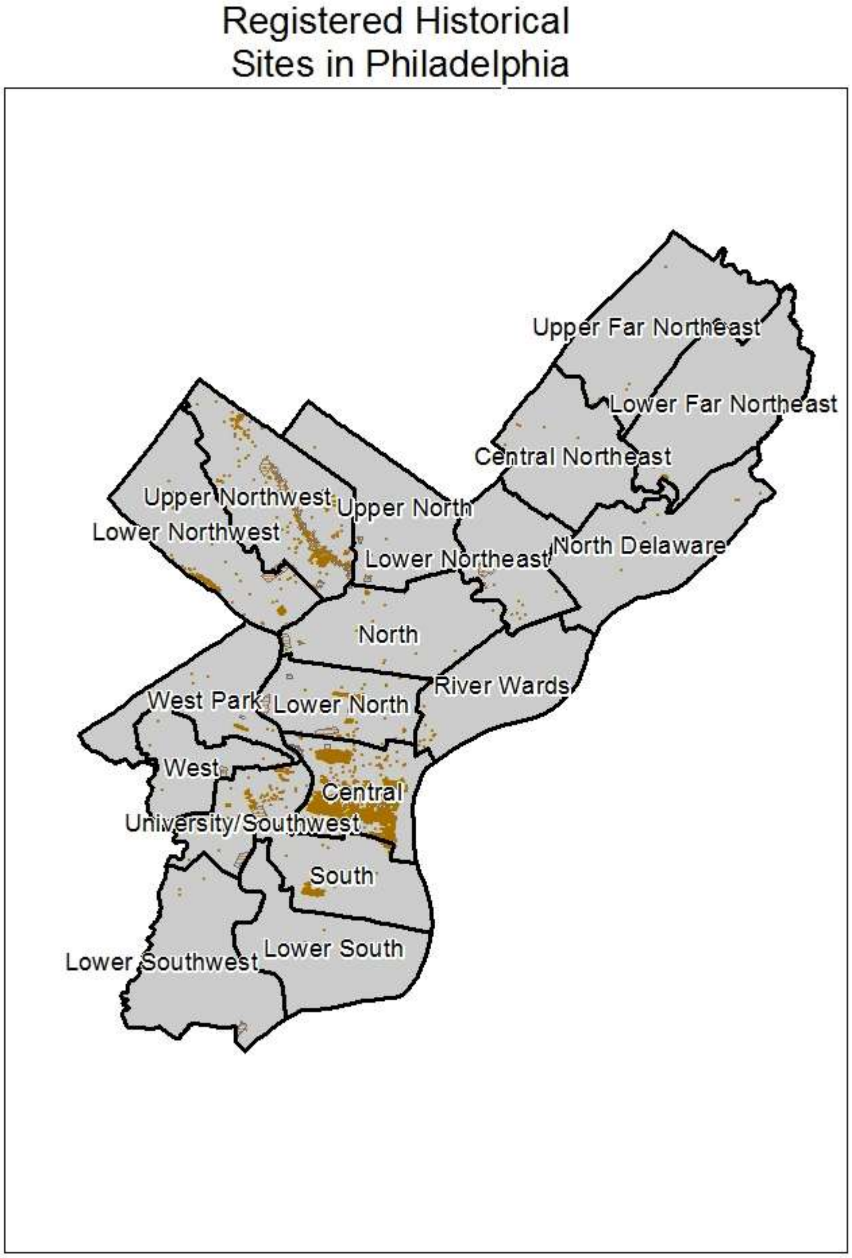
[52] "Visit Philadelphia 2014 Annual Report: Executive Summary". Visit Philadelphia. November 3, 2015.

[53] Ibid.

[54] "Visit Philadelphia 2014 Annual Report". Visit Philadelphia. November 3, 2015.

2.2.2.9 Historical significance

Philadelphia is one of the oldest cities in the nation, and as such has numerous historically significant sites. These include the Betsy Ross House, Independence Hall, the Liberty Bell, and the Constitution Center, with numerous more varying in size and recognition throughout the city. The map below shows the distribution and concentration of historical sites registered with the City of Philadelphia.

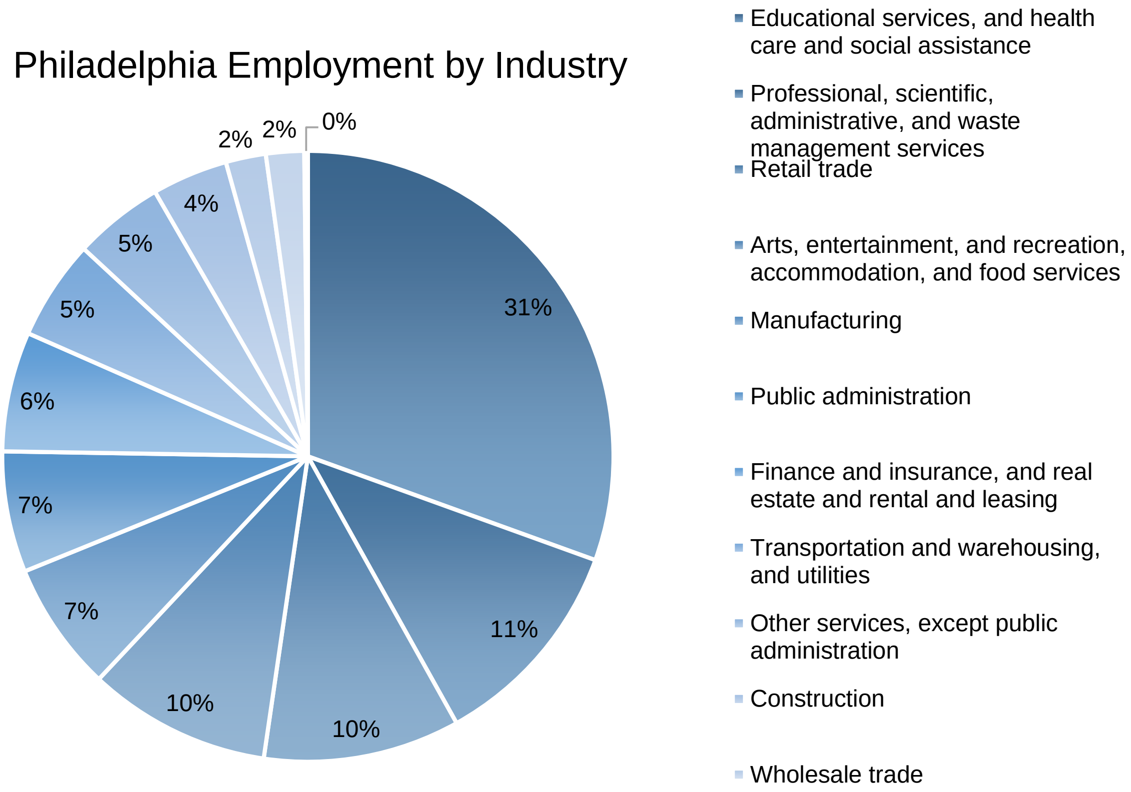


2.2.3 <u>Economic Characteristics</u>

2.2.3.1 Industries

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 and information technology have emerged strongly as principal drivers of the economy.

The educational services, healthcare, and social assistance industries employ the greatest portion of the City’s working population, with 30.0 percent of residents working in these sectors. The chart on the following page depicts the complete breakdown of Philadelphia’s employment by industry.



Industry	Individuals Employed	Percentage Employed	Industry	Individuals Employed	Percentage Employed
Educational services, and health care and social assistance	188,938	31%	Finance and insurance, and real estate and rental and leasing	39,237	6%
Professional, scientific, administrative, and waste management services	70,523	11%	Transportation and warehousing, and utilities	32,800	5%
Retail trade	64,384	10%	Other services, except public administration	29,526	5%
Arts, entertainment, and recreation, accommodation, and food services	59,917	10%	Construction	24,837	4%
Manufacturing	42,522	7%	Wholesale trade	13,123	2%
Public administration	39,645	6%	Information	12,494	2%
			Agriculture, forestry, fishing and hunting, and mining	1,148	0%

Since the completion of the 2012 Hazard Mitigation Plan, Philadelphia continues to see a modest increase in the growth of manufacturing and general service-sector firms. Philadelphia's gross domestic product (GDP) per capita decreased 0.5 percent from 2013 to 2014 alone.[55] Philadelphia headquarters several Fortune 1000 companies.[56] Fortune 1000 companies located in Philadelphia are listed below.

Company Headquartered	Industry	Rank
Comcast	Telecommunications	44
Aramark	Hospitality	209
Crown Holdings	Packaging	313
FMC	Chemicals	581
Urban Outfitters	Apparel	715
Chemtura	Manufacturing	775
Pep Boys	Automotive	945

In addition to the Fortune 1000 companies located in Philadelphia, there are thousands of businesses that are located in the City's borders. The largest private employers in Philadelphia include The Trustees of the University of Pennsylvania, Children's Hospital of Pennsylvania, Thomas Jefferson University Hospital, Temple University, Albert Einstein Medical Center, Temple University Hospital, Independence Blue Cross, Drexel University, Thomas Jefferson University, Allied Barton Security Services, Comcast, Pennsylvania Hospital, Aria Health, and Hahnemann University Hospital.[57]

---

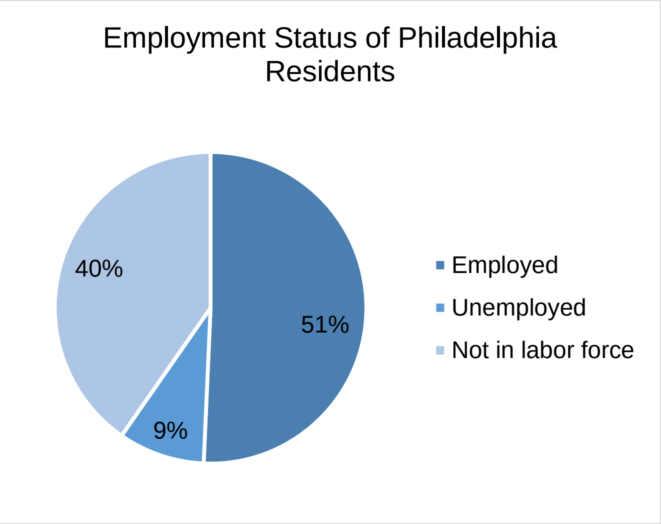
[55] "Beige Book – July 15, 2015: Third District Philadelphia". Board of Governors of the Federal Reserve System. Retrieved November 3, 2015.

[56] "Global MetroMonitor 2014: An Uncertain Recovery". Brookings Institute. Retrieved November 3, 2015.

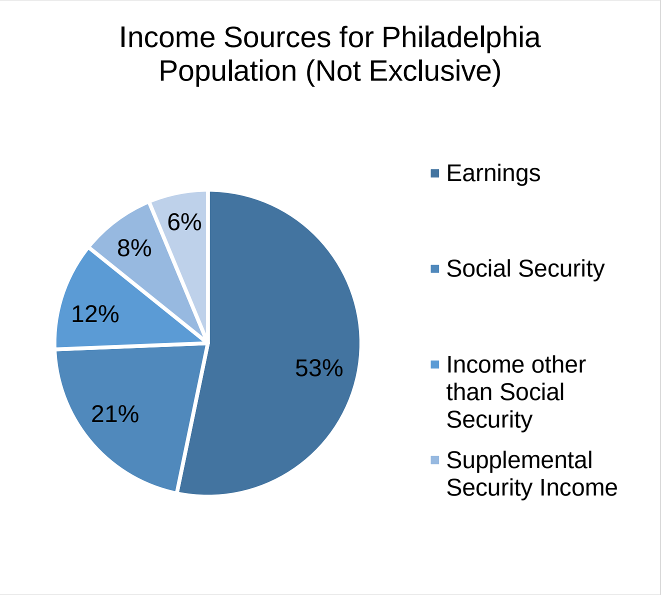
[57] "State of the City Report: Philadelphia". Pew Trusts. Retrieved November 4, 2015.

2.2.3.2 Income

As of the 2013-2014 American Community Survey (ACS), the median income of Philadelphia households is $37,192, a decrease of $523 from the amount reported in the 2012 Hazard Mitigation Plan (HMP). Of those 16 years and older, 50.3 percent of Philadelphians are employed, while 8.9 percent of the civilian labor force is unemployed.[58] Forty percent of Philadelphians are not in the labor force. The graph below depicts the breakdown of the employment status of Philadelphia residents.



70.4 percent of Philadelphia households received their income through earnings, while 27.9 percent received Social Security, and 15.1 percent received retirement income other than Social Security.[59] 10.5 percent of Philadelphians received Supplemental Security Income and 8.3 percent received public assistance income, with a mean cash public assistance income of $2,954.[60] Some households received income from more than one source. The chart to the right displays this breakdown.



---

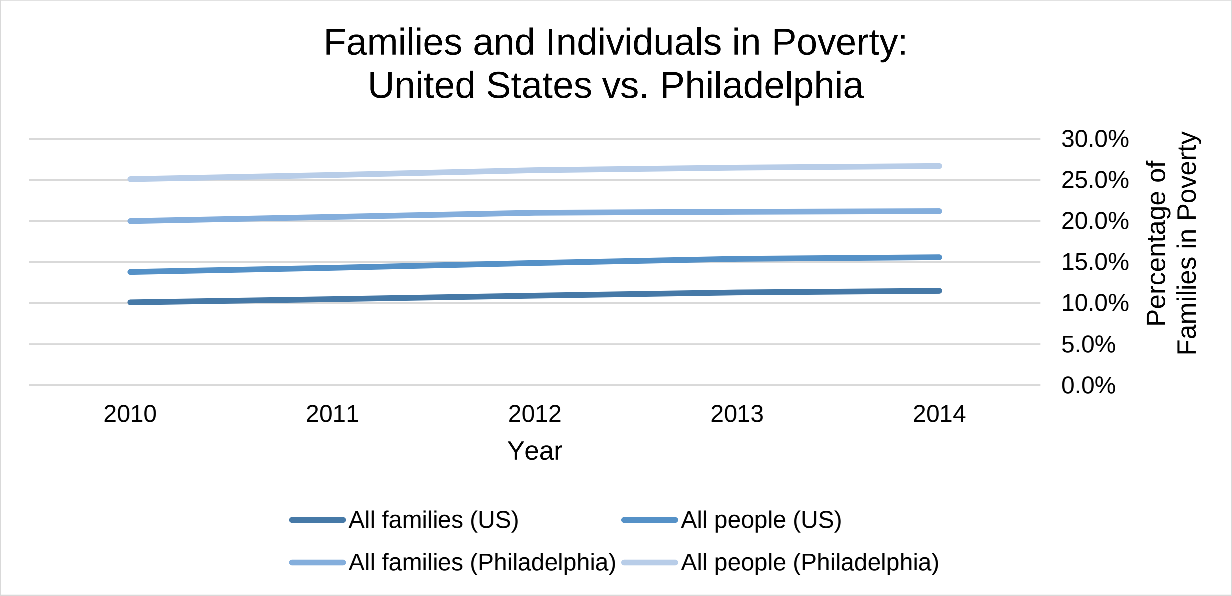
[58] Unemployed status includes all persons who had no employment, but are available for work and made specific efforts to find employment sometime in the last 4 week-period.

[59] Unemployment: Philadelphia. American Community Survey. Retrieved November 4, 2015.

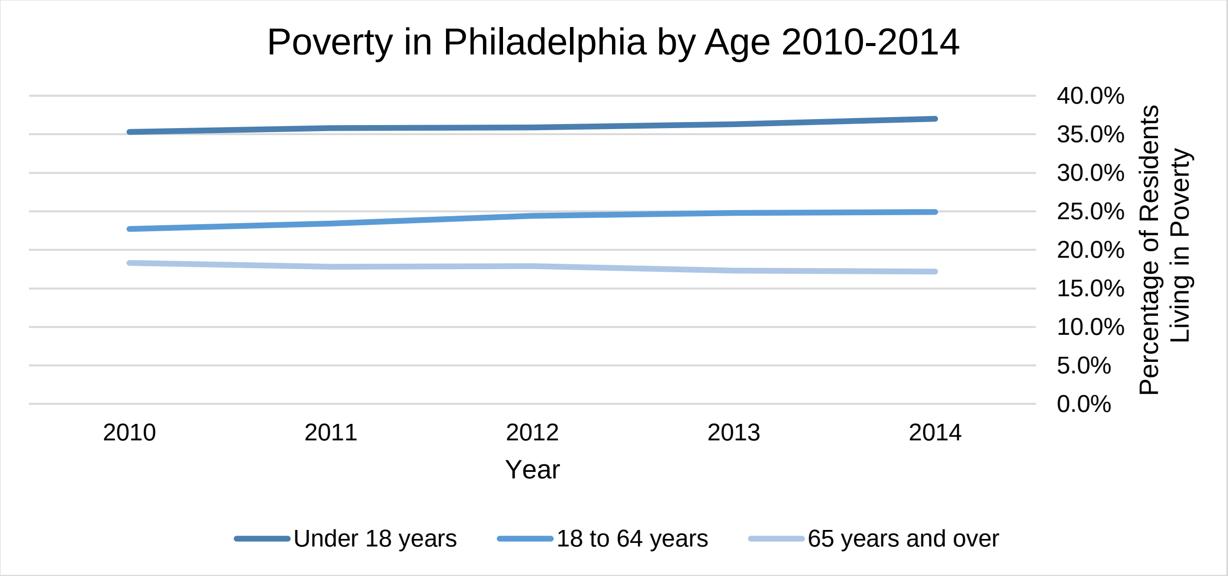
[60] Ibid.

2.2.3.3 Poverty and Participation in Government Programs

The Census Bureau defines poverty as the total income for a family or unrelated individual falls below the relevant poverty threshold, as set by the U.S. Office of Management and Budget (OMB) Directive 14. As of the 2013-2014 ACS, 26.5 percent of all Philadelphians were living below the poverty level. With the national average poverty level down to 14.5 percent, Philadelphia's poverty rate is 45.0 percent higher than the national average.



Of these individuals, 36.3 percent of children under 18 were living in poverty, an increase of 2.3 percent since the 2012 Hazard Mitigation Plan. In the older population, 17.3 percent of people 65 years old and over were living in poverty, a decrease of 1.7 percent from the last iteration of the Hazard Mitigation Plan.



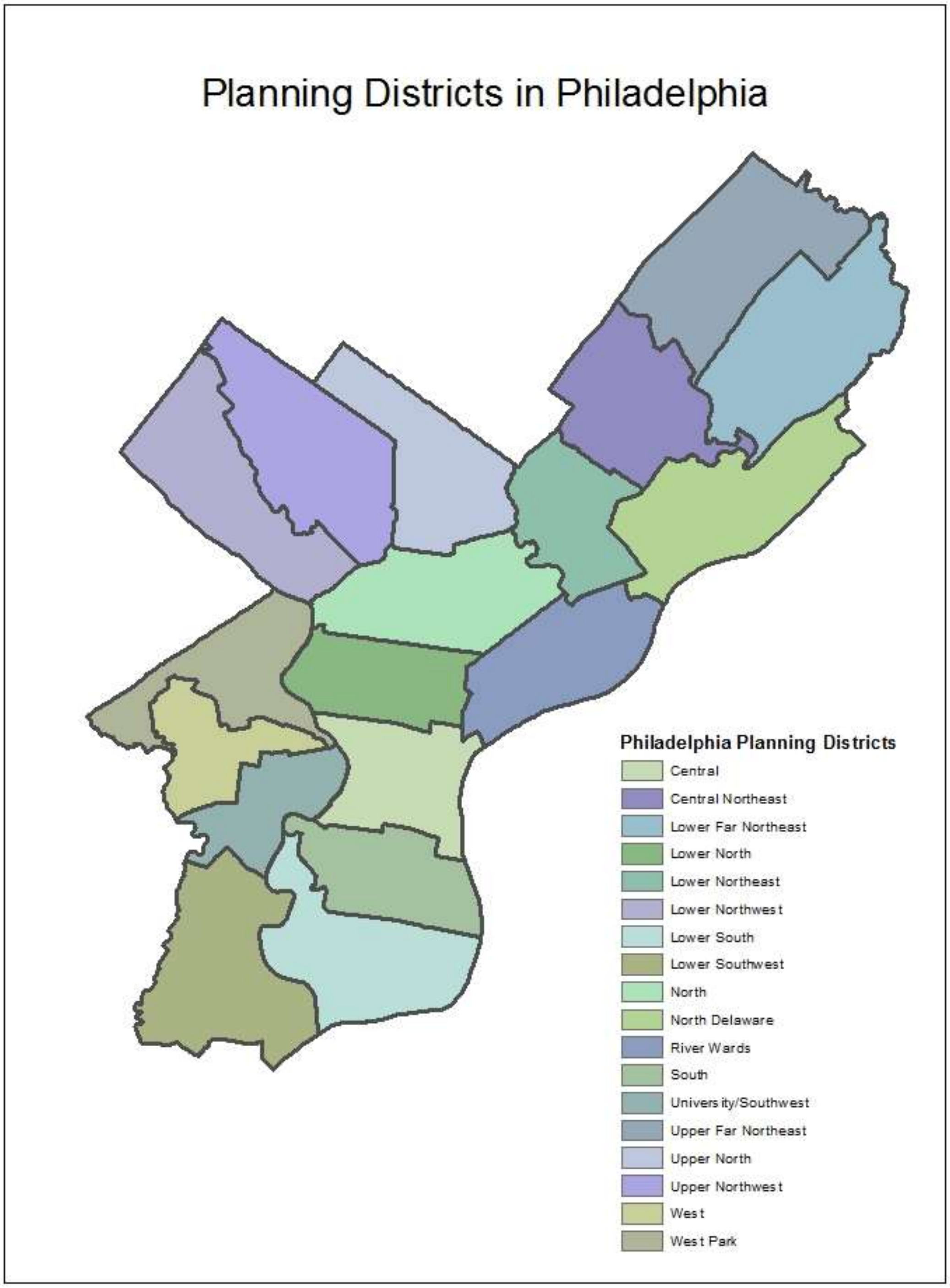
Of those employed, 9.8 percent of the civilian labor force over the age of 16 were living in poverty, while 38.9 percent of the civilian labor force were unemployed and living in poverty.

2.3 Built Environment

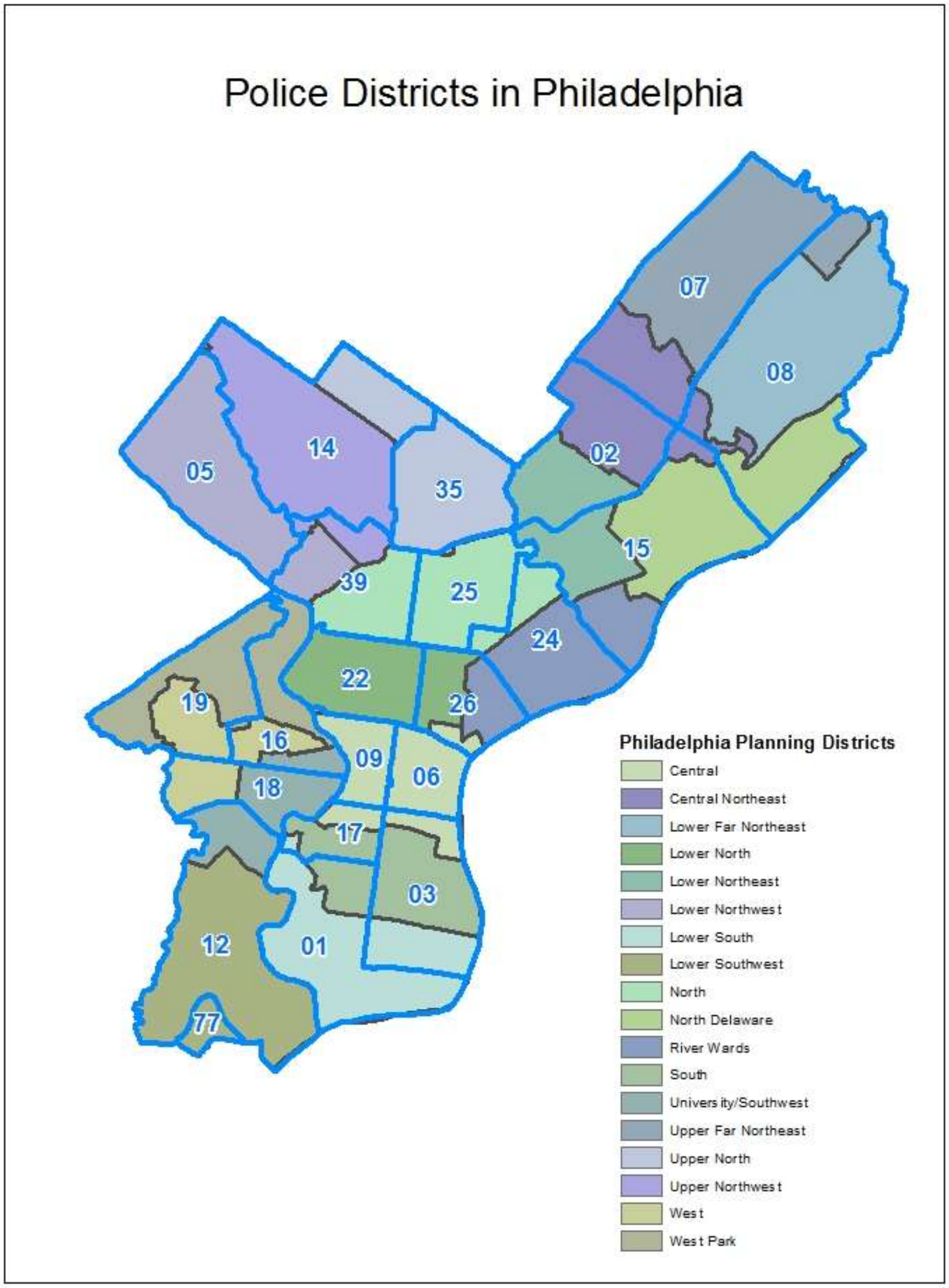
This section presents information on the built environment of the County, including neighborhoods, and land use and infrastructure.

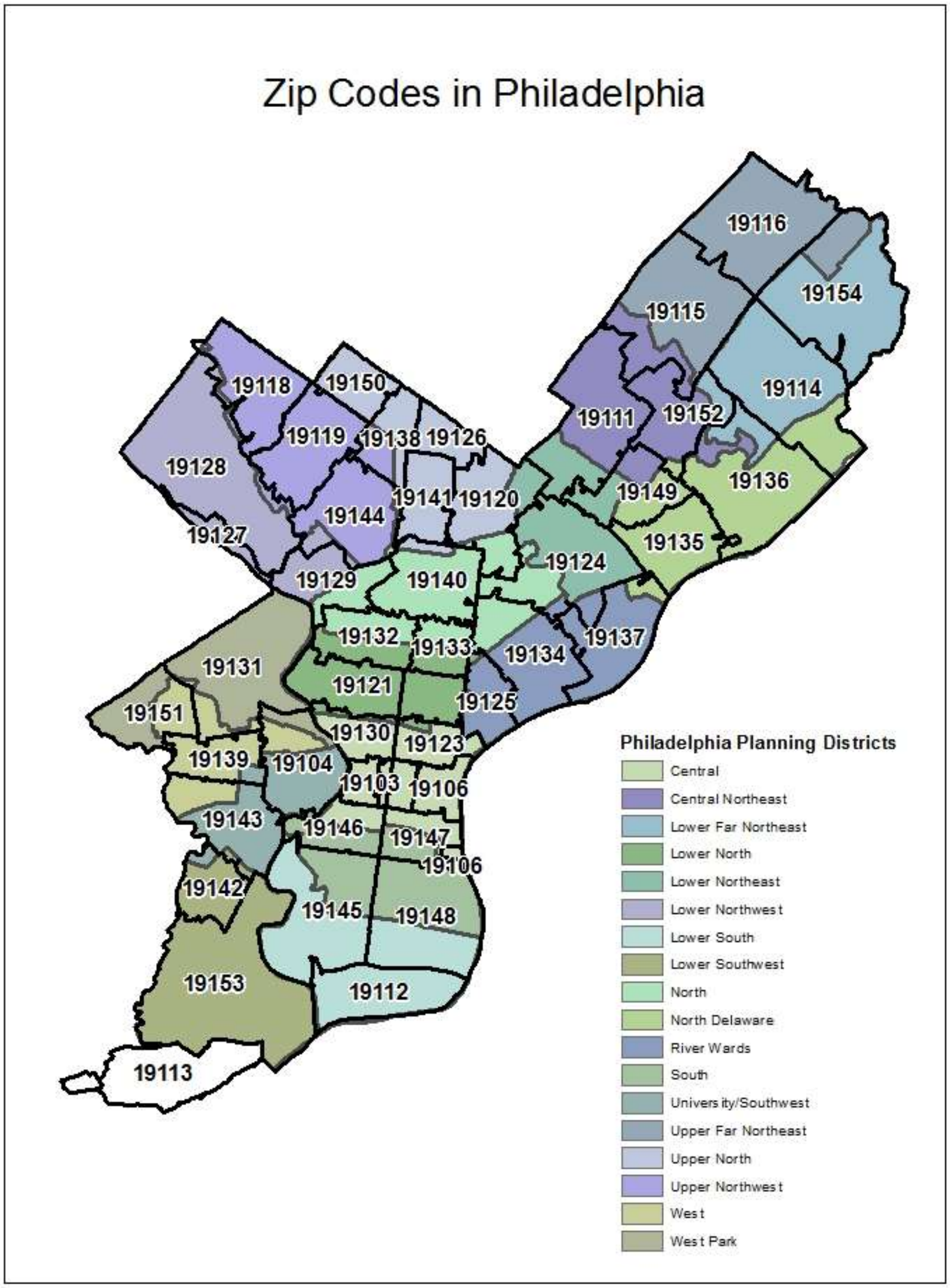
2.3.1 Districting

Philadelphia City Planning Commission (PCPC) aggregated Philadelphia neighborhoods into 18 planning analysis sections, as shown in the map below.



These districts overlap with 21 police districts, 11 fire battalion districts, and 48 zip codes within the City.





Zip Codes in Philadelphia

2.3.2 Land Use

Philadelphia has a diverse and growing population and expanding commercial and industrial sectors. Land use within the City reflects how Philadelphia businesses, residents, and government agencies use land in the city.

Land use also demonstrates the growing number of green spaces in the City. Green space is land that is partly or completely covered with grass, trees, shrubs, or other vegetation.[61] Green space includes parks, community gardens, and cemeteries. Philadelphia houses one of the largest metropolitan park systems in the United States. These green spaces also contain more than 200 historic buildings and 250 pieces of sculpture, comprising one of the largest collections of cultural and historic resources in the Commonwealth of Pennsylvania.[62]

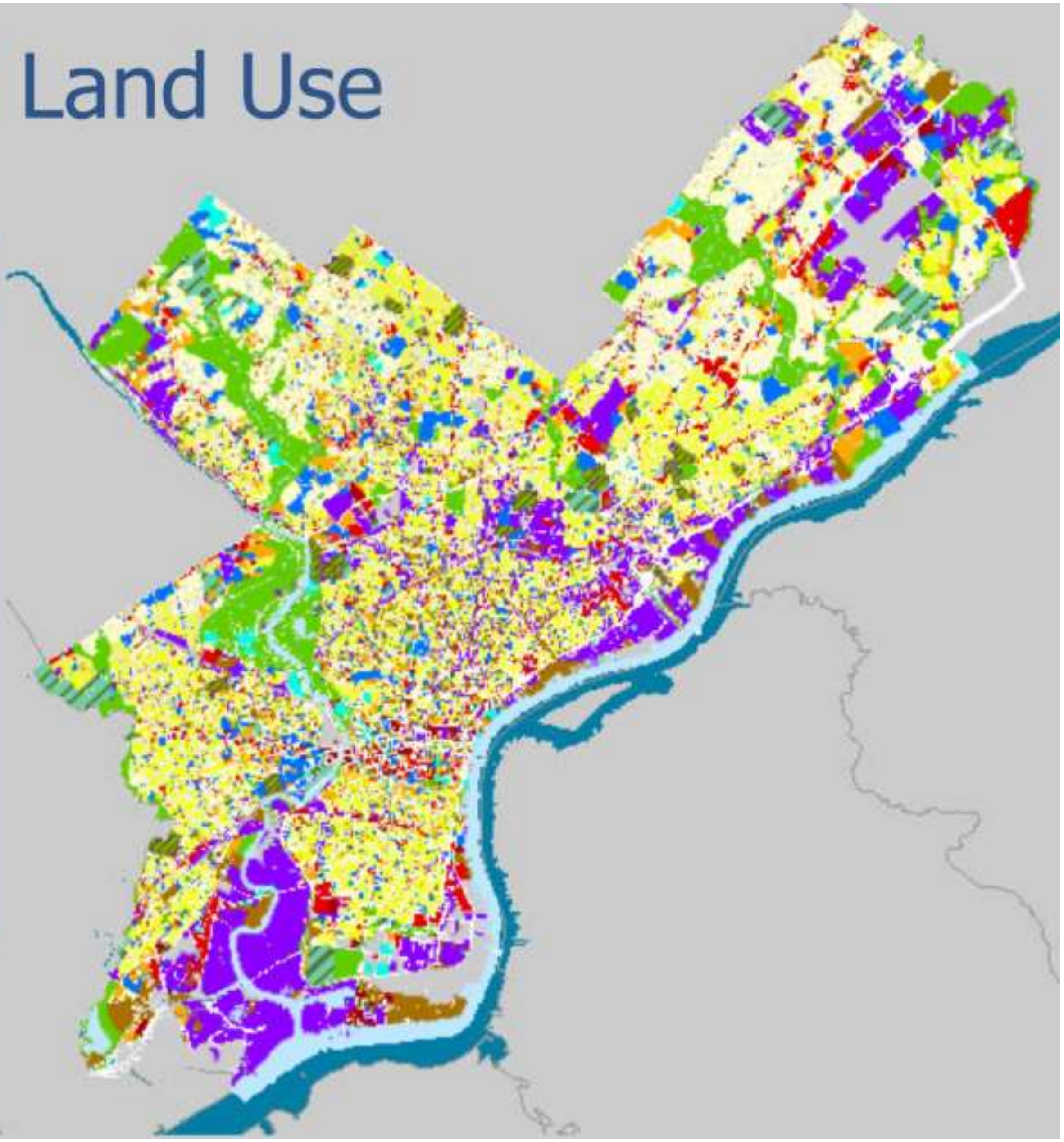
As seen in the image on the following page, land usage is diverse across the city. Outside of industrial and open space land use, much of the different land uses are scattered across the city. Industrial areas are next to commercial, commercial areas are next to residential. Land use varies greatly block-to-block within the City.

---

[61] "What is Open Space/Green Space?" United States Environmental Protection Agency. Retrieved February 10, 2016.

[62] Philadelphia Parks and Recreation. Philadelphia Park System History. Retrieved November 20, 2015.

Philadelphia Land Use



Map Legend

Landuse

Land Use

- ⬜ Residential Low
- 🟨 Residential Medium
- 🟧 Residential High
- 🟥 Commercial Consumer
- 🟥 Commerical Business/Professional
- 🟧 Commerical Mixed Residential
- 🟪 Industrial
- 🟦 Civic/Institution
- ⬜ Transportation
- 🟦 Culture/Amusement
- ▨ Active Recreation
- 🟩 Park/Open Space
- ▨ Cemetery
- 🟦 Water
- 🟫 Vacant
- ▨ Other/Unknown

2.3.2.1 Future Land Use

Since the creation and implementation of the Phila2035 comprehensive planning process, PCPC and other City agencies developed district plans to provide recommendations on future land use, development opportunities, urban design scenarios, and proposed zoning. Philadelphia City Council and PCPC adopt these plans on a district-by-district basis.

2.3.3 Housing

The housing data for Philadelphia provides an overview of housing occupancy, number of units in a housing structure, number of housing units built by decade, whether the occupants own or rent the unit, average household size, and the year the household moved into the unit. Philadelphia has a total of 668,806 housing units in the city. Of these housing units, 13.3 percent are vacant. Pennsylvania's vacancy rate is 2.2 percent, far less than that of Philadelphia. The table below demonstrates the breakdown of Philadelphia's housing occupancy by ownership type.

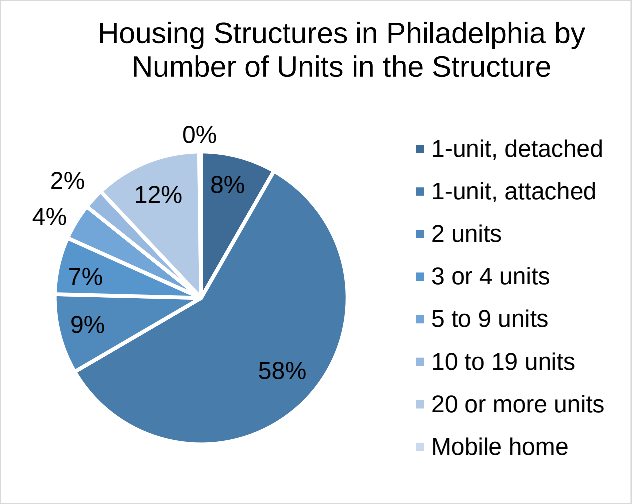
Philadelphia Housing Occupancy		
Total housing units	668,806	N/A
Occupied housing units	580,017	86.7%
Vacant housing units	88,789	13.3%
Homeowner vacancy rate[63]	2.9	N/A
Rental vacancy rate[64]	7.5	N/A

---

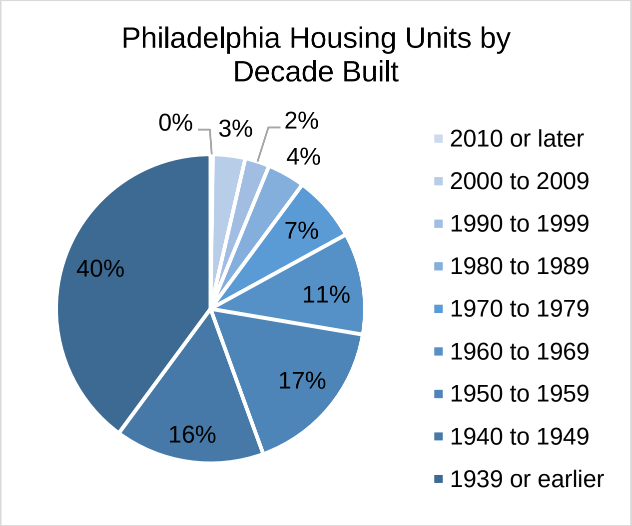
[63] Homeowner vacancy rate is the proportion of the homeowner housing inventory which is vacant for sale. The Census computes this by dividing the number of vacant units for sale only by the sum of owner-occupied units and vacant units that are for sale only, and then multiplying by 100.

[64] Rental vacancy rate is the proportion of the rental inventory which is vacant for rent. The Census computes the rate by dividing the number of vacant units for rent by the sum of the renter-occupied units and the number of vacant units for rent, and then multiplying by 100.

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. The chart to the right shows the varied types of housing structures built in Philadelphia.



Philadelphia housing units are largely aging structures, with most units built prior to 1939. These features, along with high vacancy rates, cause greater risk of fire to housing units across the city.[65] The chart to the right shows the housing units by the decade built.



2.3.3.1 Housing Costs and Housing Cost Burden

As of the 2014 ACS, the median monthly housing costs for homeowners was $921. When households spend more than 30 percent of their income on housing, housing is considered to be a cost burden on that household. As of 2014, 30.9 percent of home owners and 51.4 percent of renters in Philadelphia County experienced a housing cost burden in Philadelphia. When households spend more than half of their income on housing costs, they are severely cost-burdened. 12.8 percent of homeowners and 30.5

---

[65] Income, Housing, and Fire Injuries: A Census Tract Analysis. Shai, Donna. NCBI NIH. Retrieved December 23, 2015.

percent of renters in Philadelphia are severely cost-burdened.[66] The Philadelphia-Camden-Wilmington metropolitan area ranks 82nd out of 381 metros for housing cost burdens.[67] Higher costs burdens can contribute to increased poverty rates.

2.3.3.2 Population Density

There has been no updated population density estimate since the 2010 U.S. Census. In 2010, the population density was 11,233.6/mi^2. The highest density areas are in Center City, South Philadelphia, and portions of West Philadelphia. The Delaware Valley metropolitan area has the third highest population density of metropolitan areas in the United States. The New York metropolitan area and the greater Los Angeles area are the leading two areas in terms of population density. New York, Chicago and Philadelphia are the only cities in the United States that have both a population over one million and a population density of over 10,000 people per square mile.

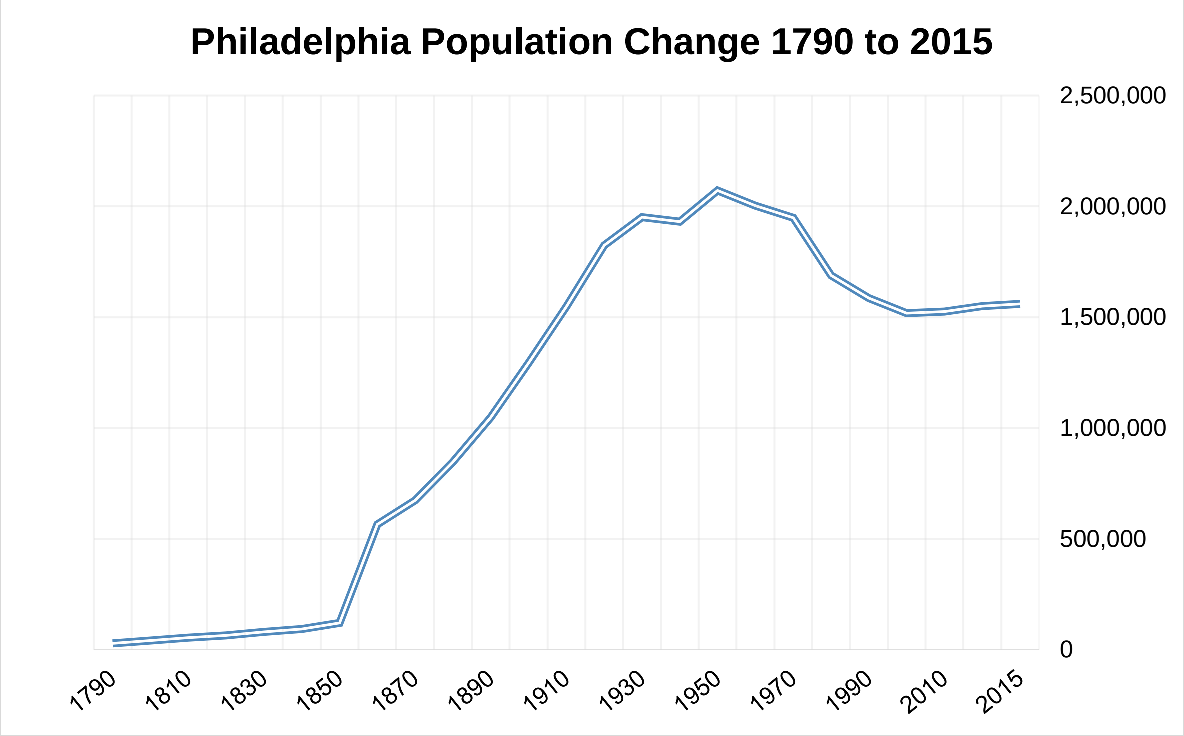
2.3.3.3 Population Change

From its founding through the early 19th century, Philadelphia's boundaries encompassed the area between the Delaware and Schuylkill Rivers between Vine and South Streets. The City and County of Philadelphia were consolidated in 1854, significantly enlarging the boundaries and creating Philadelphia's current border. This resulted in a large population increase, evident in the 1860 census. 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 was on a steady decline until 2010. Since 2010, Philadelphia has seen low population growth, with a 0.6 percent increase in residential population since the last Hazard Mitigation Plan.

---

[66] "The State of the Nation's Housing 2014". Joint Center for Housing Studies of Harvard University. Retrieved 26 October 2015.

[67] Ibid.



2.3.4 ***Infrastructure***

2.3.4.1 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.[68]

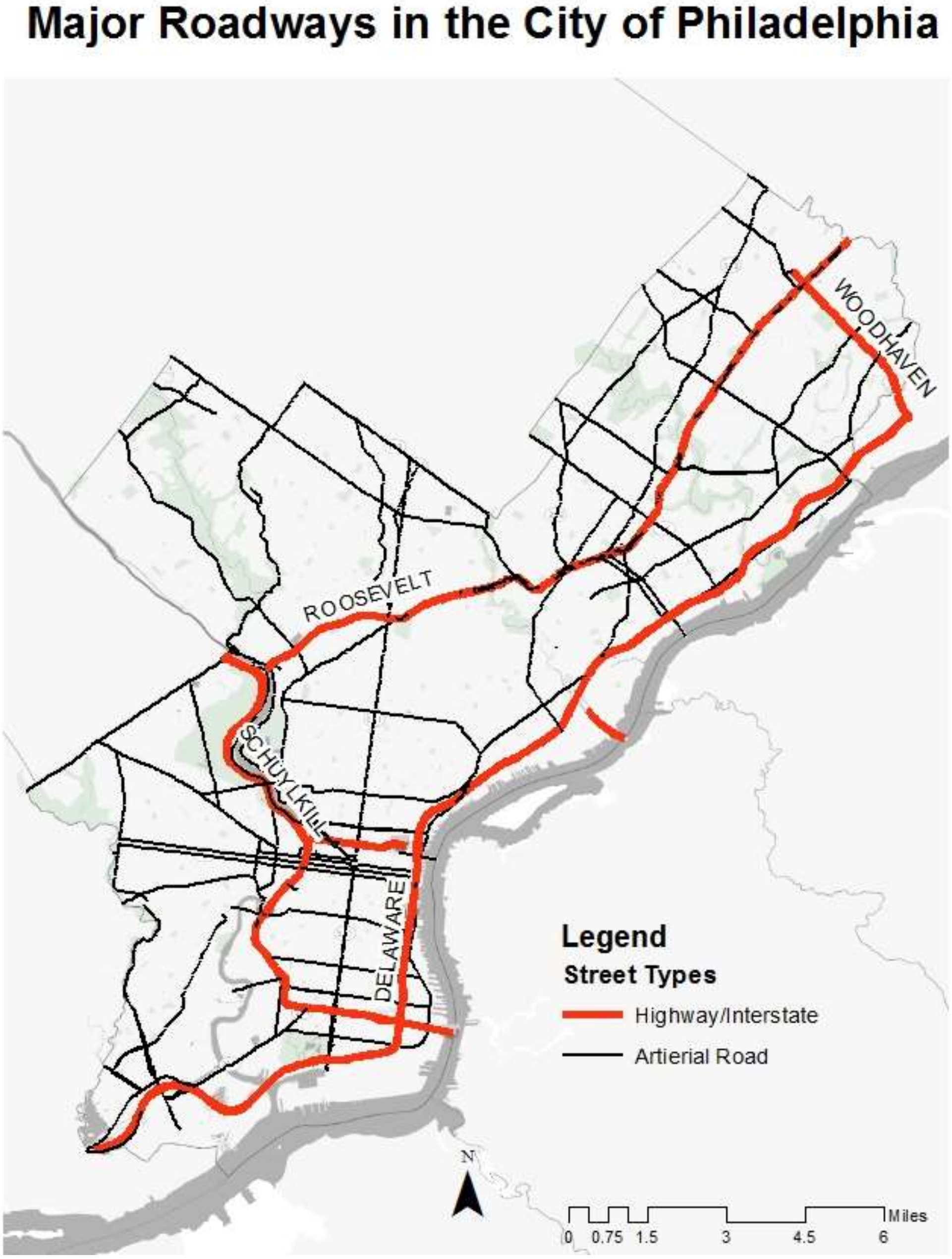
The streets system in Philadelphia totals 2,575 miles: 2,180 miles of city streets, 35 miles of Fairmount Park roads, and 360 miles of state highways.

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

---

[68] Philadelphia Streets Department. About the Streets Dept. & Its Divisions. Retrieved December 29, 2015.

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 shore of the Schuylkill River.


Major Roadways in the City of Philadelphia

Interstate 675 (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.

2.3.4.2 Freight and Passenger Rail

Philadelphia has served as a hub for major railroad transportation, including both freight, and passenger rail, since the early 19th Century, and has been home to both the Pennsylvania Railroad and the Reading Railroad companies. Philadelphia passenger rail service provides transportation both within the City's borders and to surrounding counties. Amtrak provides both passenger and high speed rail service to the City, shuttling thousands of passengers to Washington DC and New York City annually. 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. Freight lines carry an assortment of non-hazardous and distinct types of hazardous materials throughout the City and region.

Philadelphia has seen an increase in the number of crude oil shipments by rail since the 2012 Hazard Mitigation Plan. Philadelphia is home to Philadelphia Energy Solutions (PES), the tenth largest refinery in the United States, and the largest oil refining complex on the eastern seaboard. This increase in rail traffic has led to joint planning and training efforts between PES, rail companies, and city stakeholders, including the Office of Emergency Management. To learn more about the plans that City stakeholders have for hazardous material trains, including those carrying crude oil, see the Capability Assessment section of this document and its associated annexes. To learn more about trains carrying hazardous materials, and the potential risks they may pose, see the Hazardous Material Train Derailment hazard profile in the Risk Assessment section of this document.

2.3.4.3 Freight

“Philadelphia’s core rail lines carry some of the highest volume in the nation.”

Since the mid-1800s, rail transportation has been the centerpiece of industrial production and energy generation, and rail continues to be central to these industries. The Reading Railroad began in 1833 and was originally named the Philadelphia and Reading Railroad. In 1842, the Railroad connected markets in Philadelphia to the coal mining areas of Pennsylvania, but over time expanded business to incorporate coal mining and canal and ocean transport operations.[69] The Reading Railroad fell under bankruptcy in 1971, and the federal government transmitted its assets to the Consolidated Rail Corporation (Conrail). [70]

The Pennsylvania Railroad was the largest railroad by traffic and revenue in the United States for the first half of the 20th century. In 1968 the railroad merged with its rival, New York Central Railroad, to form the Penn Central Transportation Company. Like many other railroads, Penn Central filed bankruptcy in 1970 and its assets were transmitted to Conrail. In 1997, Norfolk Southern Corporation and CSX Corporation agreed to acquire Conrail through a joint stock purchase.[71]

Today Norfolk Southern, Canadian Pacific (CP) Rail, and CSX continue to distinguish Philadelphia as one of 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.

---

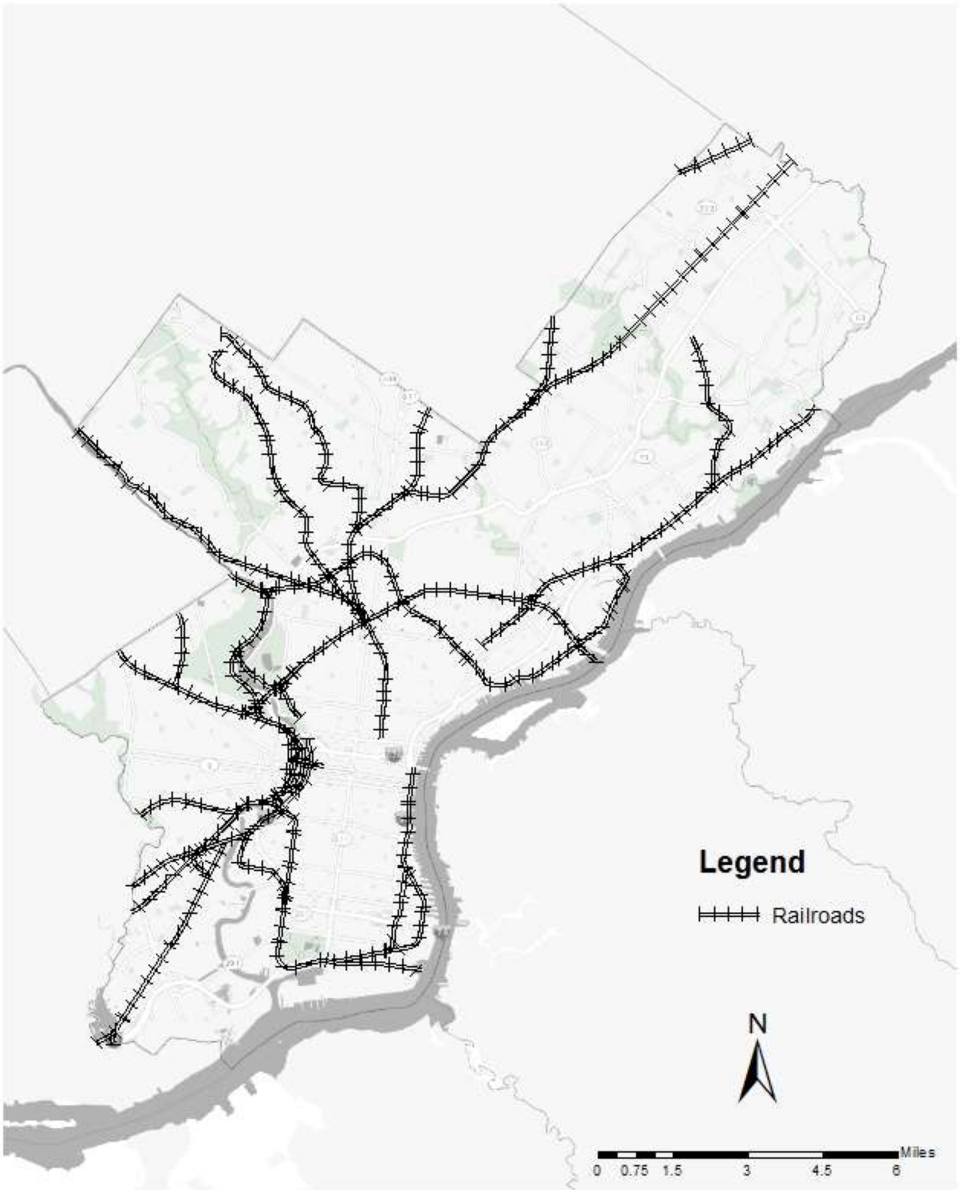
[69] Reading Company Technical & Historical Society. RDG Co. – A Brief History. Retrieved 13 February 2012.

[70] Image: "Philly blizzard 2" by Leizmonk - Own work. Licensed under Public Domain via Wikimedia Commons. Retrieved December 29, 2015.

[71] Conrail Historical Society. Conrail Company History. Retrieved 13 February 2012.

Another important core line is Amtrak's Northeast Corridor, a portion of which passes through Philadelphia. Some freight is moved on this predominantly passenger rail corridor.[72] 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.[73]

Rail Lines in the City of Philadelphia



---

[72] American Society of Civil Engineers (ASCE). 2010 Report Card for Pennsylvania’s Infrastructure. Retrieved 13 February 2012.

[73] Conrail. Freight Service. Retrieved 13 February 2012.

2.3.4.4 Passenger

The first passenger railroad in Philadelphia was the Philadelphia, Germantown and Norristown Railroad, which opened in 1832. Many other rail lines were established in the years following. Congress created Amtrak in 1970 to take over the passenger rail services that private freight railroad companies previously operated.[74]

In 2015, Philadelphia's 30th Street Station was the 3rd busiest station for Amtrak in the United States.

In modern day railroad history, Amtrak is the major semi-national railroad company that serves Philadelphia at 30th Street Station. In 2015, Philadelphia's 30th Street Station was the 3rd busiest station for Amtrak in the United States, following New York City and Washington, D.C. **[75]**

2.3.4.5 Public Transit

Philadelphia has three major public transportation lines running through the city that conduct hundreds of millions of trips throughout a single year, helping 26.5 percent of Philadelphia's population commute every day.[76] Public transit providers in Philadelphia include:

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

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

2.3.4.5.1 Southeastern Pennsylvania Transportation Authority

Philadelphia's primary source of public transportation is the Southeastern Pennsylvania Transportation Authority (SEPTA). Within Philadelphia, SEPTA operates the public buses, trolleys, trackless trolleys, Broad Street Subway, and Market-Frankford Elevated subway. In addition, SEPTA operates regional rail lines and bus services throughout Philadelphia, Bucks, Montgomery, Chester,

---

[74] Amtrak. Historical Background on Amtrak. Retrieved 13 February 2012.

[75] Amtrak National Facts. Amtrak. Retrieved December 29, 2015.

[76] Commuting Characteristics by Sex: Philadelphia County. 2014 American Community Survey 5-year Estimates. Retrieved February 10, 2016.

Delaware counties, as well as provides additional service to portions of southern New Jersey.[77] [78]

SEPTA began in the early 1950's and consisted of the subway, trolleys and buses. At this time, private companies such as the Philadelphia Transportation Company, Philadelphia Suburban Transit Company, Pennsylvania Railroad, and Reading Company owned many of the bus and trolley routes. In 1961, the city of Philadelphia along with Bucks, Montgomery, and Chester counties signed to the Southeastern Pennsylvania Transportation Compact. This initial agreement gave SEPTA the function of coordinating government subsidies to the railroads and transit companies. In1968, SEPTA took control of the Philadelphia Transportation Company which included all buses, trolleys, trackless trolley lines, the Broad Street Subway and the Market-Frankford Elevated.[79]

At the end of the 2014 reporting period, SEPTA's buses, subways, trolleys, and trains had approximately 330 million trips, down from the recorded 334 million reported in the 2012 Hazard Mitigation Plan.[80] Over the past 15 years, however, regional rail ridership alone has increased 50 percent, from 24 million to 36 million trips, in annual ridership.[81]

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.

---

[77] SEPTA. Driven to Achieve: Fiscal Year 2010 Annual Report. Retrieved 15 November 2011.

[78] Image: "SEPTA R2 Gliding Along" by jpmueller99 from Shenandoah Valley of VA, USA - Gliding Along. Licensed under CC BY 2.0 via Commons. Retrieved December 29, 2015.

[79] The Philadelphia Chapter of National Railway Historical Society. John Amelia, 2004. Retrieved 8 November 2011.

[80] Southeastern Pennsylvania Transit Authority. “SEPTA Operating Facts”. Retrieved 23 October 2015.

[81] Southeastern Pennsylvania Transit Authority. Revenue & Ridership Report September 2015. Retrieved 23 October 2015.

Doylestown
West Trenton
Warminster
Glenside
Jenkintown-Wyncote
Trenton
Trenton Transit Center
Amtrak to: New York Boston
NJ Transit to: New York New Jersey Points
River Line to Camden
Delaware River
Amtrak to: Harrisburg Pittsburgh
Thorndale
Norristown (Elm St)
Norristown Trans. Ctr.
Chestnut Hill East
Chestnut Hill West
Fern Rock Trans. Ctr.
Fox Chase
Frankford Trans. Ctr.
Schuylkill River
Cynwyd
Wayne Jct.
N. Phila
North Broad
Trolley Route: 15 to Richmond & Westmoreland
Trolley Route: 15 to 63rd & Girard
Trolley Route: 10 to 63rd & Malvern
30th Street Station (Amtrak/NJT)
Suburban Station
Jefferson Station
City Hall
NW
NE
SW
SE
69th Street Trans. Ctr.
Trolley Routes: 11 to Darby TC 13 to Yeadon/Darby TC 34 to 61st & Baltimore 36 to 80th & Eastwick
University City
Walnut-Locust
15th/16th
12th/13th
9th/10th
Lindenwold
NJ Transit to: Atlantic City
AT&T
Sports & Entertainment Complex
Sharon Hill
Media
Elwyn
Airport
Philadelphia International Airport
Newark
Amtrak to: Baltimore Washington DC
Delaware River
LEGEND
Market-Frankford Line
Broad Street Line & Broad-Ridge Spur
Norristown High Speed Line
Trolley Lines (Routes 10, 11, 13, 15, 34, 36, 101 and 102)
Regional Rail Lines (end shows route destination)
PATCO Line train to New Jersey (not a SEPTA service)
Free interchange (no transfer needed between transit services)
Pedestrian Connection (additional fare needed for connecting service)
Wheelchair accessible station
INFORMATION
Customer Service: 215-580-7800
TDD/TTY: 215-580-7853
Website: www.septa.org
© SEPTA 2014

2.3.4.5.2 Port Authority Transit Corporation

The Port Authority Transit Corporation (PATCO) Speedline first began in 1926 with the creation of the Delaware River Bridge Commission and the construction of the Benjamin Franklin Bridge. In 1931, the Delaware River Bridge Commission received permission to construct a high-speed transit line connecting Philadelphia and Camden, New Jersey. On June 7, 1936, the new bridge line completed its first run from Camden to Philadelphia. Speedline operations began on February 15, 1969, with the first trip from Lindenwold, New Jersey to Center City Philadelphia. Back then, the 14.2 mile line carried 21,200 people per day. Today, more than 38,000 people rely on the high speed line.[82] PATCO began service with eight stations in Camden County, New Jersey and four in Philadelphia. Today there are 13 stations, extending from 15th to 16th St. and Locust St. in Philadelphia to Lindenwold, New Jersey.[83]

---

[82] PATCO. A History of Commitment. Retrieved 8 November 2011.

[83] Image: Transportation Map. PATCO. Retrieved September 2015.

2.3.4.5.3 New Jersey Transit

New Jersey Transit (NJ Transit), founded in 1979, is New Jersey's public transportation corporation. 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 2,027 buses, 711 trains and 45 light rail vehicles.[84] In Philadelphia, NJ Transit provides a train line service from Philadelphia to Atlantic City, New Jersey.[85]

2.3.4.6 Airports

Philadelphia is the home of two airports: Philadelphia International Airport (PHL) and Northeast Philadelphia Airport (PNE). PHL operates under the jurisdiction of the 77th PPD district, a police district solely responsible for PHL. PNE operates under the 8th PPD district.

2.3.4.6.1 Philadelphia International Airport

Originally called Philadelphia's "Municipal Aviation Landing Field," PHL opened in 1925 as a training space for aviators in the Pennsylvania National Guard. On October 22, 1927, however, pilot Charles A. Lindbergh touched down his Spirit of St. Louis plane in Philadelphia during his tour of the United States. Because of this historical event, the training field's name changed to Philadelphia Municipal Airport.

In 1930, the county purchased Hog Island, a World War I shipbuilding yard, for $3 million from the federal government, expanding the airport. The Great Depression

---

[84] NJ Transit. About Us. Retrieved 9 November 2011.

[85] Image: NJ Transit. About Us. Retrieved 9 November 2011.

delayed construction until 1936. On June 20, 1940, the Philadelphia Municipal Airport officially opened. In its first year of operation, Philadelphia Municipal Airport transported 40,000 passengers. In the 1940s American Overseas Airline launched transatlantic service, and the airport was renamed Philadelphia International Airport (PHL) to reflect the change.[86]

In the 1950's, PHL became accessible by all means of transportation including highways, waterways, and railways. The Overseas Terminal, which catered to international and charter flights, opened in April of 1973. The airport spent over $300 million in the late 1970's for the development and transformation of the domestic terminal. In 1985, SEPTA created a rail line connecting Center City Philadelphia to the Airport.

In 2014, PHL accommodated 30.74 million passengers, down from 30.8 million from numbers reported in the 2012 Hazard Mitigation Plan. These passengers included 4.5 million international passengers, increased from 4.2 million international passengers[87] reported in the 2012 Hazard Mitigation Plan. Thirteen airlines provided approximately 525 daily departures including more than 131 nonstop flights. Nearly 404,050 tons of cargo (down from 441,000 in 2011) and 28,702 tons of mail (up from 22,000 tons in 2011) are moved annually by commercial airlines and a half-dozen cargo carriers. [88] [89] The airport contains more than 200 businesses, which employ more than 141,000 workers. PHL has a $14.4 billion economic impact on the region, making it one of the largest economic engines in Pennsylvania. The airport encompasses 7 terminal buildings with 126 boarding gates and is situated on about 2,370 acres.[90]

Philadelphia International Airport (PHL) Rankings for 2014

Among U.S. Airports:	Among Worldwide Airports:
19th Total Passengers	53rd Total Passengers
18th Total Cargo (freight + mail)	56th Total Cargo (freight + mail)
12th Total Movements (takeoffs + landings)	15th Total Movements (takeoffs + landings)

2.3.4.6.2 Philadelphia Northeast Airport

Philadelphia Northeast Airport (PNE) originally opened in June 1945. By 1953, it was ranked 21st in the nation for airfreight tonnage handled. Originally operated by the City of Philadelphia, the Civil Aeronautics Administration (this later evolved into the Federal

---

[86] Philadelphia International Airport. History of Philadelphia International Airport. Retrieved 8 November 2011.

[87] Philadelphia International Airport. Retrieved 23 October 2015.

[88] Philadelphia International Airport. Fast Facts. Retrieved 23 October 2015.

[89] Philadelphia International Airport. About Philadelphia International Airport. Retrieved 8 November 2011.

[90] Philadelphia International Airport Liaison - John Glass. Retrieved 14 February 2012.

Aviation Administration, FAA) took over the Airport's traffic control tower in 1957. In the early 1980's, Augusta Aviation Corporation opened a Northeast Service Center at the Airport and a few years later moved its headquarters from Bucks County to PNE. In 2014, PNE managed approximately 75,720 airport flight operations. PNE has 85 T-hangars, nine (9) corporate hangers, and six (6) open hangars for general aviation activities.[91]

2.3.4.7 Water transit

2.3.4.7.1 RiverLink Ferry

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

2.3.5 Emergency Services

Philadelphia's emergency services include the Fire Department (PFD), the Fire Department Emergency Medical Services (PFD-EMS), the Police Department (PPD), and hospitals. A number of other City agencies, including OEM, the Philadelphia Department of Public Health (PDPH), the Department of Behavioral Health and

---

[91] Ibid

Intellectual disAbility Services (DBHIDS), and the Department of Licenses and Inspections (L&I) also have emergency response functions.[92]

2.3.6 Hospitals and Healthcare Facilities

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

Philadelphia Hospitals				
Hospital Name	**Emergency Department**	**Trauma Center**	**Burn Center**	**Pediatric**
Angela Jane Pavilion Rehabilitation Hospital				
Aria Health – Frankford Campus	X			
Aria Health – Torresdale Campus	X	Level 2		
Cancer Treatment Centers of America - Eastern Region Medical Center				
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	X	Level 1		
Hospital of the University of Pennsylvania	X	Level 1		
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			
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
St. Joseph's Hospital	X			
Temple University Hospital	X	Level 1	X	
Temple University Hospital – Episcopal Campus	X			
Thomas Jefferson University Hospital	X	Level 1		

---

[92] Image: Office of Emergency Management. Family Assistance Center Functional Exercise. June 17, 2014.

Philadelphia VA Medical Center	X			

2.3.7 *Cultural Facilities*

Philadelphia has one of the greatest concentrations 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.

Cultural Facilities	
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	Rosenbach Museum and Library
Iconic 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
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
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
Stadiums/Arenas	
Citizens Bank Park	Palestra
Lincoln Financial Field	Liacouras Center
Wells Fargo Center	Tom Gola Arena
Franklin Field	
Zoos/Nature Centers	
Philadelphia Zoo	Shofuso Japanese House and Garden
Morris Arboretum	Bartram's Garden
Fairmount Park	John Heinz Wildlife Refuge

2.4 Data Limitations

It should be noted that the analysis presented here is based upon “best available data.” Data used in updates to this Hazard Mitigation Plan should be reassessed upon each review period to incorporate new or more accurate data if/when possible.

3 Planning Process

This section includes a description of the planning process used to develop the HMP, including how it was prepared, who was involved in the plan development, and how planners engaged the public. The plan was developed following the process outlined by DMA 2000, FEMA requirements and FEMA and PEMA guidance.

3.1 Planning Process and Participation Summary

Philadelphia applied for and was awarded funding under the Pre-Disaster Mitigation (PDM) Competitive Grant Program to assist in the development of a Hazard Mitigation Plan (HMP). The Office of Emergency Management hired a Hazard Mitigation Planning Coordinator to oversee the development of the plan.

In November 2015, OEM began the development of Philadelphia's second HMP, the first to include human-caused hazards. The HMP planning process concluded in November 2016 and the City submitted the plan to PEMA and FEMA for approval.

The Philadelphia HMP was written using the best available information obtained from a wide variety of sources. Throughout the plan development, an effort was made to solicit information from individuals with specific knowledge of certain natural hazards and their past impacts to Philadelphia.

3.2 Planning Committee

The Hazard Mitigation Planning Committee is a core group of 18 agencies that manage, operate, and/or plan for some of the City's largest infrastructure networks. The planning committee provides subject-matter expertise in the following areas:

- Emergency management;
- Public safety;
- Land use planning;
- Building codes;
- Transportation;
- Infrastructure development;
- Maintenance; and protection; and
- Natural resource protection.

This committee combines skills, expertise, and experience to achieve a common goal of natural hazard mitigation for Philadelphia.

The planning committee helps develop, manage and implement Philadelphia's HMP. The following list summarizes the planning committee's responsibilities:

- Support plan development
- Attend HMP Planning Committee meetings
- Provide subject matter expertise

- Assist in ranking hazards of concern
- Develop mitigation actions pertinent to their agency
- Assist in evaluating and prioritizing mitigation actions
- Review and comment on draft HMP sections provided by OEM
- Assist with plan maintenance

OEM served as the coordinating agency for the development of the HMP. OEM facilitated the overall plan development to ensure the HMP met the requirements of DMA 2000. As the HMP coordinator, OEM had many responsibilities including administration, content organization, and text development. The following list summarizes OEM's responsibilities:

- Organize and guide all meetings with the planning committee
- Provide support for all participants in the hazard mitigation planning process
- Coordinate with planning committee to identify relevant material for HMP
- Develop and implement the community involvement process
- Guide plan development to adhere to DMA 2000 requirements
- Manage identification, collection and analysis of capabilities submitted by the Planning Committee
- Guide hazard ranking process
- Draft, compile, and edit document language
- Manage identification, collection and analysis of mitigation actions submitted by the planning committee

3.2.1 __Participants and Agency Descriptions__

Planning committee agency participants include:

- Federal Emergency Management Agency Region III (FEMA)
- Fleet Management
- Licensing and Inspections (L&I)
- Office of Sustainability (OOS)
- Office of Behavioral Health and Intellectual disAbility Services
- Office of Emergency Management (OEM)
- Office of Innovation and Technology (OIT)
- Office of Transportation and Infrastructure Systems (OTIS, formerly MOTU)
- Pennsylvania Department of Environmental Protection (DEP)
- Pennsylvania Emergency Management Agency (PEMA)
- Pennsylvania Historical and Museum Commission (PHMC)
- Philadelphia City Planning Commission (PCPC)
- Philadelphia Department of Public Health (PDPH)
- Philadelphia Fire Department (PFD)
- Philadelphia Housing Authority (PHA)

- Philadelphia International Airport (PIA)
- Philadelphia Parks and Recreation (PPR)
- Philadelphia Streets Department (Streets)
- Philadelphia Water Department (PWD)

3.3 Planning Committee Meetings and Documentation

OEM coordinated the following planning committee meetings during the planning process. Agendas and sign-in sheets are included as an Appendix.

November 12, 2015 – Hazard Mitigation Kickoff Meeting held at the Fire Administration Building.

The meeting introduced all Planning Committee participants to the mitigation planning process, discussed timelines for implementation, reviewed potential hazards for inclusion and described specific expectations and roles of planning committee members. A brief summary was given on what hazard mitigation planning entails and why Philadelphia needs a Hazards Mitigation Plan. An initial review of current capabilities occurred at this meeting as well. The Planning Committee was broken down into sector-specific working groups to discuss past mitigation actions and review sector-relevant portions of the 2012 Hazard Mitigation Plan. These groups included a development working group, a transportation and infrastructure working group, a utilities working group, and an environment working group.

November 18, 2015; November 23, 2015; November 24, 2015 - Work Group Meetings

Work group meetings carried on throughout the rest of November, during which groups discussed sector-specific mitigation concerns, plan updates, and potential future mitigation actions.

November 2015 to May 2016 – Targeted outreach

Targeted outreach to individual agencies and departments occurred throughout the drafting process to obtain more in-depth information. Agency and department meetings focused on the internal processes that made up capital planning project development, and prioritization. Meetings also identified upcoming projects that could affect mitigation activities or general City preparedness and resilience.

3.4 Public Meetings

In compliance with hazard mitigation planning requirements, the planning team sought and encouraged public participation throughout the development of the HMP. To engage the community in the hazard mitigation planning process, OEM developed a comprehensive community involvement strategy that included a series of public meetings, extensive social media outreach, and a survey targeting city residents.

3.4.1 *Meeting Logistics*

OEM posted invitations to residents of Philadelphia via media releases and advertisements on social media sites. The Public Outreach Meeting Annex includes the press releases and agendas for each of the four public meetings.

OEM's website contains public meeting dates and agendas. The table below lists public meetings held specific to the Hazard Mitigation Plan.

Philadelphia Hazard Mitigation Public Meetings

Date and Time	Location	Attendance
June 8, 2016, 6PM	Eastwick Library Branch, 2851 Island Ave, Philadelphia, PA 19153	5
June 29, 2016	Roxborough Branch, 6245 Ridge Avenue, Philadelphia, PA 19128	4
September 14, 2016	Community Advisory Group: Eastwick (guest speaker – no sign in sheet)	18
September 26, 2016	Fishtown Branch FLP, 1217 East Montgomery Avenue	7

3.4.2 *Outreach and Community Feedback*

The hazard mitigation public meetings provided an opportunity to outline the Hazard Mitigation planning process, identify the hazards of concern, and discuss implemented and future mitigation actions. At each meeting, the public had the opportunity to provide feedback on the plan and process, and a chance to express concerns.

In addition, OEM developed an 11 question survey to gauge city residents' level of general preparedness, perception of threat from hazards, and knowledge of personal mitigation actions. The survey also asked several demographic questions to help analyze trends.

OEM made the survey available both in electronic and hard copy formats. Staff members distributed paper copies during public meetings and events including:

- HMP meetings
- ReadyHOME workshops
- ReadyBUSINESS workshops
- Service fairs

OEM compiled electronic and hard copy surveys for analysis. The Public Outreach Annex contains the compiled survey results.

OEM heavily promoted both the survey and community meetings via social media and website blog content during the summer and early fall of 2016. The survey, plan, and meetings were promoted a couple times a week. Regular tweets and blog posting drove traffic to our website and 441 unique survey respondents from City residents. Sample tweets and blog posts are also posted in the Public Outreach Annex.

3.4.3 Hazard Mitigation Plan Website

OEM and OIT launched a public website https://alpha.phila.gov/departments/oem/programs/hazard-mitigation-plan/ in February 2016 to inform Philadelphia residents of the project. The website contains the draft versions of the 2017 Hazard Mitigation Plan update, a copy of the 2012 Hazard Mitigation Plan as approved, information on hazard mitigation planning, a link to the natural hazards survey, and answers to frequently asked questions regarding hazard mitigation.

4 Risk and Vulnerability Assessment

According to the FEMA Guidance 386-2, “risk assessment is the process of measuring the potential loss of life, personal injury, economic injury and property damage resulting from natural hazards by assessing the vulnerability of people, buildings and infrastructure to natural hazards.” Philadelphia’s risk assessment is organized into three 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 2017 HMP is consistent with the process and steps presented in the Federal Emergency Management Agency (FEMA) 386-2, *State and Local Mitigation Planning How-to- Guide, Understanding Your Risks – Identifying Hazards and Estimating Losses*.

This process, broken down into four unique steps

1. Identifies the hazards of concern,
2. Profiles the hazards of concern,
3. Assesses the overall risk of the city, and
4. Assesses the vulnerability of assets (population, structures, critical facilities and the economy) at risk in Philadelphia.

The 2017 Hazard Mitigation Plan expanded on those hazards included in the 2012 Hazard Mitigation Plan. In addition to human-caused hazards included in this iteration of the Hazard Mitigation Plan, extreme temperature was broken down into extreme heat and extreme cold for the 2017 Hazard Mitigation Plan. The 2017 Hazard Mitigation Plan also includes climate change to a much greater degree within the specific hazard climate change effects.

The planning process also identified hazards through research provided by the Mayor’s Office of Sustainability, which shaped the climate change approach used throughout the document. This plan includes those human-caused hazards from the Human-caused Annex appended to the 2012 Hazard Mitigation Plan, as well as from the City of Philadelphia’s Threat and Hazard Identification and Risk Assessment. Following guidance from Emergency Management Accreditation Program’s and PEMA’s Pennsylvania All-Hazard Mitigation Standard Operating Guide, the Office of Emergency

Management included both natural and human caused hazards in this hazard mitigation plan.

Subject matter expert consensus as well as public feedback were taken into consideration when selecting the hazards for this plan. The planner received feedback from stakeholder and public meetings, as well as from public survey responses.

The planner also conducted research on hazards included in several other cities of similar size, threat level, and/or community profile. These cities included:

- Boston
- Seattle
- Miami-Dade
- Dallas
- Houston-Galveston
- San Francisco
- South Hampton Roads

The 2017 Hazard Mitigation Plan list of hazards also takes into consideration those hazards included in plans from surrounding counties. These counties include:

- Bucks County
- Chester County
- Delaware County
- Montgomery County

The "Pennsylvania Standard List of Hazards" profiles sixteen natural hazards the Commonwealth as a whole is susceptible to, and details the likeliness of each hazard to occur in Pennsylvania.[93] Using these sources and previous historical occurrences of disaster declarations and input from the Philadelphia Hazard Mitigation Planning Committee, eight natural hazards were selected to be profiled in more depth within this Plan, as they are considered the most likely to occur in the future within Philadelphia. These natural hazards include (alphabetically):

- Drought
- Earthquake
- Extreme Cold
- Extreme Heat
- Floods
- Hurricanes and Tropical Storms
- Windstorms and Tornadoes

---

[93] Pennsylvania 2010 Hazard Mitigation Plan. Retrieved November 3, 2011.

- Winter Storms

The natural hazard profiles also capture the effects of climate change, illustrating the compounding or exacerbating effects a shift in the climate can have on each of these hazards. Because climate change causes a shift in the magnitude and extent of hazards, each profile addresses climate change influence on the hazard's effects.

In addition to these natural hazards, six human-caused hazards are also included in the Philadelphia hazard profiles. Using the Human Caused Annex amended to the 2012 Hazard Mitigation Plan as well as the City's Threat and Hazard Identification and Risk Assessment, and taking into consideration nationally identified trends, six human caused hazards were selected to be profiled in more depth within this Plan, as they are the most likely to occur in the future within Philadelphia. These human caused hazards include (alphabetically):

- Active Shooter
- Bridge Failure
- Dam Failure
- Hazardous Material Train Derailment
- Improvised Explosive Device (IED)
- Urban Conflagration

4.2 Hazard Identification

4.2.1 <u>Disaster Declarations</u>

Since 1955, declarations have been issued for numerous natural hazard events in Philadelphia, including hurricanes, tornadoes, severe winter storms, flooding events, and droughts. Understanding the disaster history of Philadelphia helps provide direction on the identification of the primary natural hazards and their significance.

4.2.1.1 Presidential Major Disaster Declaration

A Presidential Major Disaster Declaration (hereon referred to as a 'Presidential Disaster Declaration') is defined by FEMA as "any natural catastrophe (including any hurricane, tornado, storm, high water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, or drought), or, regardless of cause, any fire, flood, or explosion, in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under [The Stafford] Act to supplement the efforts and available resources of States, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby."

The Governor of the affected state makes a request for a declaration by the President that a major disaster exists. The Governor makes this request in the event that the disaster is of such severity and magnitude that effective response is beyond the capabilities of the state and the affected local governments, and that federal assistance is necessary. As part of such a request, and as a prerequisite to major disaster assistance, the Governor takes appropriate response action under state law and direct execution of the state's emergency plan. Based on the request of a Governor, the President may declare that a major disaster or emergency exists.[94]

A Presidential Disaster Declaration puts into motion long-term federal recovery programs designed to aid disaster victims, businesses and public entities. The following is a list of some of the major assistance programs that may be available with a Presidential Disaster Declaration under the Stafford Act:[95]

- Public Assistance Program
- Individual Assistance Program
- Small Business Administration (SBA) Physical Loan
- Small Business Administration (SBA) Economic Injury Disaster Loan (EIDL)
- Tax Refunds
- National Flood Insurance Program (NFIP)
- The U.S. Department of Housing and Urban Development (HUD) Disaster Recovery Assistance
- Hazard Mitigation Assistance (HMA)
- Debris Removal/Public Facility Restoration through the Department of Defense (DOD)
- Flood Protection and Recovery through the U.S. Army Corps of Engineers (USACE)
- The Federal Highway Administration (FHWA) Emergency Relief Funds

4.2.1.2 Emergency Declaration

FEMA defines an Emergency Declaration as "any occasion or instance for which, in the determination of the President, federal assistance is needed to supplement state and local efforts and capabilities to save lives and to protect property and public health and safety, or to lessen or avert the threat of a catastrophe in any part of the United States."

---

[94] 44 C.F.R. § 206.36 sets out the requirements to be fulfilled by the Governor or Acting Governor in his or her absence in requesting a Presidential major disaster declaration: § 5191. Procedure for declaration § 206.36 Requests for major disaster declarations.

[95] This list represents a selection of the programs that may be available after a disaster. For a complete listing of Federal Disaster Assistance programs, please refer to DisasterAssistance.gov.

An Emergency Declaration is more limited in scope and without the long-term federal recovery programs of a Presidential Disaster Declaration. Federal assistance and funding are provided to meet a specific emergency need or to help prevent a major disaster from occurring.

The table below identifies Presidential Disaster and Emergency Declarations issued between 1955 through 2011 for Philadelphia. These dates indicate the declaration date, not the date of the disaster.

Presidential Disaster and Emergency Declarations affecting Pennsylvania

Date	Event	Disaster Number	Public Assistance	Individual Assistance
March 2016	Severe Winter Storm and Snowstorm	4267	X	
January 2013	Hurricane Sandy	4099	X	
October 2012	Proclamation of Emergency - Hurricane Sandy			
September 2011	Proclamation of Emergency - Remnants of Tropical Storm Lee	4030		X
September 2011	Hurricane Irene	4025	X	X
August 2011	Proclamation of Emergency - Hurricane Irene			
April 2010	Severe Winter Storm	1898	X	
June 2006	Proclamation of Emergency - Flooding	1649		
August 2004	Multiple Storm Systems	1538		
September 2004	Tropical Depression Ivan	1557		X
September 1999	Hurricane Floyd	1294	X	X
June 1998	Severe Storms/ Tornadoes	1219	Public Assistance/ Individual Assistance data not available prior to 1998	
January 1996	Flooding	1093		

January 1996	Severe Winter Storms	1085	
September 1971	Flood	312	

4.2.1.3 *Small Business Administration Disaster Declaration*

Philadelphia has also received numerous Small Business Administration (SBA) Disaster Declarations. An SBA declaration can activate the Physical Loan and/or Economic Injury Disaster Loan (EIDL) programs, which make disaster assistance available to affected homeowners, renters, and businesses in the form of low-interest loans. The table below illustrates SBA Disaster Declarations issued for Philadelphia between 1992 and 2016.[96]

Disaster Events Receiving Small Business Administration Loan Assistance	
Date	**Event**
January 2016	Winter Storm Jonas
April 2013	Hurricane Sandy
September 2011	Tropical Storm Lee
September 2011	Hurricane Irene
February 2010	Fire
August 2009	Storms and Flooding
September 2008	Fire
August 2008	Fire
November 2007	Fire
April 2007	Severe Storms and Flooding
October 2001	Fire
May 2001	Fire
March 2001	Fire
September 1999	Hurricane Floyd
June 1998	Severe Storms/Tornadoes
January 1998	Fire
January 1996	Severe Winter Storm
January 1996	Flooding
January 1994	Severe Winter Storm
July 1994	Flooding

---

[96] Data limitations from Small Business Administration limit the time span available for Small Business Administration disaster loan assistance.

March 1993	Blizzard
March 1993	Fire
July 1992	Fire

4.2.1.4 Commonwealth Declarations

In addition to the presidentially declared events, the Governor of Pennsylvania is authorized under state law to declare a Gubernatorial State of Emergency (also referred to as a Proclamation) upon the occurrence of a natural or man-made disaster. The law gives the Governor broad authorities to implement emergency measures to ensure the safety and health of the residents of the Commonwealth, take appropriate steps to mobilize state assets, and conduct other emergency business for the protection of the Commonwealth. The Governor of Pennsylvania may declare a disaster emergency by executive order or proclamation if a disaster has occurred or if the threat of a disaster is imminent. When a disaster affects two or more counties, the Governor will exercise directional authority and control through PEMA. The PEMA Director shall be prepared to become the Executive Officer in charge of carrying out the decisions of the gubernatorial administration for direction, coordination, and support of response activities for all commonwealth departments/ agencies, counties, municipalities, and designated institutions. PEMA will exercise this authority through the affected county emergency management agencies.

The table below outlines the Gubernatorial Disaster Proclamations issued for Philadelphia between 1955 and 2010. Several other natural hazard events received Gubernatorial Disaster Proclamations, including all events listed under the Presidential Disaster and Emergency Declaration table. The table below only lists the events that escalated to the state level, and does not include those which required federal assistance.

Pennsylvania Gubernatorial Disaster Emergency Declarations or Proclamations	
Date	**Event**
January 2016	Severe Winter Storm
June 2013	High Winds, Thunderstorms, Heavy Rain, Tornado, Flooding
October 2012	Hurricane Sandy
April 2012	Spring Winter Storms
August 2011	Severe Storms and Flooding (Lee/Irene)
January 2011	Severe Winter Storm
February 2010	Severe Winter Storm
April 2007	Severe Winter Storm
February 2007	Severe Winter Storm
September 2006	Tropical Depression Ernesto

September 2005	Hurricane Katrina
February 2002	Drought and Water Shortage
July 1999	Drought
March 1996	Highway Bridge (I95) Destruction
September 1995	Drought
November 1980	Drought Emergency
December 1972	Steam Heat Problem
February 1958	Heavy Snow
September 1955	Drought

4.2.1.5 Philadelphia Declarations

Chapter 75, Section 7501 of the Pennsylvania Emergency Management Services Code authorizes both cities and counties to issue local state of emergency declarations. The effect of these declarations varies by county and articulated in local statutes.[97]

Philadelphia operates under a Home Rule Charter, where the mayor may declare a municipal state of emergency.[98] The Mayor is authorized to declare a State of Emergency if he or she finds that the city or any part thereof is suffering or is in imminent danger of suffering civil disturbance, disorder, riot, or other occurrence, which will seriously and substantially endanger the health, safety and property of the citizens.[99] By declaring a State of Emergency, the Mayor may take any of the following measures:

- Prohibit or limit the number of persons who may gather or congregate upon the public highways or public sidewalks, or in any outdoor place, except persons who are awaiting transportation, engaging in recreational activities at a usual and customary place, or peaceably entering or leaving buildings;
- Halt access or egress upon public highways to or from the city or any part thereof;
- Suspend operations at municipal airports;
- Halt the movement of trains, boats or other vehicles into, within or from the city;
- Establish a curfew limiting the hours when persons may go upon or travel the public streets;
- Require the closing of taprooms and bars and prohibit the sale or service of alcoholic beverages in any hotel, restaurant, club or other establishment;
- Prohibit or restrict the sale of gasoline or other inflammable liquids;

---

[97] Commonwealth of Pennsylvania Emergency Management Handbook for Elected Officials. Retrieved 21 February 2012.

[98] The Philadelphia Code and Home Rule Charter. Title 10. Regulation Of Individual Conduct and Activity. Chapter 10-800. Safety §10-819. State of Emergency.

[99] City of Philadelphia Emergency Operations Plan. Office of Emergency Management. June 2015.

- Prohibit the sale, carrying or possession on public streets or public sidewalks, or in any public park or square, of weapons including, but not limited to, firearms, bows and arrows, air rifles, slingshots, knives, razors or missiles of any kind.[100]

The State of Emergency declared by the Mayor is in place for the period set forth in the Proclamation, but not exceeding two weeks.[101] The City provides prompt and general publicity for all declarations and files declarations with the Pennsylvania Emergency Management Agency (PEMA). The table below outlines the Mayoral State of Emergencies issued for Philadelphia between 1985 and 2016.

Mayoral State of Emergency for Philadelphia	
Date	**Event**
October 2012	Hurricane Sandy
August 2011	Hurricane Irene
December 1985	Racial Violence

---

[100] Ibid.

[101] The Philadelphia Code and Home Rule Charter. Title 10. Regulation Of Individual Conduct and Activity. Chapter 10-800. Safety §10-819. State of Emergency.

4.2.2 Summary of Hazards

The table below provides brief description for each hazard identified as a threat to the City of Philadelphia.

Profiled Hazards for Philadelphia's Hazard Mitigation Plan	
Hazard	**Description**
Active Shooter	An active shooter is an individual actively engaged in killing or attempting to kill people in a populated area".[102]
Bridge Failure	A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[103] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines.
Dam Failure	A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but immense damage and loss of life is possible in downstream communities when such events occur. Aging infrastructure, hydrologic, hydraulic and geologic characteristics, population growth, and design and maintenance practices should be considered when assessing dam failure hazards.[104] The failure of the South Fork Dam, located in Johnstown, PA, was the deadliest dam failure ever experienced in the United States. It took place in 1889 and resulted in the Johnstown Flood which claimed 2,209 lives.[105] Today there are approximately 3,200 dams and reservoirs throughout Pennsylvania.[106] Failures and breaches can occur without warning, or happen over a span of days to weeks, such as in result of debris jams, the accumulation of melting snow, or by the buildup of water pressure on a dam.[107]

---

[102] Federal Bureau of Investigation. "Active Shooter Incidents". Retrieved October 5, 2015.

[103] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[104] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

[105] FEMA, 1997.

[106] Pennsylvania Department of Environmental Protection, 2009.

[107] Why Dams Fail. FEMA. Retrieved January 29, 2016.

Drought	Drought is a natural climatic condition which occurs in virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a long period of time, usually a season or more in length. High temperatures, prolonged winds, and low relative humidity can exacerbate the severity of drought. This hazard is of particular concern in Pennsylvania due to the presence of farms as well as water-dependent industries and recreation areas across the Commonwealth. A prolonged drought could severely affect these sectors of the local economy, as well as residents who depend on wells for drinking water and other personal uses.[108]
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. Structural failure and collapse due to ground shaking causes most property damage and earthquake-related deaths.[109] Ground shaking is dependent upon amplitude and duration of the earthquake.
Extreme Cold	Extreme cold temperatures drop well below what is considered normal for an area during the winter months and often accompany winter storm events. Combined with increases in wind speed, such temperatures in Pennsylvania can be life threatening to those exposed for extended periods of time.[110]
Extreme Heat	Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[111]

---

[108] "Drought Basics". National Drought Mitigation Center. Retrieved February 16, 2016.

[109] "Earthquake". FEMA. Retrieved February 16, 2016.

[110] Lawrence County 2015 Hazard Mitigation Plan. MCM Consulting Group, Inc. Retrieved February 16, 2016.

[111] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.

Floods	Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces. The severity of a flood event is dependent upon a combination of: - stream and river basin topography and physiography, - hydrology, - precipitation and weather patterns, - present soil moisture conditions, - the degree of vegetative clearing, and - the presence of impervious surfaces in and around flood-prone areas.[112] 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. All forms of flooding can damage infrastructure.[113]
Hazardous Material Train Derailment	Deficiencies with a train or rolling stock can cause a train's chassis to unseat from the rail. This reduces the train's ability to brake or control the vehicle's movement, possibly resulting in a derailment. Depending on the train's speed and surroundings, the momentum of rail cars can be sufficient enough to rupture tanks and cause significant impact damage to surrounding structures or buildings. Impacts and damaged rail equipment present numerous ignition sources for flammable or explosive materials exposed to the environment, possibly resulting in combustion and explosion.

---

[112] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

[113] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Hurricane/ Tropical Storm	PEMA classifies hurricanes, tropical storms, and nor'easters as cyclones. Cyclones are any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise (in the Northern Hemisphere) and whose diameter averages 10-30 miles across. While most of Pennsylvania is not directly affected by the devastating impacts cyclonic systems can have on coastal regions, many areas in the state are subject to the primary damaging forces associated with these storms including high-level sustained winds, heavy precipitation, and tornadoes. Areas in southeastern Pennsylvania could be susceptible to storm surge and tidal flooding. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico during the official Atlantic hurricane season (June through November).[114]
Improvised Explosive Device	An IED attack is the “use of a ‘homemade’ bomb and/or destructive device to destroy, incapacitate, harass, or distract”.[115] 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. The majority of terrorism-related attacks worldwide use explosives.[116] Shrapnel material, propellant, or additional hazardous materials can worsen the impact of an IED.
Urban Conflagration	Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[117] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders.

---

[114] “Standard Operating Guide”. Commonwealth of Pennsylvania’s All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

[115] Department of Homeland Security. “IED Attack Improvised Explosive Devices”. News & Terrorism Communicating in a Crisis. Retrieved 6 October 2015.

[116]

[117] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.

Windstorm/Tornado	A wind storm can occur during severe thunderstorms, winter storms, coastal storms, or tornadoes. Straight-line winds such as a downburst have the potential to cause wind gusts that exceed 100 miles per hour. Based on 40 years of tornado history and over 100 years of hurricane history, FEMA identifies western and central Pennsylvania as being more susceptible to higher winds than eastern Pennsylvania.[118] A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes or tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of high wind velocities and wind-blown debris. According to the National Weather Service, tornado wind speeds can range between 30 to more than 300 miles per hour. They are more likely to occur during the spring and early summer months of March through June and are most likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small, short-lived tornadoes can inflict tremendous damage. Destruction ranges from minor to catastrophic depending on the intensity, size, and duration of the storm. Structures made of light materials such as mobile homes are most susceptible to damage. Waterspouts are weak tornadoes that form over warm water and are relatively uncommon in Pennsylvania. About 1,200 tornadoes hit the U.S. yearly[119], resulting in an average of 60 deaths per year, most from flying or falling (crushing) debris.[120] The actual number of tornado deaths in a year can vary wildly -- from single digits to hundreds, depending on many factors from both weather and society. Based on NOAA Storm Prediction Center Statistics, the number of recorded F3, F4, & F5 tornadoes between 1950-1998 ranges from <1 to 15 per 3,700 square mile area across Pennsylvania.[121] A water spout is a tornado over a body of water.[122] [123]

---

[118] FEMA, 1997.

[119] National Severe Storms Laboratory.

[120] "Tornado FAQ: Tornado Climatology And Data". NOAA Storm Prediction Center. Retrieved February 16, 2016.

Winter Storm	Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. 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. Many winter storms are accompanied by low temperatures and heavy and/or blowing snow, which can severely impair visibility and disrupt transportation. The Commonwealth of Pennsylvania has a long history of severe winter weather.[124]

4.2.2.1 Hazard Relationships

Hazards can have secondary affects that trigger a secondary hazard, called cascading hazards. For example, a dam failure could trigger a flooding incident or an extreme heat event could cause a drought. The chart below displays the interaction between hazards, showing the cascading effects a hazard can create. The chart also captures climate change, which is addressed in those hazards it impacts rather than as a separate hazard.

---

[121] FEMA, 2009.

[122] American Meteorological Society, 2009.

[123] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

[124] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Hazard Relationship Chart

		Secondary Hazard													
		Active Shooter	Bridge Failure	Dam Failure	Drought	Earthquakes	Extreme Cold	Extreme Heat	Floods	HazMat Train Derailment	Hurricane/ Tropical Storm	Improvised Explosive Device	Urban Conflagration	Wind Storms/ Tornado	Winter Storms
Primary Hazard	Active Shooter	X													
	Bridge Failure		X						X	X					
	Infrastructure Failure			X					X				X		
	Drought				X								X		
	Earthquakes		X	X		X			X				X		
	Extreme Cold						X								X
	Extreme Heat				X			X					X		
	Floods			X					X						
	Hazardous Materials Train Derailment									X			X		
	Hurricane/Tropical Storm								X		X		X		
	Improvised Explosive Device		X	X						X		X	X		
	Urban Conflagration												X		
	Wind Storms and Tornado													X	
	Winter Storms						X								X
	Climate Change				X		X	X	X		X		X	X	X

4.2.2.2 Limitations of Hazard Inclusion

The table below outlines the natural hazards not covered in the 2017 Hazard Mitigation Plan, as well as the rationale for omission.

Natural Hazard	Reason for Non-Inclusion
Avalanche/Glacier	While avalanches and glaciers are present in North America, they have not existed in Pennsylvania for approximately 17,000 years.
Coastal Erosion	With the exception of portions of Erie County, coastal erosion is not a hazard for communities in Pennsylvania.
Dust, Sand Storm	Dust and sandstorm events occur in the dry regions of the United States and historically have not been considered a significant hazard in Pennsylvania.
Expansive Soils	The City of Philadelphia's soil types are primarily sandy and silt, not clay which causes expansive soil events.
Invasive species	There is little impact to the entire community in Philadelphia from an invasive species. While there have been some invasive species in the Philadelphia area, such as stink bugs and English Ivy, these species do not pose a large, widespread impact to life, property, infrastructure, or economy.
Landslide	Given the topography of Philadelphia, a landslide is unlikely to occur.
Lightning Strike	Lightning strike is included as an effect of hazards, such as hurricanes and tropical storms. It is not treated as a separate hazard as it is a secondary, cascading hazard rather than a primary.
Radon Exposure	While singular incidents of radon exposure occur throughout Philadelphia, authorities handle incidents without widespread affects to the City's infrastructure, economy, environment, or population.
Subsidence, Sinkhole	Subsidence and sinkholes are addressed as a result of hazards such as flooding and earthquakes, rather than as a primary hazard.

Tsunami	No known tsunami events have been documented in Pennsylvania in the past 200 years.
Wildfire	Philadelphia's limited expanse of fields and forests drastically reduces the risk of wildfires, but increases the risk for urban conflagration, which is addressed in the 2017 Hazard Mitigation Plan.
Volcano	There are no active or dormant volcanoes in Pennsylvania.

Human Caused Hazard	Reason for Non-Inclusion
Civil Disturbance	While small incidents of civil disturbances occur throughout Philadelphia, authorities handle incidents without widespread affects to the City's infrastructure, economy, environment, or population. Operations and tactics for handling such events are outside the scope of this document.
Disorientation	Disorientation refers to people becoming lost or disoriented in remote or rugged wilderness areas.[125] The City of Philadelphia does not have extensive wilderness areas.
Drowning	While singular incidents of drownings occur throughout Philadelphia, authorities handle incidents without widespread affects to the City's infrastructure, economy, environment, or population.
Levee Failure	The City of Philadelphia does not have any levees within its jurisdiction. The surrounding counties' levees play a small role in flood protection and would not affect Philadelphia.

---

[125] Commonwealth of Pennsylvania's All-Hazard Mitigation Planning Standard Operating Guide. PEMA. October 18, 2013. Retrieved April 7, 2016.

Mass Food/Animal Feed Contamination	The City of Philadelphia has no history of mass food contamination. Additionally, less than 1% of Philadelphia is farmland, and the extremely limited number of livestock limits the effect of mass animal feed contamination.
Nuclear Incidents	The City of Philadelphia is not in the plume exposure pathway for surrounding nuclear power plants, and is therefore not in an emergency planning zone.
War and Criminal Activity	While singular incidents of criminal acts occur throughout Philadelphia, authorities handle incidents without widespread affects to the City's infrastructure, economy, environment, or population. Operations and tactics for handling such events are outside the scope of this document.

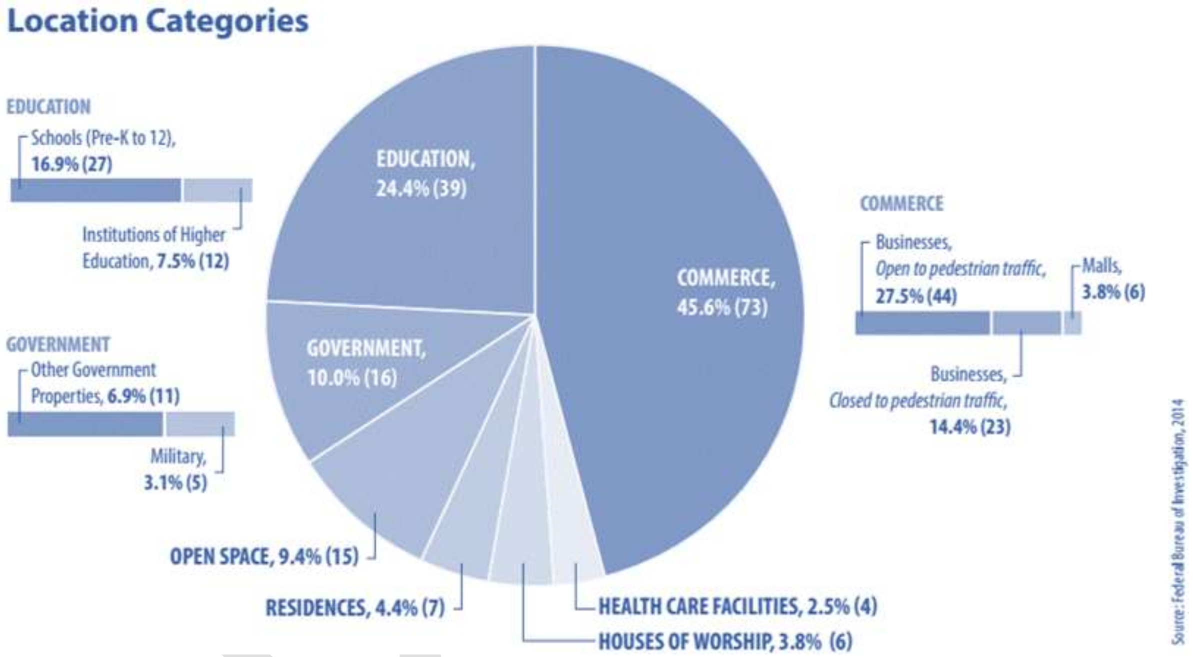
4.3 Hazard Profiles and Vulnerability Analysis

4.3.1 ***<u>Active Shooter</u>***

The Federal Bureau of Investigation (FBI) defines an active shooter as one or more individuals “actively engaged in killing or attempting to kill people in a populated area.”[126]

4.3.1.1 Location

Active shooter 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 shooter may target more than one place. The graphic below shows the number of incidents by location as identified by the FBI where the public may be most at-risk for active shooter attacks in the United States.[127]



Source: Federal Bureau of Investigation, 2014

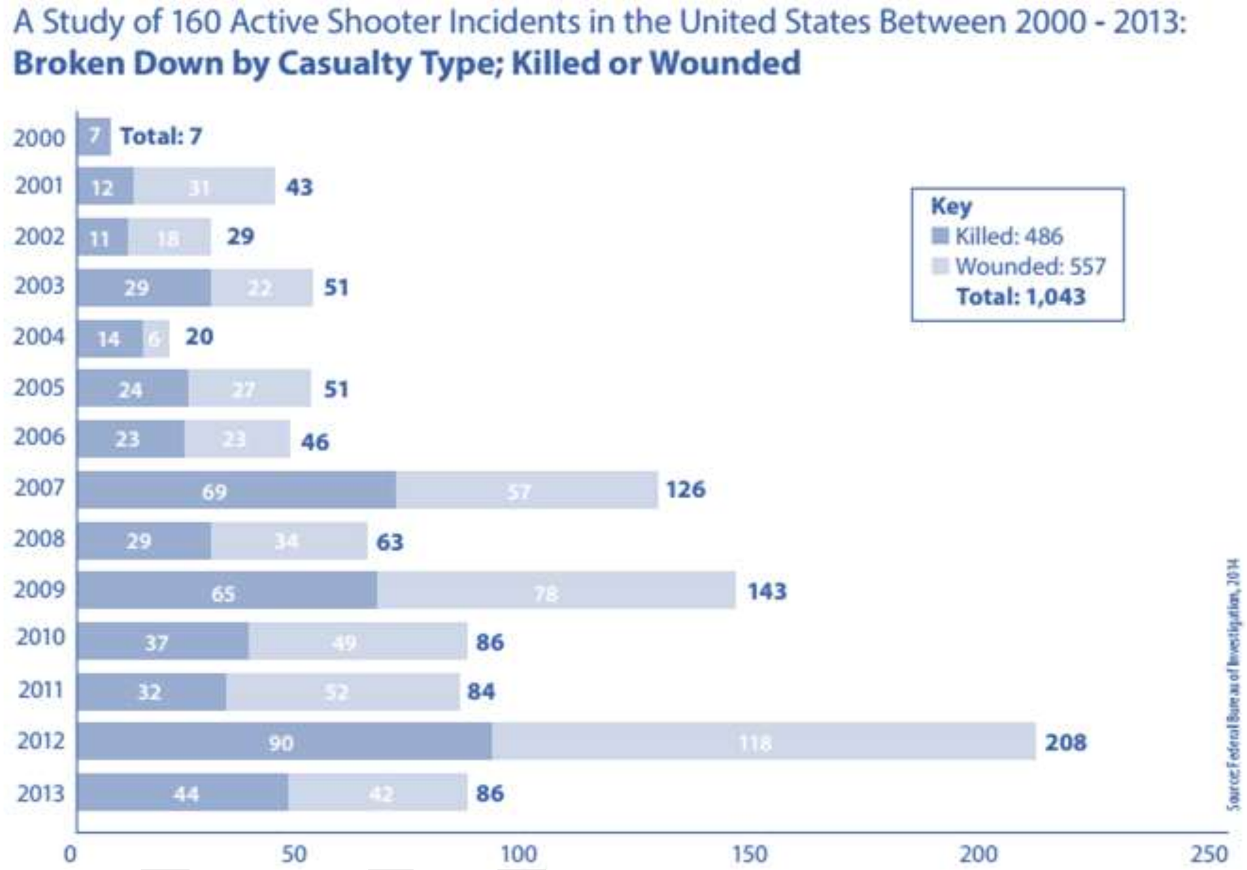
---

[126] Federal Bureau of Investigation. “Active Shooter Incidents”. Retrieved October 5, 2015.

[127] Federal Bureau of Investigation. “A Study of Active Shooter Incidents in the United States Between 2000 and 2013”. Retrieved January 14, 2016.

4.3.1.2 Magnitude

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. The chart below illustrates incidents by casualty type between the years 2000 and 2013.[128]



4.3.1.2.1 Worst-case Scenario

The following worst case scenario is derived from analysis of events in San Bernardino, Virginia Tech, Paris, and other recent active shooter incidents.

A small group of trained gunmen obtain a cache of weapons. They target a local busy street fair, with approximately 20,000 people in attendance in a six block stretch of road. The gunmen open fire at several locations along the route and side streets. Thirty fair goers and bystanders are killed, and nearly one hundred are injured. Officials lock down local schools and surrounding neighborhoods because of the shootings until the killers are confirmed to be dead or in custody.

---

[128] Federal Bureau of Investigation. "A Study of Active Shooter Incidents in the United States Between 2000 and 2013: Broken Down by Casualty Type; Killed or Wounded". Retrieved January 14, 2016.

4.3.1.2.2 Environmental Impact

Active shooter incidents typically occur in or near facilities or public spaces where groups are gathered, and often result in little to no impact on the environment. Additionally, active shooter incidents typically have little to no impact on essential utilities, as the goal of an active shooter is to cause injury and death to people, not physical damage to the environment.

4.3.1.3 Past Occurrences

For the purposes of this plan, past active shooter incidents include those events where the shooter's gun discharged, causing three or more casualties, not including the shooter. Incidents of active shootings in Philadelphia appear in the table below. [129] [130] Data access is limited to 2013 to 2016.

Shootings in Philadelphia Resulting in Three of More Casualties 2013-2016

Incident Date	Deaths	Injuries
17-Apr-16	3	1
26-Dec-15	0	4
15-Nov-15	0	4
20-Sep-15	1	3
22-Jun-15	0	7
20-Jun-15	0	11
28-Sep-14	0	4
21-Sep-14	2	2
9-Aug-14	0	4
1-Aug-14	1	3
28-Jul-14	1	4
21-Nov-13	0	4
6-Oct-13	1	5
13-Aug-13	0	4
16-May-13	0	4
11-May-13	0	4
9-Apr-13	1	3

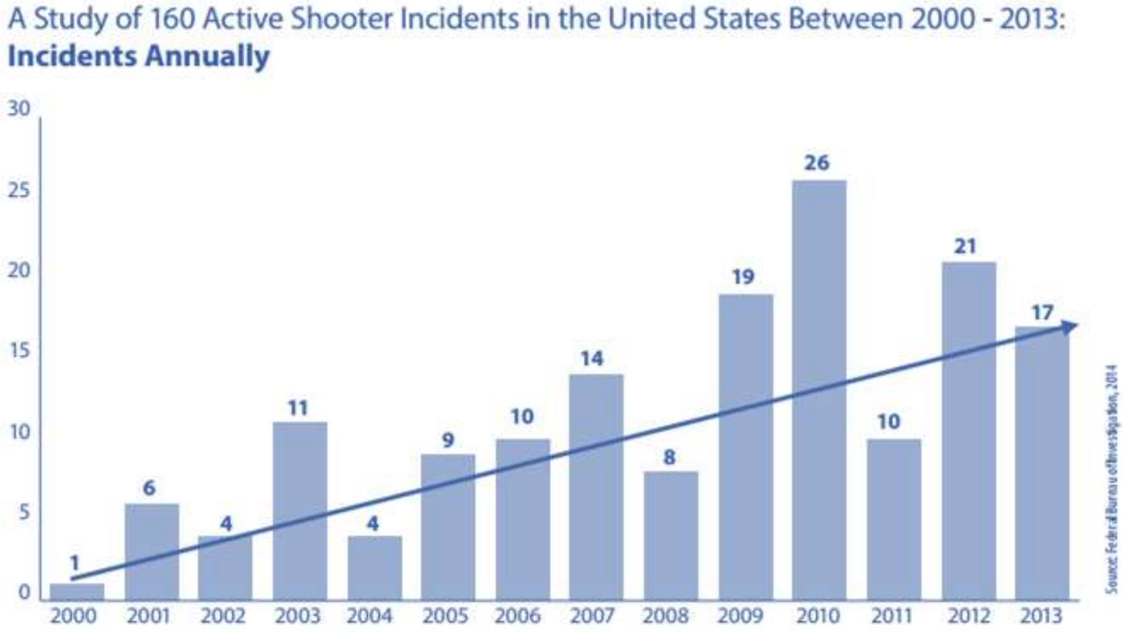
---

[129] Gun Violence Archive. Pennsylvania, Philadelphia, Three or more victims. Retrieved May 25, 2016.s

[130] City of Philadelphia Threat and Hazard Identification and Risk Assessment. 2014. Retrieved January 14, 2016.

4.3.1.4 Future Occurrences

Past active shooter incidents in Philadelphia do not provide enough data points to determine a local trend, but rising trends nationally suggest an increasing likelihood of an active shooter incident occurring. Between the 2000 and 2013, for example, average annual incidents increased from 6.4 to 16.4, with the largest percentage of these incidents occurring in commercial areas (46.5 percent) or educational environments (24.3 percent).[131] The chart below depicts national trends for active shooter incidents.[132]



A Study of 160 Active Shooter Incidents in the United States Between 2000 - 2013: **Incidents Annually**

Source: Federal Bureau of Investigation, 2014

4.3.1.5 Vulnerability Assessment

All loss estimates for this active shooter vulnerability assessment are from Philadelphia’s 2014 and 2015 Threat and Hazard Risk Assessment.

The largest impact of an active shooter is the loss of life and injuries caused by the event. The 2015 evaluations estimated that approximately 150 individuals would require triage and treatment in an active shooter scenario. In a worst-case scenario, deaths could reach 115 fatalities.[133] As a result, local hospitals and medical services would need to implement surge procedures and disaster plans, and request additional resources.

---

[131] Ibid.

[132] Image: “A Study of 160 Active Shooter Incidents in the United States Between 2000-2013: Incidents Annually”. A Study of Active Shooter Incidents in the United States Between 2000 and 2013. Federal Bureau of Investigation. September 2014. Retrieved January 29, 2016.

[133] 2015 City of Philadelphia Threat and Hazard Risk Assessment.

An active shooter scenario would have minimal impact to city infrastructure. Ingress and egress routes would close around the immediate area of the event, except to allow first responders priority access to victims.

Economic impacts resulting from an active shooter scenario are minimal, with only short-term economic disruption occurring in the area due to transportation corridor closures.

4.3.2 Drought

Drought is a natural climatic condition which occurs in virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a long period of time, usually a season or more in length. High temperatures, prolonged winds, and low relative humidity can exacerbate the severity of drought. Such imbalances can cause problems, including crop damage and water supply shortages. The severity of the drought depends on the degree of moisture deficiency, the size of the affected area, and the duration of the drought.

There are four types of droughts[134]:

Meteorological	Meteorological droughts occur when dry weather patterns dominate a region.
Hydrological	Hydrological droughts typically follow prolonged meteorological droughts and occur when water supplies become meaurably lower in streams, resevoirs and ground water levels.
Agricultural	Agricultural droughts occur when a lack of water and moisture in the soil adversely affect agricultural crops.
Socioeconomic	Socioeconomic droughts happen when the supply and demand of certain goods and services, such as drinking water, food, and enegy, are threatened or reduced by drought conditions.

The two types of drought of most concern to Philadelphia are hydrological drought and socioeconomic drought.

4.3.2.1 Location

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 in coordination with Delaware River Basin Commission (DRBC) closely monitor drinking water levels and quality during times of drought. The actions of the Delaware River Basin Commission (DRBC), neighboring states, federally and privately owned reservoirs work together to prevent severe declines in the rivers that Philadelphia and other municipalities use as drinking water supplies. The agricultural land in Philadelphia is not immune to the effects of a drought. However, only about 60 acres of land in Philadelphia is for agricultural purposes.[135]

---

[134] National Drought Mitigation Center (NDMC). Types of Drought. Retrieved 23 January 2012.

[135] Vitiello, D, Nairn, M.; Community Gardening in Philadelphia, 2008 Harvest Report. October 2009

4.3.2.2 Magnitude

Droughts are normal meteorological occurrences that result from natural decreases in precipitation over prolonged periods, usually a season or more. Most droughts cause direct impacts to aquatic resources. High temperatures, sustained winds, and low relative humidity may exacerbate the severity of a drought. [136]

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. The table below details the PDSI:

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
Unusual Moist Spell	+2.0 to +2.9
Very Moist Spell	+3.0 to +3.9
Extremely Moist	+4.0 and above

---

[136] Image: Brian Rademaekers. The lack of rain in May led to wilted and stunted plants in this Chestnut Hill garden". Philly Watersheds – Philadelphia Water Department. Retrieved January 15, 2016.

4.3.2.2.1 Phases

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. The chart below describes the drought phases in order of increasing severity.[137]

Drought Phase Conditions	
Drought Watch	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.
Drought Warning	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 percent 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.
Drought Emergency	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 non-essential 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 percent. The PDSI classifies a drought *emergency* as an "extreme" drought.

---

[137] Pennsylvania Department of Environmental Protection. Managing Drought in Pennsylvania. Retrieved 2 November 2011.

4.3.2.2.2 Worst-case Scenario

The following worst-case scenario is based on droughts experienced in Philadelphia in 1960, 2002, 2005, and 2010.[138]

In mid-September, a hot dry spell affects northeastern Pennsylvania and New Jersey. Over a four-month period, the average flow of the Delaware River is one quarter the long-term average flow. The salt front advances up the estuary as far as the Benjamin Franklin Bridge, affecting regional water intakes. Unusually high salinities stresses shellfish production. The supply of groundwater dwindles, and the monthly precipitation falls to half an inch.

The Governor declares a drought emergency and requires residents to conserve water by 15 percent. Those found in noncompliance face penalties for violating regulations. The Fire Department suspends pump testing and water training.

The heat and lack of water affect regional food supplies, causing damages to temperature-sensitive plants such as lettuce, parsley, cabbage, leeks, and arugula. Tomatoes, peppers, beans, and squash plants blister. Milk production is down due to stress on cows. Tree leaves begin to show signs of scorching along their edges, and dogwoods and maples show signs of water stress.

4.3.2.2.3 Environmental Impacts

Drought affects the environment in numerous ways. Depending on the severity of the drought, varying degrees of environmental effects can occur. Some impacts can last a short period, while others can last years if the drought is severe enough.

The lack of water during a drought can cause the loss or destruction of wildlife habitats, in both waterways, green spaces, and a shortage of food and water for wild animals, as well as an increase in disease in wild animals due to food and water supply reductions. Longer-term droughts may cause wildlife to migrate to better-stocked areas. A drier environment increases the risk for brush fires in the area. Erosion can also occur because of very dry soil, as winds can pick up and carry away the topsoil. Erosion, as well as the lack of water and nutrients, can also reduce soil quality.

4.3.2.2.4 Response Techniques

Local Water Rationing: Local municipalities, with the approval of the Pennsylvania Emergency Management Council, may implement local water rationing to share a rapidly dwindling or severely depleted water supply in designated water supply service areas. Water rationing plans, authorized through provisions of the Pennsylvania Code

---

[138] The droughts of 1960, 2002, 2005, and 2010 encompass droughts that had a large impact on the City of Philadelphia. Narratives and detailed descriptions on droughts are limited prior to 1949.

(Chapter 120), would require specific limits on individual water consumption to achieve significant reductions in use. [139]

Philadelphia Water Department Drought Emergency Restrictions: In the event a drought emergency occurs in Philadelphia, the Philadelphia Water Department (PWD) has developed mandatory water use restrictions to conserve water resources. Throughout a drought emergency, these restrictions make it illegal to: [140]

- Use water to clean personal, leased or rented vehicles, trailers, and boats by any means other than by bucket.
- Use water to clean sidewalks, streets or gutters, unless determined to be necessary for public health and safety.
- Use water for ornamental purposes, like fountains, waterfalls, and reflecting pools.
- Water gardens, trees, shrubs, except between 5 p.m. and 9 a.m. and then only by a bucket, can, or hand-held hose equipped with an automatic shutoff nozzle.
- Water lawns at all, except newly seeded or sodded lawns, which may be watered between 5 p.m. and 9 a.m. by bucket, can, or hand-held hose equipped with an automatic shutoff nozzle; sprinklers are strictly prohibited.
- Fill residential swimming pools; (NOTE: The state has permitted water providers, depending on their supplies, to allow residential swimming pools to be filled.)
- Fill swimming pools serving at least 25 dwelling units such as hotels, motels, and apartment complexes, unless they have filtration equipment to allow for continued use and recycling of water over the swimming season.
- Fill swimming pools unless they are operated by health care facilities used in relation to patient care and rehabilitation.
- Serve water in restaurants, clubs or eating places, unless requested by an individual.

4.3.2.3 Past Occurrences

The table below 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.[141] [142] The Drought Past Occurrences Annex encompasses a full list of declarations.

---

[139] Pennsylvania Department of Environmental Protection. Managing Drought in Pennsylvania. Retrieved 2 November 2011.

[140] The Philadelphia Water Department. Philadelphia Water Department Outlines Drought Emergency Restrictions. Retrieved 7 November 2011.

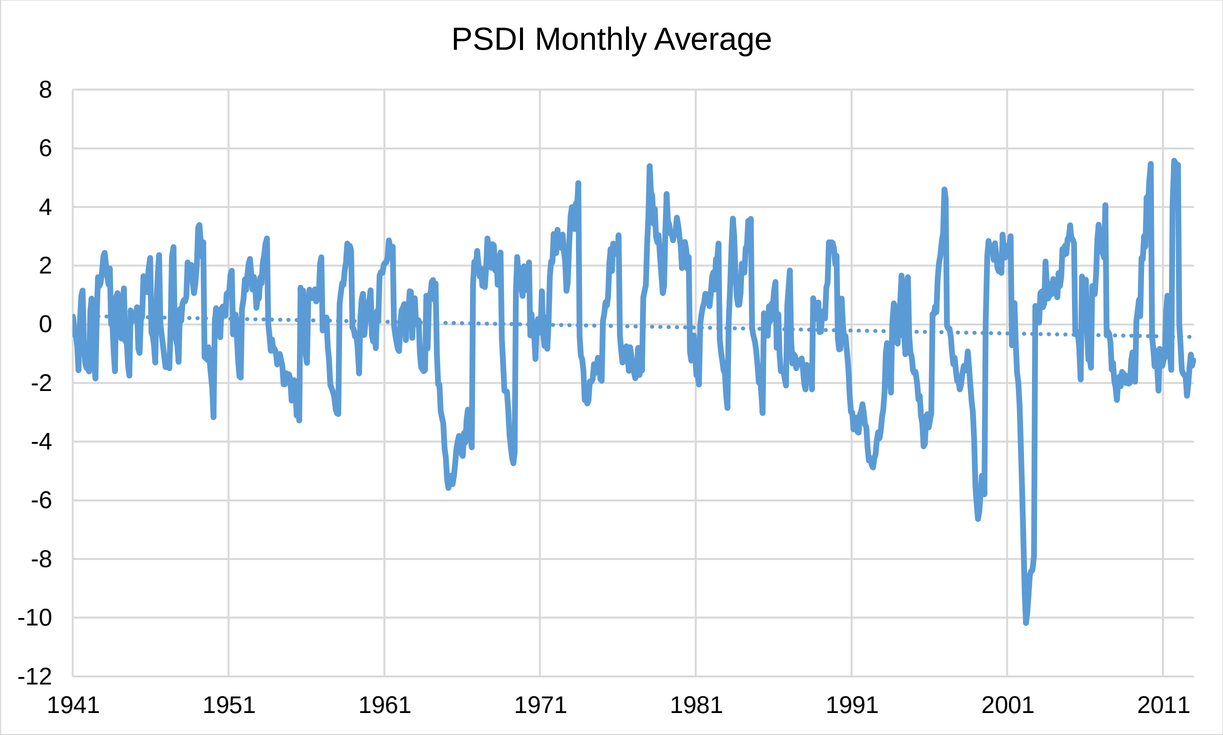
[141] Pennsylvania Department of Environmental Protection. Drought Status. Retrieved 2011.

[142] Drought Risk Atlas. National Drought Mitigation Center. Retrieved January 14, 2016.

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

4.3.2.4 Future Occurrences

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. There is a slight downward trend in PSDI over the past seven decades, indicating the possible increase in drought risk for the future. The graph below illustrates these trends.



4.3.2.5 Vulnerability Assessment

The impact of a drought depends not only on its severity, duration, and spatial extent, but also on ever-changing social conditions. A wide-range of factors, both physical and social, determines vulnerability to drought. According to the 2013 Pennsylvania Hazard Mitigation Plan, Philadelphia has an estimated 262 acres of farmland in the city.[143] The USDA estimates that economic losses resulting from drought impact on agricultural production for Philadelphia's farmland is approximately $487,000.[144]

Reduced water levels and subsequent curtailment of water usage will have a direct economic impact on businesses and industries that are water-dependent. The indirect impacts associated with drought are far-reaching but so diffuse that financial estimates of potential damages are not feasible.

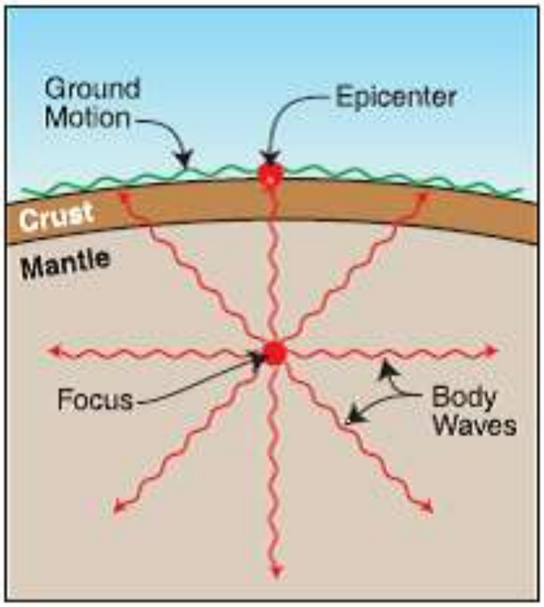
---

[143] "Drought: Jurisdictional Loss Estimation". 2013 Commonwealth of Pennsylvania State Standard All-Hazard Mitigation Plan.

[144] "Table 4.3.2-10: Estimated jurisdictional losses relating to agricultural production". USDA, Census of Agriculture, 2007. 2013 Commonwealth of Pennsylvania State Standard All-Hazard Mitigation Plan.

4.3.3 Earthquakes

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. An earthquake’s severity depends on the amount of energy released from the fault or epicenter. The image below depicts how an earthquake feels and spreads. In this image, the focus is the point within the earth where an earthquake rupture starts; the epicenter is the point directly above the focus at the surface of the earth; and a body wave is a seismic wave that moves through the interior of the earth, as opposed to surface waves that travel near the earth's surface.[145] [146]



According to the USGS Earthquake Hazards Program, more than 90 percent of earthquakes occur at boundaries where the earth’s tectonic plates converge, though it is possible for earthquakes to occur within plates. As plates continue to move and plate boundaries change over geologic time, weakened boundary regions become part of the interior of the plates. These zones of weakness within the continents cause earthquakes in response to stresses that originate at the edges of the plate or in the deeper crust.[147]

4.3.3.1 Location

Philadelphia is located within the North American plate, far from the plate boundary located approximately 2,000 miles east in the Atlantic Ocean. Due to zones of

---

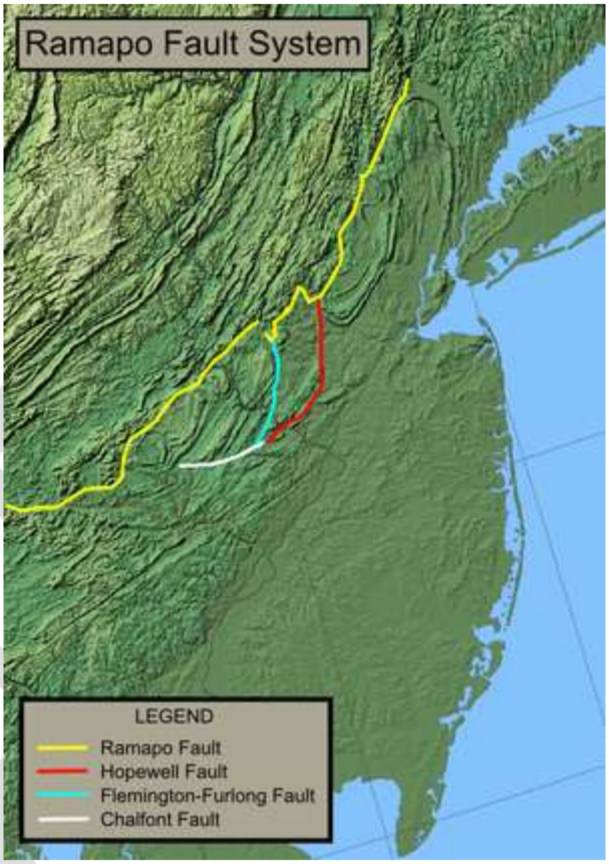
[145] USGS. Earthquake Glossary. Retrieved 6 October 2015.

[146] Image: FEMA. Earthquake Description. 2001. Retrieved January 15, 2016.

[147] United States Geological Survey (USGS). Earthquakes and Plate Tectonics. Retrieved 15 November 2011.

weakness or deep fault lines within the North American plate, earthquakes are a possible hazard within Philadelphia.

East of the Rocky Mountains earthquake faults do not break the ground surface. Their focuses are a few miles below the Earth's surface and their locations are determined by interpreting seismographic records. The closest fault to Philadelphia is the Ramapo Fault that is part of a system of northeast striking, southeast-dipping faults. These faults occur from southeastern New York to eastern Pennsylvania and beyond. The Ramapo Fault and its series were active at different times during the evolution of the Appalachians approximately 200 million years ago.[148] [149]



Soil type can have an impact on the severity of an earthquake at a given location because some rock types transmit seismic wave energy more readily. Seismic waves propagate out from the earthquake epicenter and travel outward through the bedrock up into the soil layers. A soil's firmness affects the wave speed and velocity. Generally, in a stiff or hard soil, the wave will travel at a higher velocity. With soft soils, the wave will slow, traveling at lower velocities. Slower waves modify the seismic energy, resulting in waves with greater amplitude, which results in greater earthquake damage. Some soils can liquefy when saturated.[150] When liquefaction occurs, the strength of the soil decreases and, the ability of a soil to support structural foundations reduces.[151]

The National Earthquake Hazard Reduction Program (NEHRP) Soil Classification System describes how soils affect seismic waves. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an

---

[148] Columbia University. Earthquakes and the Ramapo Fault System in Southeastern New York. Retrieved 21 February 2012.

[149] Ramapo Fault, USGS, Retrieved 13 October 2015.

[150] The Encyclopedia of Earth. Earthquake. Retrieved 16 November 2011.

[151] The transformation of loose sediment or soil into a fluid state as a result of increasing the pressure of the fluid in between the grains due to strong ground shaking. Liquefaction typically occurs in poorly consolidated, water-saturated sediment. Liquefaction can cause significant earthquake-related damage because structures located on ground that liquefies can collapse or sink into the ground.

earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses.[152]

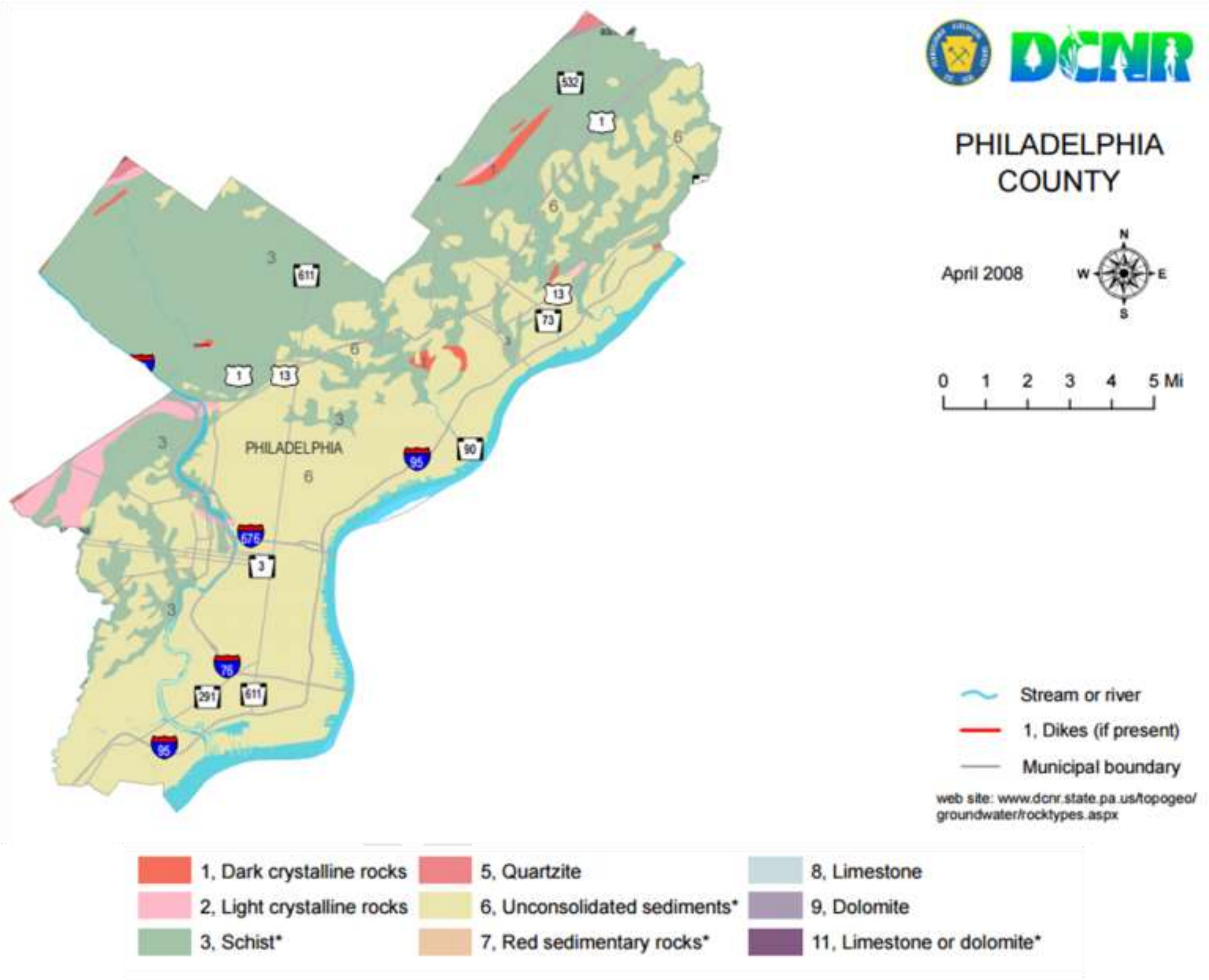
EHRP Soil Classifications	
Soil Classification	**Description**
A	Very hard rock (e.g., granite, gneisses)
B	Sedimentary rock or firm ground
C	Stiff clay
D	Soft to medium clays or sands
E	Soft soil including fill, loose sand, waterfront, lake bed clays

Philadelphia has a variety of soil types, including siltstone, shale, sandstone, limestone, claystone, coal, granite, and phyllite. Most of Philadelphia is classified as Class D (soft to medium clays or sands), and Class B (sedimentary rock or firm ground), with small amounts of Class A (very hard rock), and Class E (soft soils). The image on the following page shows the breakdown of Philadelphia by rock type.[153]

---

[152] Federal Emergency Management Agency. FEMA Region II Hazard Mitigation Plan Toolkit: Risk Assessment. Retrieved 12 November 2011.

[153] “County Rock Type Maps of Pennsylvania: Philadelphia”. PA DCNR. Retrieved March 23, 2016.


DCNR
PHILADELPHIA
COUNTY
April 2008
N
W
E
S
0
1
2
3
4
5 Mi
Stream or river
1, Dikes (if present)
Municipal boundary
web site: www.dcnr.state.pa.us/topogeo/groundwater/rocktypes.aspx
PHILADELPHIA
1, Dark crystalline rocks
2, Light crystalline rocks
3, Schist*
5, Quartzite
6, Unconsolidated sediments*
7, Red sedimentary rocks*
8, Limestone
9, Dolomite
11, Limestone or dolomite*
532
1
611
13
73
95
90
676
3
76
291
6
3

4.3.3.2 Magnitude

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 State Geological Survey (USGS) relies on specific measurement tools to account for magnitude and intensity, and describe the overall severity of an earthquake.

Magnitude refers to the energy released at the source of the earthquake. The Richter scale, an open-ended logarithmic scale, measures the magnitude of earthquakes. 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 two-point quake is barely noticeable while an 8.0 quake can cause serious damage across a large area. According to PEMA, earthquakes in Pennsylvania historically do not exceed a 6.0 magnitude.

Richter Scale Magnitudes & Associated Effects[154]

Richter Magnitudes	**Earthquake Effects**
Less than 3.5	Generally not felt, but recorded.
3.5 - 5.4	Often felt, but rarely causes damage.
5.5 - 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 kilometers 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 kilometers across.

Intensity refers to the strength of shaking produced by the earthquake at a certain location.[155] It considers the effects earthquakes have on people, human structures, and the natural environment. The Modified Mercalli Intensity (MMI) scale measures intensity. Intensity measurements provide insights to the amount of damage caused by an earthquake. The table on the following page describes the MMI Scale.

---

[154] "Table 4.3.3-1 Richter scale magnitudes and associated earthquake size effects". Pennsylvania 2013 Hazard Mitigation Plan. Retrieved March 23, 2016.

[155] United States Geological Survey (USGS). Earthquake Hazard Program: Earthquake Facts. Retrieved 15 November 2011.

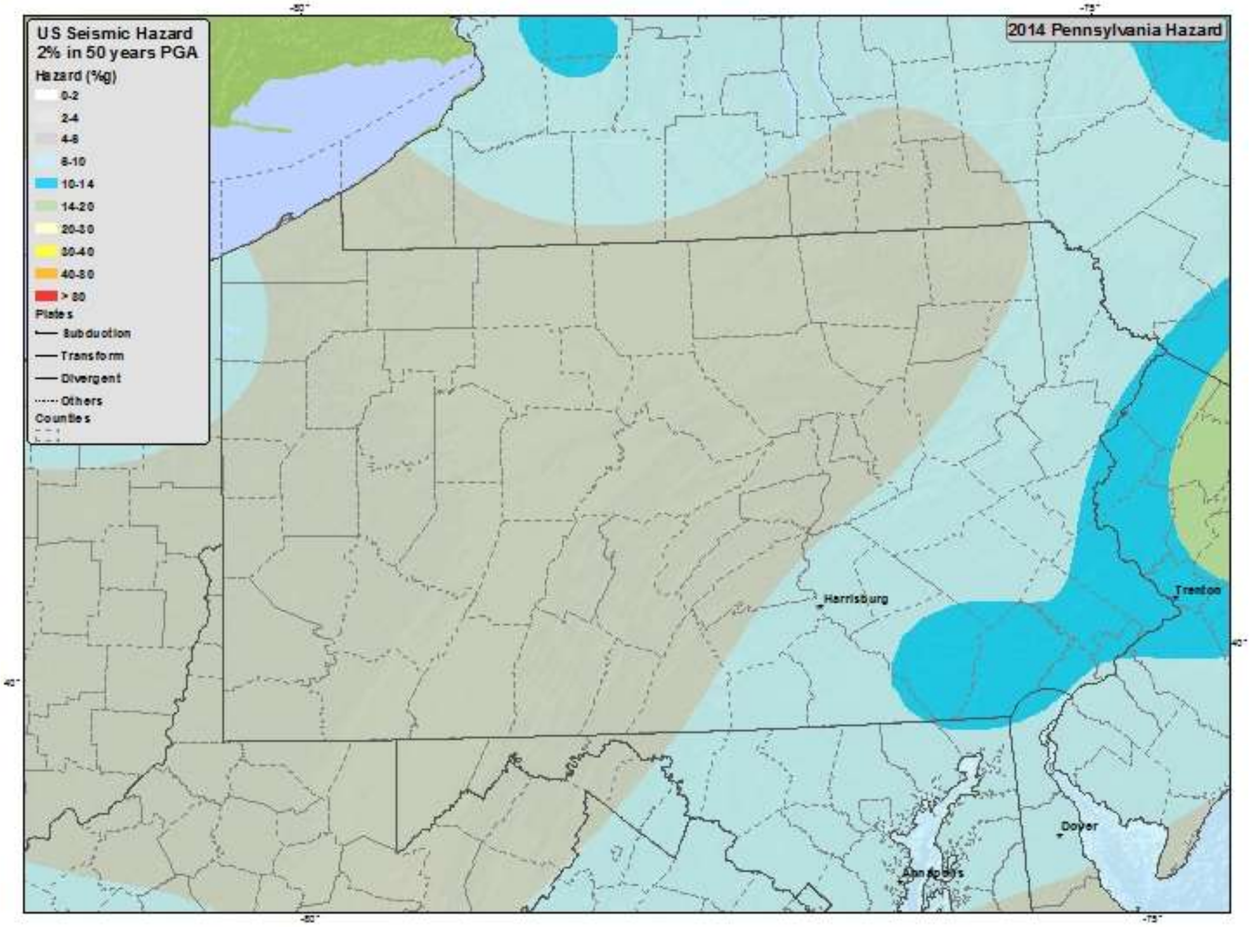
Modified Mercalli Intensity (MMI) scale[1] [1]

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only by seismographs	<4.2
II	Feeble	Some people feel it	<4.2
III	Slight	Felt by people resting; like a truck rumbling by	<4.2
IV	Moderate	Felt by people walking	<4.2
V	Slightly Strong	Sleepers awake; church bells ring	<4.8
VI	Strong	Trees sway; suspended objects swing; objects fall off shelves	<5.4
VII	Very Strong	Mild alarm; walls crack; plaster falls	<6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures; poorly constructed building damaged	<6.9
IX	Ruinous	Some houses collapse: ground cracks; pipes break open	<6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	<7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes, and cables destroyed; general triggering of other hazards	<8.1

XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	>8.1

The USGS further evaluates the intensity of earthquakes through Peak Ground Acceleration (PGA) and Spectral Acceleration (SA)[156].

PGA expresses the severity of an earthquake and measures how hard the earth shakes or accelerates in a given geographic area. The map below shows the probability of shaking in Pennsylvania over a 50-year period. As seen in the map, Philadelphia falls largely within the 10 to 14 percent range, with a small portion of the City falling into the 8 to 10 percent range.[157] This means that for the majority of Philadelphia, there is a two percent risk that the City will experience and earthquake with 10 and 14 percent-g. This range implies the City would feel strong perceived shaking, but experience only light damages.



---

[156] Additional information distinguishing Peak Ground Acceleration (PGA) and Spectral Acceleration (SA) is available at USGS: http://earthquake.usgs.gov/hazards/about/technical.php.
[157] USGS. 2014 Seismic Hazard Map. Retrieved December 4, 2015.

Spectral association (SA) determines approximately what a building experiences during an earthquake, and a better indicator of damage for specific building types and heights than PGA, which models what a particle on the ground experiences.[158]

Both PGA and SA can be measured in *g* (the acceleration of gravity), or expressed as a percent acceleration force of gravity (%*g*). [159] The chart below provides the approximate equivalents MMI for each range of PGA.

MMI/PGA Equivalents Chart[160]

MMI	Acceleration (%g) (PGA)	Perceived Shaking	Potential Damage
I	<.17	Not felt	None
II	.17 - 1.4	Weak	None
III	.17 - 1.4	Weak	None
IV	1.4 - 3.9	Light	None
V	3.9 - 9.2	Moderate	Very Light
VI	9.2 - 18	Strong	Light
VII	18 - 34	Very Strong	Moderate
VIII	34 - 65	Severe	Moderate to Heavy
IX	65 - 124	Violent	Heavy
X	>124	Extreme	Very Heavy
XI	>124	Extreme	Very Heavy
XII	>124	Extreme	Very Heavy

4.3.3.2.1 Worst-case Scenario

The following worst-case scenario is derived from analysis of the earthquakes experienced in the Philadelphia region, as well as PA DCNR information and risk analysis for the region.

Around 7PM on a September weekday, an earthquake measuring V. Moderate on the MMI scale shakes the greater Philadelphia region. Homes shake, with almost everyone in the city able to feel the equivalent of a heavy truck hitting a building. Cracked plaster and some broken windows occur throughout the City. Household contents shift and fall,

---

[158] Ibid

[159] United States Geological Survey. What do the ground-motion parameters on these maps mean? Retrieved 1 December 2011.

[160] "Approximate Relationship between MMI and PGA". 2014 New York City Hazard Mitigation Plan. Retrieved April 13, 2016.

and some unsecured furniture overturn. Slight damage occurs in some well-built houses with a few instances of fallen plaster. Poorly constructed or maintained homes exhibit some damage, such as cracks in the masonry. Stopped vehicles noticeably move. The 9-1-1 call center quickly becomes overwhelmed with calls from concerned citizens.

4.3.3.2.2 Environmental Impacts

More severe earthquakes can result in subsidence, soil liquefactions, and landslides. The sections below explore each of these results and their respective environmental impacts.

Subsidence

Earthquakes can result in subsidence, which is the gradual caving in or sinking of an area of land. Subsidence can result from the ground shaking, which causes looser sediment to "settle" and lose bearing strength.[161] Subsidence can affect a large area, and can permanently shift flooding patterns if the land sinks far enough, or if the subsidence occurs near a body of water.

Soil Liquefactions

Earthquakes generate a large amount of pressure on soil and sand. Saturated or partially saturated soil may lose strength and stiffness, causing it to act like a liquid. Soil liquefaction can affect trees and plants, causing felled trees and damaged habitats.

Landslides

Earthquakes can shift or add loads to an existing slope, resulting in a landslide. Philadelphia is more prone to shallow landslides, which include debris flows, debris slides, and failures of roads in cut-slopes. Shallow landslides often result where there is an existing slope on permeable soil. Upper soil fills with water and becomes heavy, creating pressure on wet lower soil. As the pressure increases, slopes can become unstable, resulting in top soil sliding over lower soil. Landslides can wipe out areas of plant life, as well as increase the level of sediment in a waterway if the landslide flows into a waterway.

4.3.3.3 Past Occurrences

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. For a

---

[161] Earthquake Hazards. GNS Science. Retrieved January 28, 2016.

full list of those earthquakes with epicenters in or around Southeast Pennsylvania, visit the Past Occurrences of Earthquakes in or around Southeast Pennsylvania Annex.

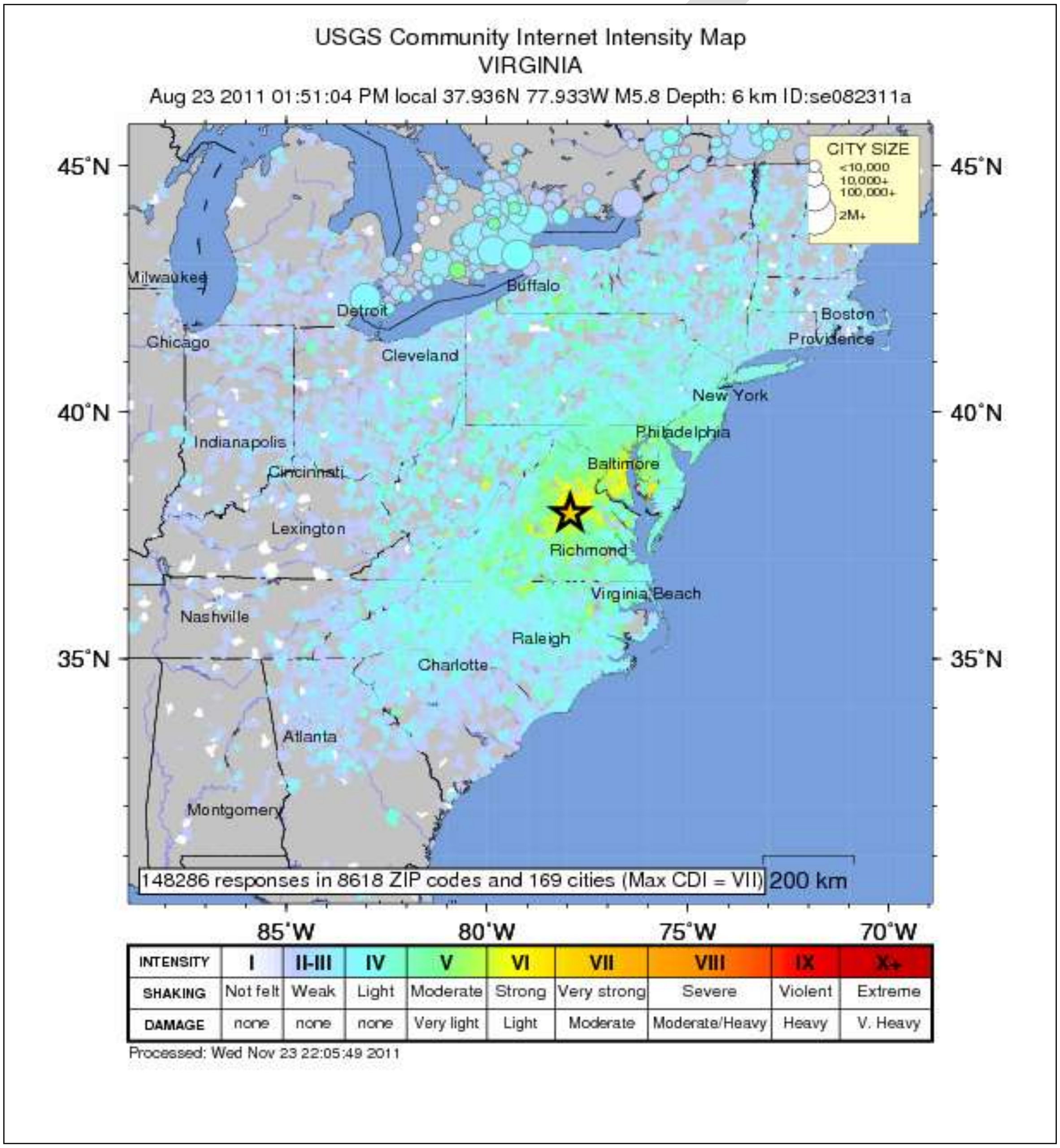
Top Ten Earthquakes by Magnitude

Date	Location	Magnitude	Intensity
10/9/1871	Deepwater, NJ	4.1	VII
2/28/1973	Penns Grove, NJ	3.8	V-VI
11/15/1939	Folsom, NJ	3.8	V
12/17/1752	Sadsburyville, PA	3.6	IV
3/5/1980	Abington, PA	3.5	IV
1/26/1926	Cinnaminson, NJ	3.5	N/A
4/28/1974	Centerville, DE	3.3	IV
7/10/1973	Newark, DE	3.3	IV
8/14/1972	Wilmington, DE	3.3	IV
12/29/1971	Wilmington, DE	3.3	IV

Top Ten Earthquakes by Intensity

Date	Location	Magnitude	Intensity
10/9/1871	Deepwater, NJ	4.1	VII
2/10/1977	Wilmington, DE	2.6	VI
3/11/1975	Wilmington, DE	2	VI
2/28/1973	Penns Grove, NJ	3.8	V-VI
11/15/1939	Folsom, NJ	3.8	V
12/27/1961	Croyden Heights, PA	3.3	V
1/26/1921	Cinnaminson, NJ	3.3	V
2/11/1972	Wilmington, DE	3.2	V
1/8/1944	Bellefonte, DE	3.2	V
12/10/1968	Medford, NJ	3	V

The epicenter of an earthquake does not need to be within a close distance of Philadelphia for the city to experience its effects. On August 23, 2011 a magnitude 5.8 earthquake centered northwest of Richmond, VA, shook most of the East Coast, including Philadelphia. Numerous buildings in Center City Philadelphia evacuated as a precaution (this is not the recommended course of action during an earthquake), and many people around the region reported feeling structures shake. The image below depicts the intensity of the August 23, 2011 earthquake.[162]



---

[162] Image: USGS. Intensity Map. Retrieved 2011.

4.3.3.4 Future Occurrences

Though the Eastern United States experiences far fewer moderate or large magnitude earthquakes than the Pacific Coast, which sits directly on an active tectonic plate boundary, this does not mean the area is immune to such a hazard. A few very large and very damaging earthquakes have occurred in stable continental regions like the one Philadelphia lies within. The table below demonstrates the probabilities associated with higher magnitude earthquakes in or around 50 km of Philadelphia, using the most recent USGS calculations from 2009.

Earthquake Probability Within the Next 100yr:
50 km vicinity of Philadelphia[163] [164]

Magnitude	Probability	Magnitude	Probability
5.0	2.957%	6.4	0.342%
5.1	2.402%	6.5	0.269%
5.2	2.402%	6.6	0.229%
5.3	1.954%	6.7	0.208%
5.4	1.592%	6.8	0.153%
5.5	1.301%	6.9	0.123%
5.6	1.209%	7.0	0.106%
5.7	0.992%	7.1	0.067%
5.8	0.877%	7.2	0.046%
5.9	0.725%	7.3	0.035%
6.0	0.677%	7.4	0.015%
6.1	0.545%	7.5	0.002%
6.2	0.472%	7.6	0.001%
6.3	0.373%		

---

[163] Data limitations exist in the data used by USGS to create this probability. No data for earthquakes after 2006 are included in calculations. The USGS tool utilized states that the tool will underestimate the probability because it is based on the 2008 National Seismic Hazard Maps.

[164] 2009 Earthquake Probability Mapping. USGS. Retrieved December 11, 2015.

4.3.3.5 Vulnerability Assessment

A strong earthquake with an epicenter located in downtown, though a low probability would cause extensive critical services disruptions, financial losses, and casualties. The following list of earthquake-induced impacts either directly or indirectly would affect Philadelphia's economy, environment, and residents.

Earthquake Impacts		
Economy	**Environment**	**People**
▪ 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 ▪ Break down of social order ▪ Disease ▪ Lack of basic necessities ▪ Increased fire hazard ▪ Loss in aesthetic values ▪ Increased poverty

The table below summarizes earthquake losses for Philadelphia predicted by a HAZUS analysis run in April 2016. HAZUS, in its most up to date form, analyzes population and building data provided in the 2010 Census data. The table also includes analyses from the Pennsylvania 2013 Hazard Mitigation Plan (HMP) and 2012 Philadelphia Hazard Mitigation Plan (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 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.

Earthquake Impacts			
	2017 Philadelphia HMP Model	**2013 PEMA HMP Model**	**2012 Philadelphia HMP Model**
Buildings at Least Moderately Damaged	120,147	157,484	37,980
Buildings Damaged Beyond Repair	9,908	7,428	873
Economic Losses for Buildings – Including Capital and Income Losses (Millions)	$23,377.88	$20,547.92	$6,321.69
Shelter Requirement	18,861	9,695	2,237
Injury Estimates (2AM)	1,548	25	1,375
Casualty Estimates (2AM)	372	1	41

The image below 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 the largest economic losses.

Below is a full overview of the HAZUS-MH Loss Estimation for the 2017 Hazard Mitigation Plan. Planners used HAZUS loss estimation methodology software to estimate impacts contained in this overview. There are uncertainties inherent in any loss estimation technique. Therefore, there may be discrepancies between these numbers and the results of an actual earthquake event.

Earthquake Information	
Magnitude:	5
Epicenter Latitude/Longitude:	39.99 / -75.11
Depth:	10 feet
Type:	Arbitrary
Maximum PGA:	1.00
Ground Motion/Attenuation:	Central & East US (CEUS 2008)

Estimated Economic Loss ($ Billions)

Category	**Description**	**Range**
General Building Stock	Building Damage	7.00-28.10
	Building Contents	0.40-1.60
	Business Interruption	2.20-8.70
Infrastructure	Lifelines Damage	-
	Total	11.70-46.80

Estimated Building Damage (Thousands of Buildings)

Description	**Residential**	**Commercial**	**Other**	**Total**
Minor	100-400	6-30	2-9	110-500
Major	17-70	2-10	1-3	20-80
Total	120-500	9-40	3-12	130-500

Estimated Casualties: Night Time

Severity Level	**Description**	**# Persons**
Level 1	Medical Aid	3,000-12,000
Level 2	Hospital Care	700-3000
Level 3	Life-threatening	90-400
Level 4	Fatalities	190-700

Estimated Shelter Needs

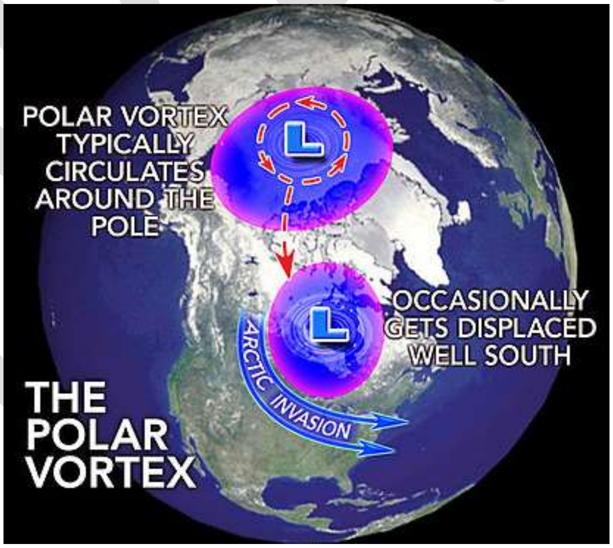
Type	**Households**	**People**
Displaced Households	12,000-50,000	30,000-125,000
Public Shelter	7,544	18,861

4.3.4 Extreme Cold

Extreme cold events are days where the mean daily temperature, the average between the high-recorded temperature and the low-recorded temperature over a 24-hour period, falls below 32°F. In Philadelphia, extremely cold temperatures often accompany a winter storm, which can bring snow and ice. Prolonged exposure to cold temperatures, whether indoors or outside, can lead to serious or life-threatening health problems, such as hypothermia, cold stress, frostbite, or freezing of exposed extremities. Extreme cold can cause emergencies in susceptible populations, including those without shelter, or those who live in a poorly insulated home, or a home without heat. Infants and the elderly are particularly at risk, but extremely cold temperatures can affect anyone.[165] [166]

4.3.4.1 Location

Located about 60 miles from the Atlantic Ocean, Philadelphia generally experiences warm summers and mild winters. Extreme temperature events do occur, however. Cold artic air masses can move down from Canada during winter months bringing frigid temperatures to the region for an extended period. A Polar Vortex—large pockets of very cold air in the northern polar region—can move into the Philadelphia region when the vortex is pushed farther south by a powerful high-pressure system in the Eastern or Western Pacific. A Polar Vortex can deliver below-zero temperatures for extended periods until it moves back above the pole.[167]

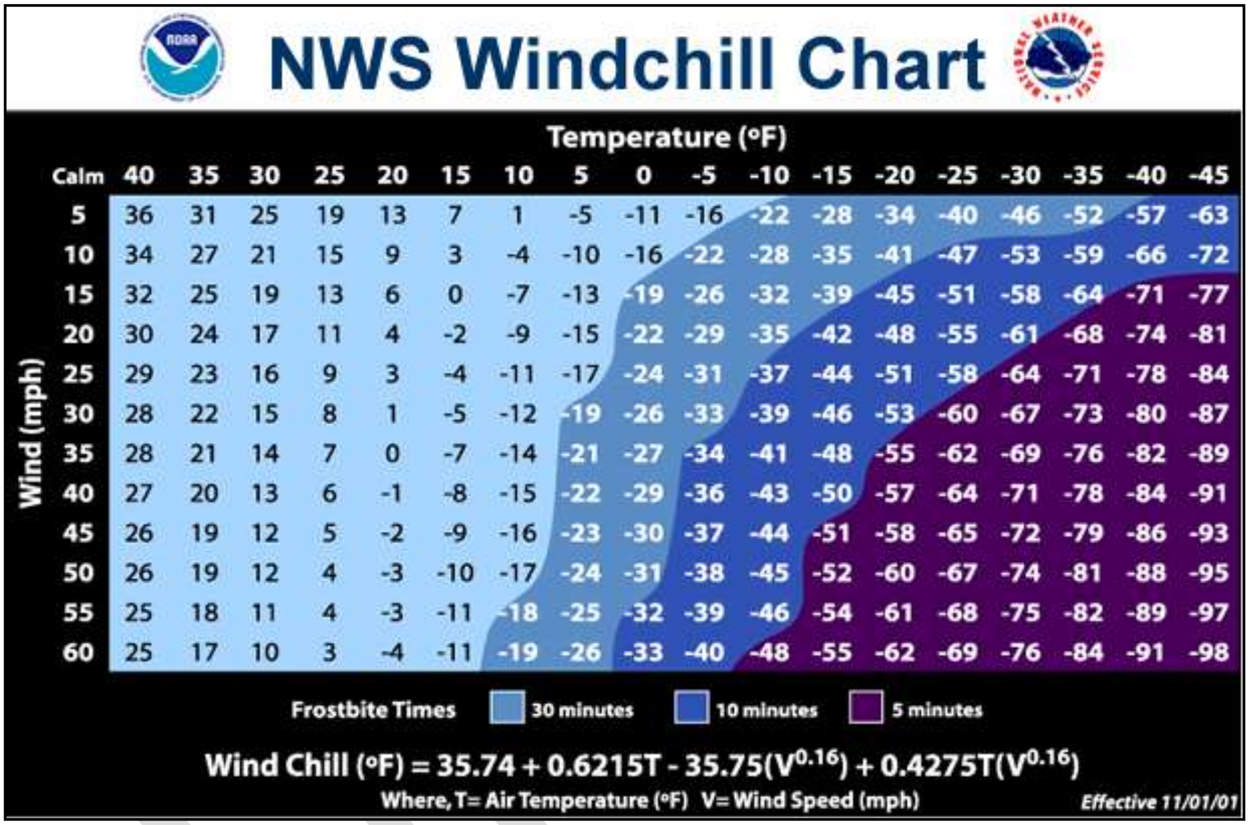


---

[165] Center for Disease Control and Prevention (CDC). Emergency Preparedness and Response Extreme Cold: A Prevention Guide to Promote Your Personal Health and Safety. Retrieved December 7, 2011.
[166] Image: Frozen Schuylkill River, Philadelphia 2014" by Shuvaev - Own work. Licensed under CC BY-SA 3.0 via Commons. Retrieved December 28, 2015.
[167] Image: Accuweather. Polar Vortex. Retrieved December 1, 2015.

4.3.4.2 Magnitude

The Wind Chill Temperature Index for extreme cold measures the severity or magnitude of extreme temperatures. Whenever temperatures drop well below normal, and wind speed increases, heat leaves a body rapidly. NWS has developed a wind chill chart depicting apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.[168]



NWS Windchill Chart

Temperature (°F)

Wind (mph)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
	5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
	10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
	15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
	20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
	25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
	30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
	35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
	40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
	45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
	50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
	55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
	60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times ▨ 30 minutes ▨ 10 minutes ▨ 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

---

[168] Image: NWS Wind chill Chart. National Weather Service. Retrieved January 29, 2016.

When conditions warrant, NWS issues wind chill watches, advisories, and warnings. The table below describes the criteria for these weather products.

NWS Wind Chill Products[169]

Product	**Description**
Wind Chill Watch	Conditions are favorable for wind chill temperatures to meet or exceed local wind chill warning criteria in the next 24 to 72 hours. Wind chill temperatures may reach or exceed -25°F.
Wind Chill Advisory	Wind chill temperatures are expected to meet or exceed local wind chill advisory criteria in the next 12 to 36 hours. Wind chill temperatures may reach or exceed -15°F.
Wind Chill Warning	Wind chill temperatures are expected to meet or exceed local wind chill warning criteria in the next 12 to 36 hours. Wind chill temperatures may reach or exceed -25°F.

---

[169] National Weather Service Expanded Winter Weather Terminology. National Weather Service. Retrieved January 29, 2016.

4.3.4.2.1 Common Extreme Temperature Health Concerns

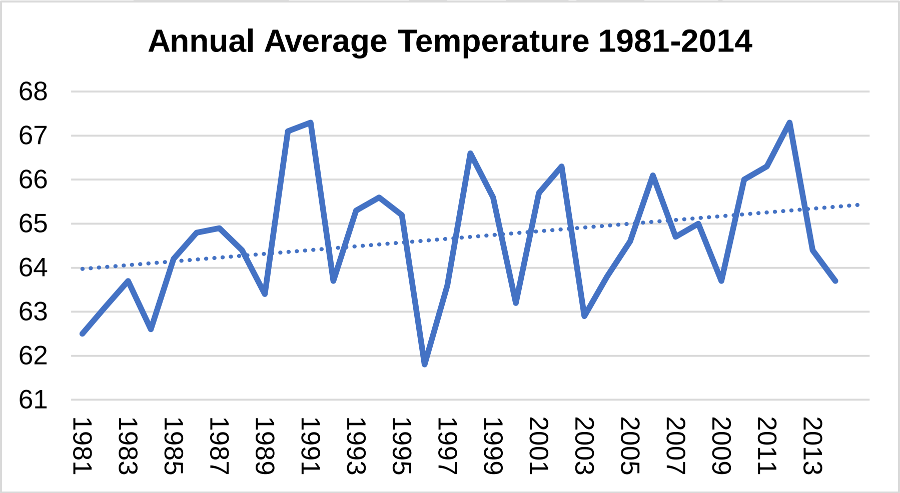
The table below describes the heath-related illness and health concerns associated with extreme cold temperatures.

Cold Related Illnesses/Health Concerns	
Illness/Health Concern	**Description**
Frostbite	Frostbite is the most common injury caused by exposure to cold. Before the onset of frostbite, exposed skin may become slightly flushed, pink in color, then change to white or yellow as the condition develops. Pain sometimes occurs, followed by a feeling of intense cold and numbness. In cases of severe frostbite, large blisters appear on and beneath the skin. The affected area is hard, cold and without sensation.
Hypothermia	Hypothermia is the rapid and progressive physical and mental collapse that results from a loss of body heat. Hypothermia occurs from a combination of cold, exhaustion, wind chill and moisture. Hypothermia can occur in above freezing (32º F) temperatures, and symptoms include uncontrollable shivering, drowsiness or exhaustion, slurred speech, fumbling or staggering, and lack of concern for physical well-being.
Carbon Monoxide Poisoning	Carbon monoxide (CO) is a colorless, odorless, tasteless, non-irritating, toxic gas that is undetectable without a monitoring device. Sources of carbon monoxide poisoning include heating systems and any appliance that burns fuel, such as poorly ventilated gas ranges and kerosene space heaters. Automobile exhaust fumes are another source of carbon monoxide. The risk of CO exposure increases in the winter because windows and doors are shut tight, trapping gases inside.
Exacerbation of Pre-Existing Respiratory Conditions	Cold air constricts soft tissue of the respiratory tract. Thus, individuals with a history of respiratory ailments, such as asthma, emphysema, chronic bronchitis are particularly susceptible to a worsening of their conditions.
Death	

4.3.4.2.2 Climate Change

According to the Environmental Protection Agency, “climate change refers to any significant change in the measures of climate lasting for an extended period of time”[170]. Changes include major deviations in temperature, precipitation, or wind patterns, among other fluctuations, that occur over several decades or longer.[171] The EPA states that the Earth's average temperature has risen by 1.5°F over the past century[172]. The EPA also projects that the planet’s temperature will rise another 0.5 to 8.6°F over the next hundred years[173]. These seemingly small changes can translate to large and potentially dangerous shifts in climate and weather. Climate data project changes in the average winter temperature to be greater than changes in average summer temperature.[174] The most extreme scenarios show a 9.3°F increase by 2081-2099, with more conservative models projecting a 2.5°F to 4°F increase in the winter months.[175]

Local temperature trends also show the local effects of climate change. NOAA data track average annual temperature over time for Philadelphia. Trends resulting from this data show an increase in the average annual temperature from 1981 to the present. The image below depicts these trends.

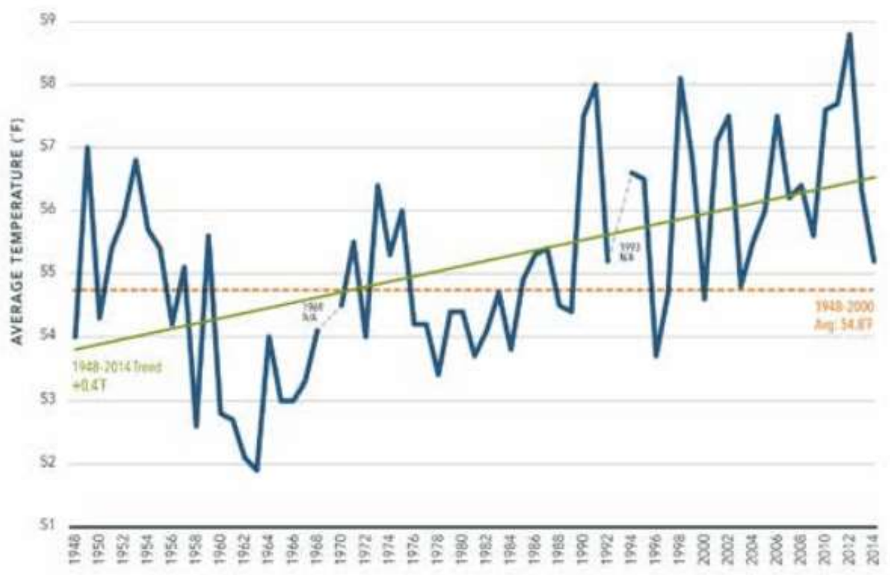


---

[170] Environmental Protection Agency. Glossary. Retrieved 5 October 2015.
[171] Ibid.
[172] Environmental Protection Agency. Climate Change: Basic Information. Retrieved 6 October 2015.
[173] Ibid.
[174] Useful Climate Science for Philadelphia. ICF International. Mayor’s Office of Sustainability. Retrieved December 9, 2015.
[175] Useful Climate Science for Philadelphia. ICF International. Mayor’s Office of Sustainability. Retrieved December 9, 2015.

The Mayor's Office of Sustainability conducted an analysis in 2015, tracking annual temperature trends for Philadelphia from 1948 to 2014. The image below shows the upward trend resulting from this analysis.[176]

ANNUAL TEMPERATURE TREND FOR PHILADELPHIA, 1948–2014



4.3.4.2.3 Worst-case Scenario

The following scenario is a hypothetical worst-case scenario that uses trends in temperature and gas/electricity consumption in combination with occurrences from real extreme cold events from 2015, 2007, and 2000 in Philadelphia.

An arctic air mass that originated near the North Pole moves down into Eastern Pennsylvania in mid-January. Temperatures drop into the single digits, and combined with gusty northwest winds, wind chills fall to 15 below zero for the next few mornings.

Many pipes freeze across the region. Two large water mains burst in Center City, flooding basements in the area and creating localized icy situations. The Fire Department experiences difficulties in battling blazes in these conditions.

The City declares a Code Blue, expanding homeless shelter capacity and extending additional assistance. Schools close for two days, and delay openings during the most extreme temperatures. PECO experiences a new winter usage record for electricity consumption. PGW sets a new consumer gas usage record city-wide.

---

[176] Mayor's Office of Sustainability and ICF International. Growing Stronger: Toward a Climate-Ready Philadelphia. November 2015. Retrieved January 12, 2016.

4.3.4.2.4 Environmental Impacts

Extreme cold affects growing season of plants, particularly when frost and freeze events occur early or late in growing seasons. Absolute temperature and duration of extreme cold can have detrimental effects on trees and winter crops as well. Extreme cold events can also negatively affect pets and other animals not suited for colder temperatures.

Extreme cold events, when longer term, can cause water in and along waterways to freeze. During the spring and early winter, there is the risk that these ice bodies can break free and float into the river creating an ice floe. Ice floes can create ice jams on the river, potentially causing flooding and affecting turbidity and flow of the waterway.

4.3.4.3 Past Occurrences

Since the 2012 update of the Hazard Mitigation Plan, Philadelphia has seen 207 days where the daily average temperature was below 32 degrees.[177] In late 2013, and early 2014 and 2016, Philadelphia experienced the effects of a polar vortex, sending temperatures into single digits for three consecutive days. Philadelphia has never experienced temperatures remaining below zero for longer than a 24-hour period, but single-digit temperatures have persisted through a 24-hour period on 12 different occasions.[178] The tables below show the coldest days recorded in Philadelphia, followed by the longest freezing streaks in Philadelphia.

Coldest Days on Record in Philadelphia[179]

Date	Low Temperature (°F)	Date	Low Temperature (°F)
Feb 9, 1934	-11	Jan 21, 1985	-6
Jan 17, 1982	-7	Jan 10, 1875	-5
Jan 22, 1984	-7	Dec 30, 1880	-5
Feb 10, 1899	-6	Jan 29, 1963	-5
Feb 11, 1899	-6	Jan 19, 1994	-5

---

[177] NOWData. NOAA Online Weather Data. Retrieved December 7, 2015.

[178] NOWData – NOAA Online Weather Data. National Weather Service Forecast Office: Philadelphia/Mount Holly. Retrieved December 8, 2015.

[179] Nese, Swartz, 2002.

Longest Freezing Streaks in Philadelphia[180]	
Number of Days	**Dates**
15	Feb. 6 to, Feb. 19, 1979
15	Jan. 19 to, Feb. 2, 1961
13	Jan. 10 to, Jan. 22, 1893
12	Jan. 23 to, Feb. 3, 1936
12	Feb. 3 to, Feb. 14, 1895
11	Jan. 8 to, Jan. 18, 1981
11	Dec. 21 to, Dec. 31, 1935
10	Dec. 16 to, Dec. 25, 1989
10	Jan. 10 to, Jan. 19, 1982
10	Dec. 7 to, Dec. 16, 1958
10	Jan. 23 to, Feb. 1, 1948
10	Dec. 15 to, Dec. 24, 1945
10	Feb. 5 to, Feb. 14, 1899

4.3.4.4 Future Occurrences

Currently, several extreme cold temperature events occur each year in Philadelphia. Warming trends related to climate change may cause these extreme cold events to decrease in frequency. Climate warming trends vary by the model used, but all predict an increase in temperature. Several climate models forecast that changes in the average winter temperature will be greater than changes in average summer temperature.181 The extreme scenarios show a 9.3°F increase by 2081-2099 during winter months, with more conservative models showing a 2.5°F to 4°F increase in the winter months.182 Climate science data project that Philadelphia will experience more frequent and intense precipitation events, including snow events. Increasing precipitation in winter has several effects detailed in the Winter Storms hazard profile of this document.

4.3.4.5 Vulnerability Assessment

Though extreme temperatures generally occur over a short period of time, they can cause a range of impacts to humans, animals, and infrastructure.

The most impacted populations in extreme temperatures include vulnerable populations with little or no access to adequate cooling or heating, such as those groups listed as most affected by extreme heat scenarios.

---

[180] NOWData – NOAA Online Weather Data. National Weather Service Forecast Office: Philadelphia/Mount Holly. Retrieved December 8, 2015.

[181] Useful Climate Science for Philadelphia. ICF International. Mayor's Office of Sustainability. Retrieved December 9, 2015.

[182] Useful Climate Science for Philadelphia. ICF International. Mayor's Office of Sustainability. Retrieved December 9, 2015.

During periods of extreme cold, inadequate protection from the harsh temperatures is extremely dangerous to individuals. Subsequently, Philadelphia’s homeless population is especially vulnerable. The City of Philadelphia plans for extreme weather, including extreme cold events that takes into consideration outreach strategies to the homeless population.

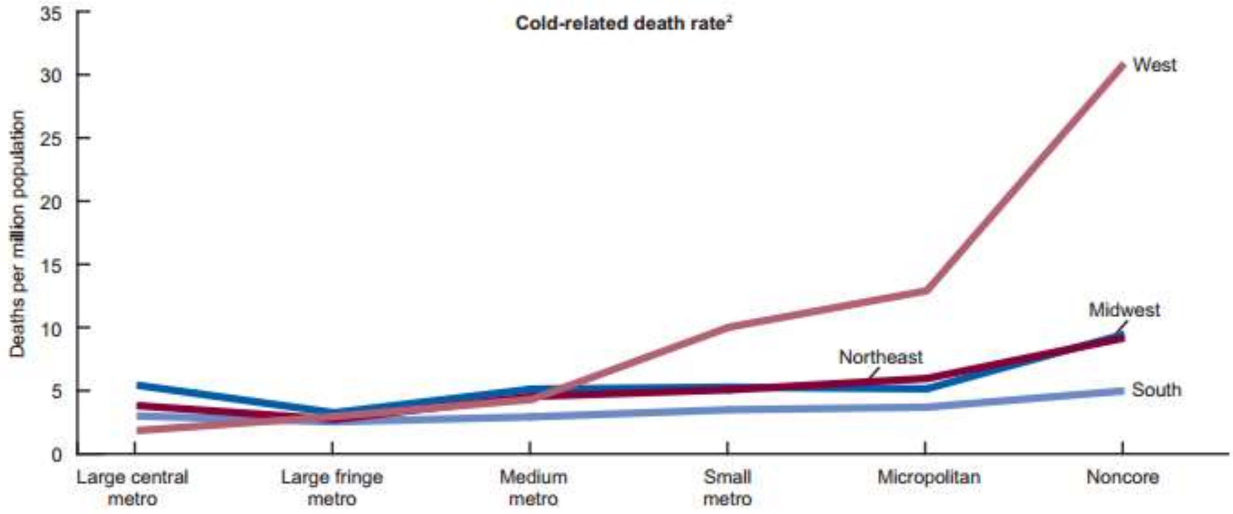
A portion of Philadelphia’s utility infrastructure is susceptible to extreme temperatures. Frozen pipes can create service interruptions in water, drainage, and gas supply. In addition, water intakes in Philadelphia can freeze, slowing operations. Following an extreme cold event, there is often an increase in water main breaks and gas main breaks. Water or gas expands following a cold period, sometimes cracking or rupturing the line.

Unlike other natural hazards, extreme temperatures have limited physical destructive force. Economic losses can be observed through the repairing of damaged infrastructure like roads and bridges following a freeze-thaw cycle associated with extreme cold scenarios. However, the primary concern associated with extreme temperatures is public health and safety. Fatalities caused by extreme temperatures rank the highest in the United States, with 6,660, or 63 percent, of all weather-related deaths resulting from exposure to excessive natural cold, hypothermia, or both.[183] The image below illustrates extreme cold temperature-related fatalities between 2006 and 2010 as they compare between different populations. In this graphic, Philadelphia would qualify as a “large central metro” in the Northeast.[184]

---

[183] Deaths Attributed to Heat, Cold, and Other Weather Events in the United States, 2006–2010. Jeffrey Berko, M.P.H., Deborah D. Ingram, Ph.D., National Center for Health Statistics; Shubhayu Saha, Ph.D., National Center for Environmental Health; and Jennifer D. Parker, Ph.D., National Center for Health Statistics. National Health Statistics Reports, Number 26. Retrieved March 30, 2016.

[184] Image: Ibid.


Cold-related death rate²
Deaths per million population
35
30
25
20
15
10
5
0
West
Midwest
Northeast
South
Large central metro
Large fringe metro
Medium metro
Small metro
Micropolitan
Noncore

4.3.5 ***Extreme Heat***

Extreme heat occurs when summertime temperatures hover 10 degrees or more above the average high temperature for a region, and lasts for several weeks. The National Weather Service defines a heat wave as a period of at least three days when the temperature reaches 90 degrees or higher. The term ‘heat wave’ applies to routine weather variations and to extraordinary spells of heat, which may occur only once a century. Individuals exposed to extreme heat for a prolonged time may experience serious health problems including heat cramps, heat stroke, heat exhaustion, and death. Seniors, young children, and those who have respiratory problems, or are overweight, are more likely to succumb to extreme heat than others are.[185]

Extreme heat events can also affect infrastructure. Heat can cause the buckling of roadways and bridges, affecting vehicular traffic. Hot weather can also cause rail expansion on rail lines, diverting both passenger and freight trains until repairs can occur. The denser air that comes with extreme heat events can effect air travel as well when temperatures reach above 118°F.

4.3.5.1 Location

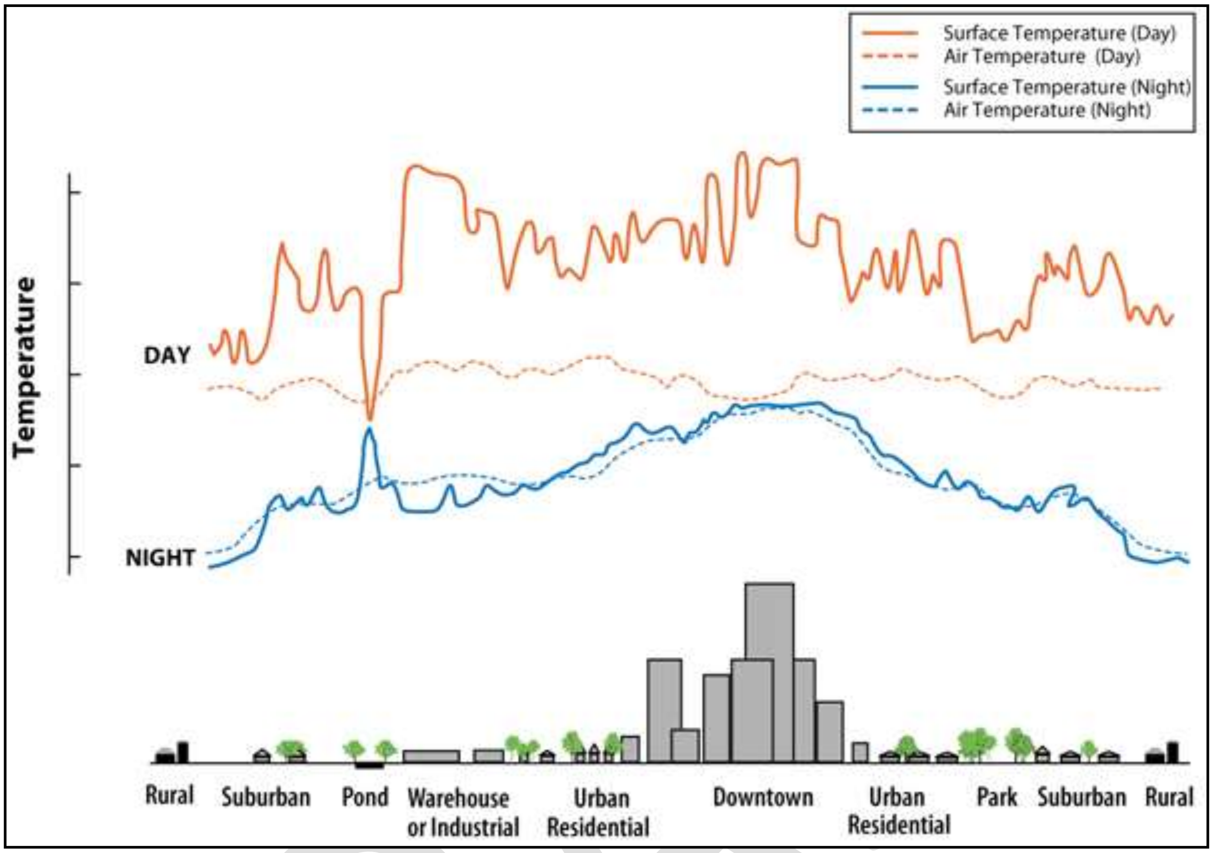
Extreme heat in Philadelphia can exacerbate a phenomenon known as the urban heat-island effect. As urban areas develop, changes occur in their landscape. Buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist become impermeable and dry. Impervious surfaces such as asphalt may release heat hours after the sun is down. These changes cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape. Other by-products, such as exhaust fumes, burning furnaces, heating units, and smokestacks contribute to heat retention and entrapment.

The image below depicts the variance in surface and air temperatures for both night and day in a spectrum of urban and rural locations. Note how the air temperature above the “Downtown” (urban) region does not vary much between day and night. This leaves little opportunity for the region to cool and can affect a community’s environment and quality of life.[186]

---

[185] Center for Disease Control and Prevention (CDC). Emergency Preparedness and Response Extreme Heat: A Prevention Guide to Promote Your Personal Health and Safety. Retrieved 7 December 2011.

[186] Image: Variance in Surface and Air Temperatures by Rural/Urban Location, EPA 2011. Retrieved January 29, 2016.



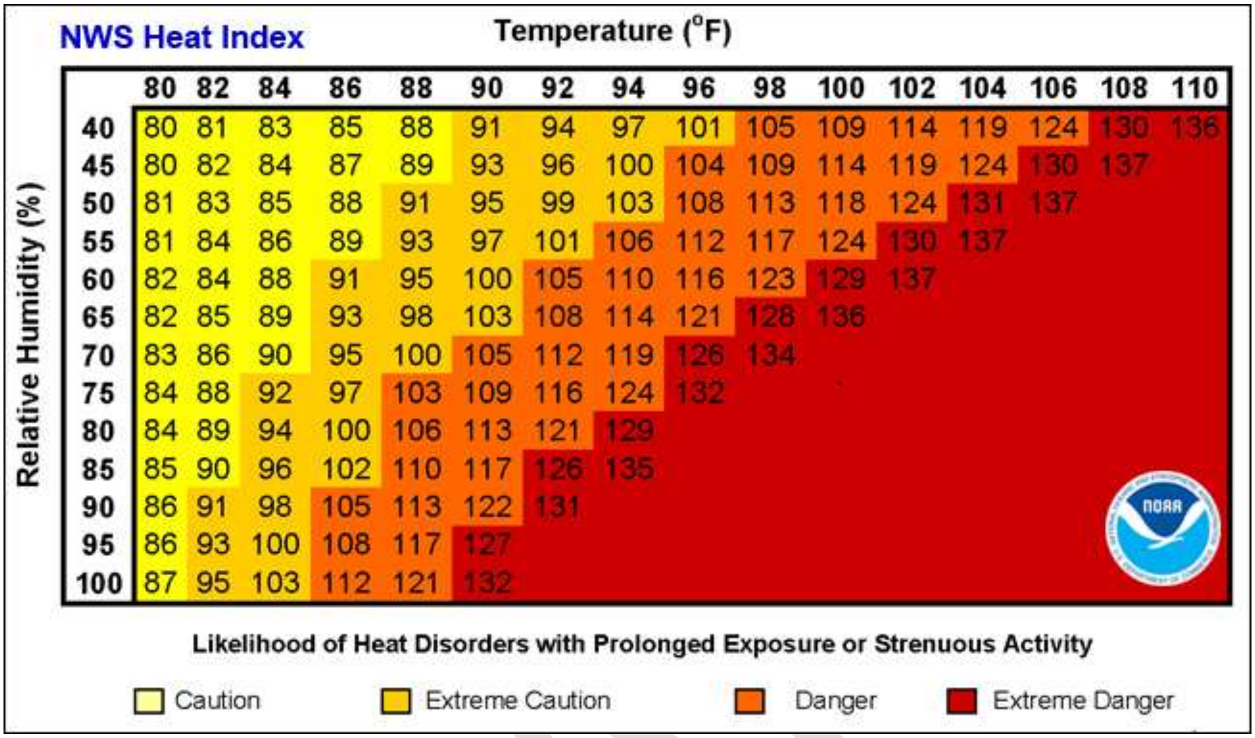
4.3.5.2 Magnitude

The National Weather Service (NWS) generally measures extreme heat through the Heat Index. Conditions that induce extreme temperature-related illnesses include stagnant atmospheric conditions and poor air quality. This section, therefore, also discusses the air quality index and illnesses associated with extreme temperatures. Additionally, climate change will affect temperature trends in the future. This section also addresses climate change in order to take into considerations the affects climate change will have on temperature trends in the future.

As identified by the NWS and NOAA, the Heat Index is the temperature the body feels when heat and humidity combine. Higher humidity plus higher temperatures often combines 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.[187]

---

[187] Image: NWS Heat Index. National Weather Service. Retrieved January 29, 2016.



NWS Heat Index

Temperature (°F)

Relative Humidity (%)

	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

☐ Caution ☐ Extreme Caution ☐ Danger ☐ Extreme Danger

The table below identifies the four NWS categories for heat hazards, as well as their associated heat index and health hazards.

Health Hazards Associated with Heat Index Values[188]

Category	Heat Index	Health Hazards
Extreme Danger	130°F-Higher	Heat Stroke/Sunstroke is likely with continued exposure
Danger	105°F-129°F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity
Extreme Caution	90°F-105°F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity
Caution	80°F-90°F	Fatigue possible with prolonged exposure and/or physical activity

NOAA bases Heat Alert procedures on heat index values. Research has shown that heat index thresholds do not always fully account for a variety of factors that could

---

[188] Summer Heat: The Silent Killer. NOAA, Red Cross, FEMA. Retrieved January 29, 2016.

influence public health. Based on this research, NOAA/NWS has supported the implementation of a new Heat Health Watch/Warning System (HHWS) to guide the production of localized daily warnings and forecast products. Philadelphia currently uses this system. The system considers not only heat and humidity, but also cloud cover, wind, and expected duration of the event.[189]

When conditions warrant, NWS issues the heat-related weather products described in the table below for Philadelphia.

NWS Heat Products[190]

Product	Criteria
Excessive Heat Outlook	NWS issues an Excessive Heat Outlook when the potential exists for an excessive heat event in the next 3-7 days. An Outlook provides information to those who need considerable lead-time to prepare for the event, such as public health officials, emergency managers, and public utilities.
Excessive Heat Watch	NWS issues heat watches when conditions are favorable for an excessive heat event in the next 24 to 72 hours. The NWS issues a Watch when the risk of a heat wave has increased but its occurrence and timing is still uncertain. The purpose is to allow those who need to set plans in motion enough lead time to do so.
Excessive Heat Advisory	NWS issues an advisory when an event is occurring, is imminent, or has a very high probability of occurring. The purpose of an Advisory is to strongly recommend that people take caution when outside.
Excessive Heat Warning	NWS issues an Excessive Heat Warning within 12 hours of the onset of extremely dangerous heat conditions. A Warning occurs when the NWS expects the maximum heat index temperature to be 105° or higher for at least two days and night time air temperatures will not drop below 75°. People living in an area under an excessive heat warning should take precautions immediately as this level of heat poses a threat to life and/or property.

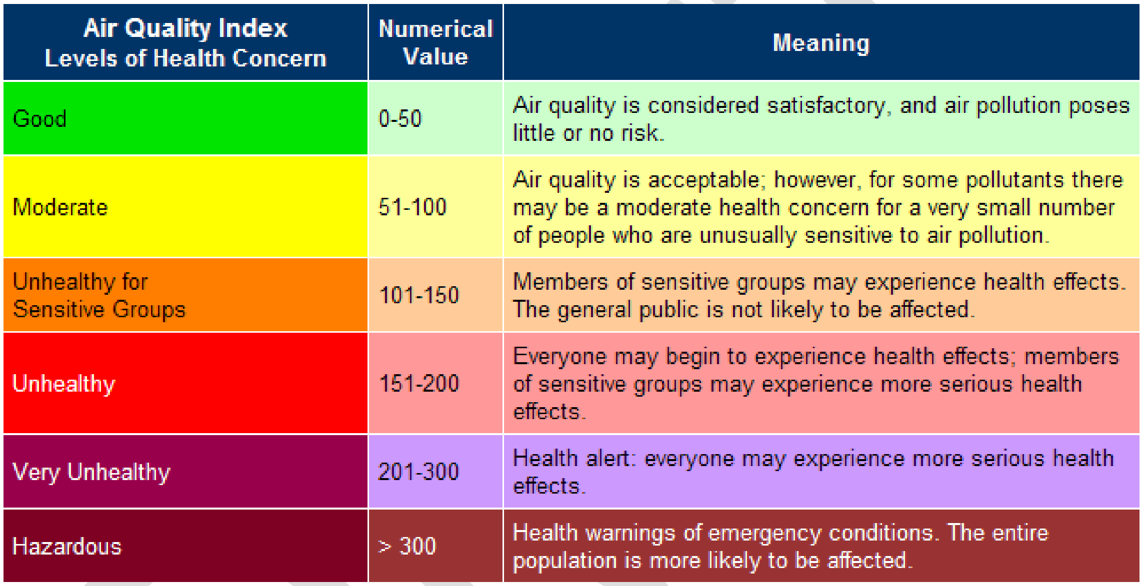
---

[189] Heat Wave a Major Summer Killer. National Weather Service (NWS). Accessed 5 December 2011.

[190] Heat Watch vs. Warning. National Weather Service. Retrieved January 29, 2016.

4.3.5.2.1 Air Quality

The United States Environmental Protection Agency (EPA) created the Air Quality Index (AQI), a color-coded scale to exhibit pollution levels in the atmosphere. The AQI breaks air quality down into six categories: Good (green), Moderate (yellow), Unhealthy for Sensitive Populations (orange), Unhealthy for Everyone (red), Very Unhealthy (purple), and Hazardous (maroon). Each color relates to quantitative levels of air pollution and indicates the health risks associated with air quality conditions. The table below depicts the six AQI ranges, with each range assigned a descriptor and a color code.[191]



Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0-50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51-100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101-150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151-200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201-300	Health alert: everyone may experience more serious health effects.
Hazardous	> 300	Health warnings of emergency conditions. The entire population is more likely to be affected.

4.3.5.2.2 Climate Change

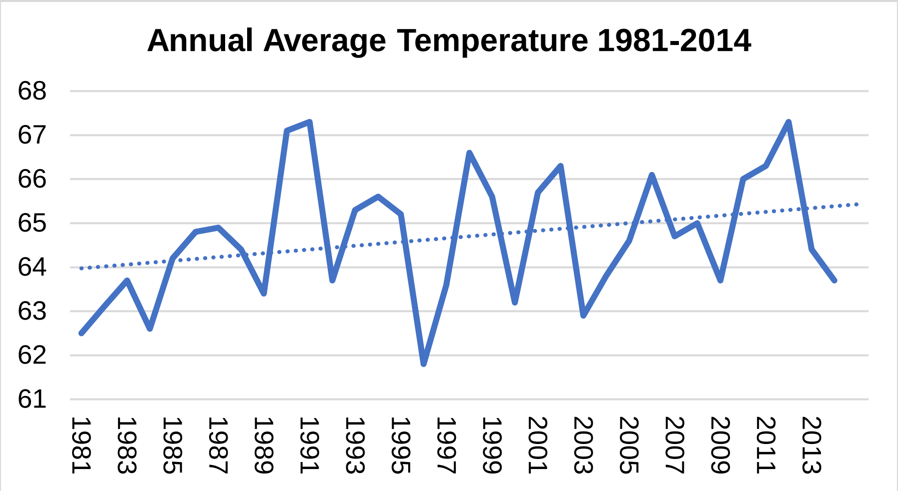
According to the Environmental Protection Agency, "climate change refers to any significant change in the measures of climate lasting for an extended period of time."[192] Changes include major deviations in temperature, precipitation, or wind patterns, among other fluctuations, that occur over several decades or longer.[193] The EPA states that the Earth's average temperature has risen by 1.5°F over the past century.[194] The EPA also projects that the planet's temperature will rise another 0.5 to 8.6°F over the next hundred years.[195] These seemingly small changes can translate to large and potentially dangerous shifts in climate and weather.

---

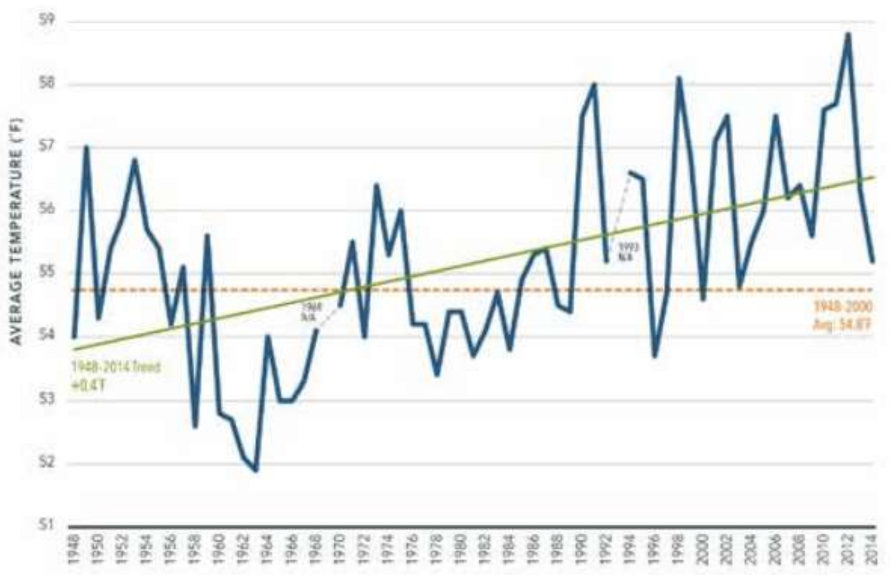
[191] Image: Air Quality Index. Environmental Protection Agency. Retrieved May 2011.
[192] Environmental Protection Agency. Glossary. Retrieved 5 October 2015.
[193] Ibid.
[194] Environmental Protection Agency. Climate Change: Basic Information. Retrieved 6 October 2015.
[195] Ibid.

Climate science shows rising temperatures correlate with an increasing frequency and intensity of storms. Rising global temperatures also mean that droughts will be more frequent, as will flooding and intense rains.

Overall trends in temperature demonstrate the local effects of climate change, sea level rise, and precipitation. NOAA data track average annual temperature over time for Philadelphia, showing an increase in the average annual temperature from 1981 to the present. The image below depicts this trend.



The Mayor’s Office of Sustainability conducted a trend analysis in 2015, tracking annual temperature trends for Philadelphia from 1948 to 2014. The image below shows the upward trend resulting from this analysis.[196]



ANNUAL TEMPERATURE TREND FOR PHILADELPHIA, 1948–2014

4.3.5.2.3 Worst-case Scenario

The following scenario is a hypothetical worst-case scenario that uses trends in temperature and energy/water consumption in combination with real extreme heat events from 1999, 1997, and 2011 in Philadelphia.

A strong and oppressive high-pressure system that extends from the surface to aloft moves into Eastern Pennsylvania just prior to July 4. High temperatures reach 90 degrees by July 2. The combination of temperature and high humidity produces heat indices of 115 degrees by mid-afternoon over the next week. Philadelphia declares a Code Red, extending cooling center hours.

Tourists and residents in town for the July 4 celebration find themselves out in the sun and heat for an extended period, causing numerous cases of heat exhaustion and other heat-related illnesses. There are reports of at least 30 heat-related deaths in the City.

The heat affects regional food supplies, causing damage to temperature-sensitive plants such as lettuce, parsley, cabbage, leeks, and arugula. Tomatoes, peppers,

---

[196] Mayor’s Office of Sustainability and ICF International. Growing Stronger: Toward a Climate-Ready Philadelphia. November 2015. Retrieved January 12, 2016.

beans, and squash plants blister. Milk production is down due to stress on cows. Tree leaves begin to show signs of scorching along their edges, and dogwoods and maples show signs of water stress.

The heat causes buckling of I-95 and Route 1 in the City, affecting traffic patterns already stressed by incoming tourists for the July 4 celebrations. Schools throughout the City dismiss students early and remain closed for two days.

Philadelphia Water Department sees record levels of water usage. Surrounding counties experience stressed water supplies. PECO sees record usage of power at 7650 megawatts, forcing the reduction of voltage citywide causing brownouts. Electric suppliers curtail power delivery to numerous industrial customers. Despite these precautions, customers experience outages across several areas of the City.

4.3.5.2.4 Environmental Impacts

Extreme heat can have many of the same effects on the environment that drought does. Extreme heat, when sustained for an extended period combined with low rainfall, can trigger a drought. The lack of water during a drought can cause the loss or destruction of wildlife habitats, both in waterways and green spaces.

Even in the shorter term, extreme heat can have an effect on the environment. Heat waves affect livestock, pets, and other animals. Above average temperatures can affect the growth of plants and trees negatively, inhibiting their development. Rises in water temperature from a sustained period of extreme heat contributes to the degradation of water quality and negatively impacts fish populations.[197] Research links high temperatures to increased algae growth, causing fish deaths in rivers and lakes.[198] In addition, with climate change comes the increased likelihood of more frequent extreme heat events.

4.3.5.3 Past Occurrences

Due to its location, extreme heat events occur frequently in Philadelphia. No extreme heat event in Philadelphia has resulted in a Presidential Disaster Declaration. On average, the temperature reaches 90°F between 25 and 30 days annually in Philadelphia.

The National Weather Service (NWS) measures summer heat by three different methods:

- Identifying average temperature;

---

[197] Adams, Christopher. “Impacts of Extreme Temperatures”. Cooperative Institute for Research in the Atmosphere Foothills Research Campus, Colorado State University. Fort Collins, CO. Retrieved January 28, 2016.

[198] Ibid.

- Identifying the longest stretches of days 90°f and above; and
- Identifying summers that had the most days over 90°F.

Using the first method, the table below depicts the highest average summer temperatures in Philadelphia. Measured in this way, three of the hottest summers in Philadelphia occurred since 2011.

Hottest Summers by Average Temperature[199]			
Year	**Average Temp (°F)**	**Year**	**Average Temp (°F)**
2010	79.6	1991	77.9
2016	78.8	2015	77.6
1995	78.5	1900	77.1
1994	78.3	1973	77.1
1993	78.2	1988	77.1
2011	78.0	1999	77.1
2012	78.0		

---

[199] NOWData – NOAA Online Weather Data. Monthly Mean Avg Temperature for Philadelphia Intl Ap, PA. Retrieved December 9, 2015.

Another way to understand the hottest summers in Philadelphia is to look at which summers had the longest stretches of days over 90°F.

Hottest Summers by Longest Stretches of 90°F or Greater Days[200]			
Dates	**Length**	**Dates**	**Length**
Jul 29- Aug 15, 1988	18 days	Jun 28- Jul 9, 2012	12 days
Jul 20- Aug 5, 1995	17 days	Jul 23- Aug 3, 1999	12 days
Aug 24- Sep 5, 1953	13 days	Jul 12- Jul 23, 1952	12 days
		Jun 25- Jul 6, 1901	12 days

The final way the National Weather Service observes extreme heat events is by looking at those summers that had the most numbers of 90°F or greater days.

Hottest Summers by Most 90°F or Greater Days[201]			
Year	**Number of 90+ F days**	**Year**	**Number of 90+ F days**
2010	55	1943	42
1991	53	1983	41
1988	49	1993	41
1995	49		

---

[200] NOWData – NOAA Online Weather Data. Calendar Day Summaries: Max temp for Philadelphia Intl Ap, PA. Retrieved December 9, 2015.
[201] Ibid.

Philadelphia's all-time record high temperature is 106 °F, set on August 7, 1918. The table below illustrates the nine hottest days on record in Philadelphia.

Hottest Days on Record [202]

Date	High Temperature (°F)	Date	High Temperature (°F)
Aug 7, 1918	106	July 21, 1930	103
July 10, 1936	104	July 9, 1936	103
July 3, 1966	104	July 4, 1966	103
July 2, 1901	103	July 7, 2010	103
Aug 6, 1918	103	July 22, 2011	103

4.3.5.4 Future Occurrences

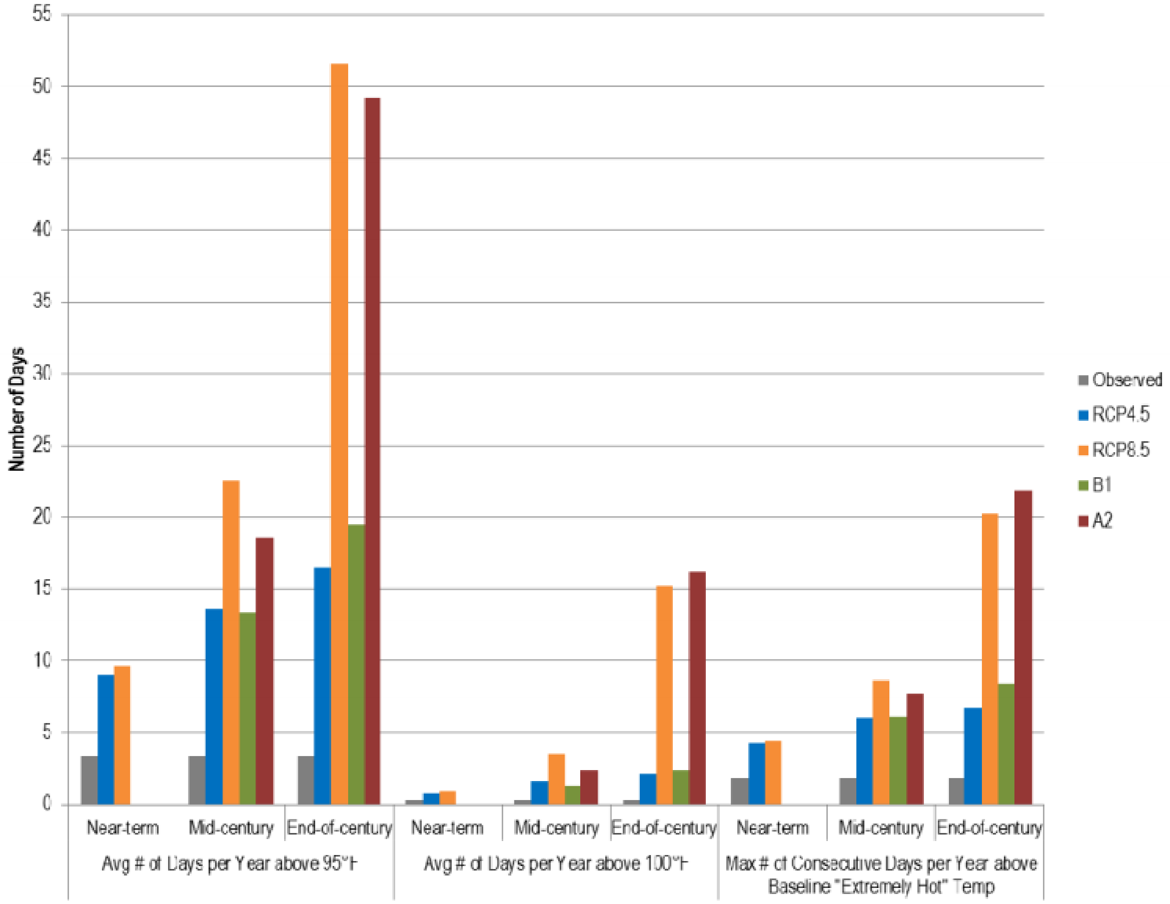
Several extreme heat events occur each year in Philadelphia, and climate data projects this trend will continue. Given the compounding effects of climate change, climate modeling projects that the number of days that qualify as an extreme heat event will increase. By the end of the century, the projections suggest that Philadelphia may experience 17 to 52 days above 95°F, and 2 to 16 days above 100°F, depending on the scenario.[203] The image below depicts these projections and their effects on the number of days.[204]

---

[202] NOWData – NOAA Online Weather Data. Calendar Day Summaries: Max temp for Philadelphia Intl Ap, PA. Retrieved December 9, 2015.

[203] Useful Climate Information for Philadelphia. ICF International. Mayor's Office of Sustainability. Retrieved December 9, 2015.

[204] Projected Temperature Extremes in Philadelphia. Useful Climate Science Data for Philadelphia. ICF International. Retrieved December 9, 2015.



Extreme heat events can also influence, complicate, or compound other hazards in Philadelphia such as hail, windstorms, drought, human health impacts, utility failures, and transportation accidents. For a full list of how hazards influence one another, see the graphic in the introduction of the Risk Assessment.

4.3.5.5 Vulnerability Assessment

Though extreme temperatures generally occur over a short time, they can cause a range of impacts to humans, animals, and infrastructure.

Often the most impacted populations in extreme temperatures include vulnerable populations 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:[205]

---

[205] Centers for Disease Control and Prevention (CDC). Emergency Preparedness and Response: Information for Specific Groups. Retrieved 7 December 2011.

- The elderly, 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 persons that cannot afford proper cooling;
- Those living without adequate shelter;
- Individuals with limited access to healthcare; and
- The general public who may overexert during work or exercise during extreme heat events.

A significant portion of Philadelphians meet criteria that make them more susceptible to hazardous effects of extreme heat, such as seniors (12.3% of the population), infants/children up to five years of age (6.9%),[206] and those living below the poverty line (26.7%).[207] Philadelphia's homeless population is especially vulnerable. The City of Philadelphia plans for extreme weather events, including extreme heat, which includes outreach strategies to vulnerable populations.

In addition, Philadelphia's susceptibility to the urban heat-island effect exacerbates hazardous conditions to individuals from extreme heat. 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.

A portion of Philadelphia's utility infrastructure is susceptible to extreme temperatures. During extreme heat episodes roads and bridges can buckle due to expansion. To limit these effects, utility providers monitor conditions, perform routine maintenance and address problems as they arise.

In warmer months, a direct link exists between extreme heat and power disruptions. The demand for electricity rises during extreme heat events as residents use air conditioners, fans and other devices to keep cool. This increase in demand stresses the electrical generation, transmission, and distribution infrastructure, which in turn increases the likelihood that sections or components of the electrical system will fail, causing power outages.

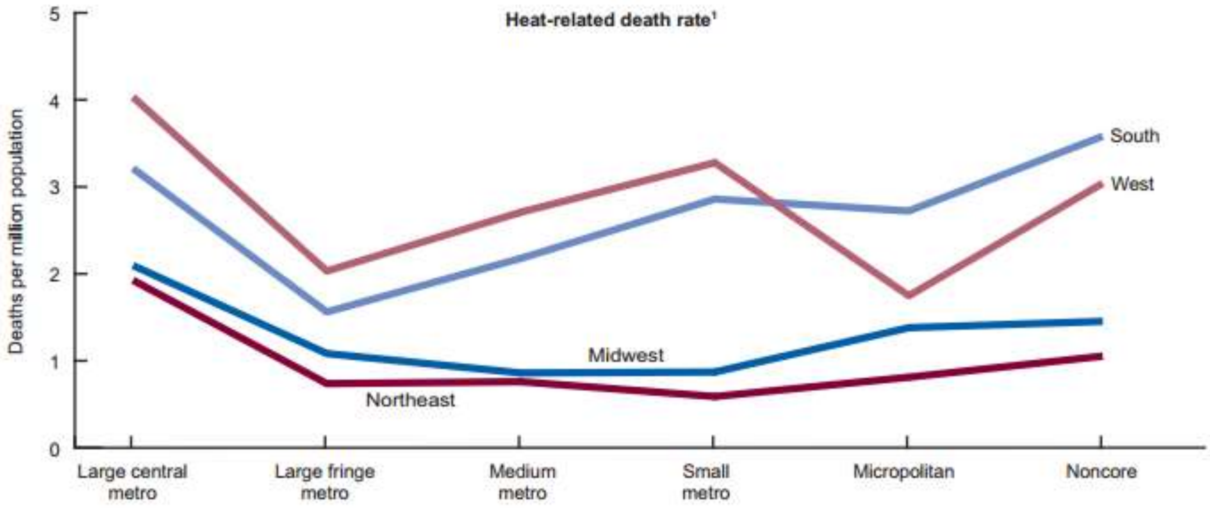
Unlike other natural hazards, extreme temperatures have limited physical destructive force. Economic losses can be observed through the repairing of damaged

---

[206] American FactFinder. Age and Sex. 2010-2014 American Community Survey 5-Year Estimates. Retrieved April 26, 2016.

[207] American FactFinder. Selected Economic Characteristics. 2010-2014 American Community Survey 5-Year Estimates. Retrieved April 26, 2016.

infrastructure like roads and bridges, as well as through the disruption in transportation services caused by the unreliability of equipment, such as rail switches and trolley lines. However, the primary concern associated with extreme temperatures is public health and safety. Fatalities caused by extreme temperatures ranks the highest of all weather-related deaths in the United States. Between 2006 and 2010, 3332 heat-related deaths occurred in the United States, 31 percent of all weather-related deaths.[208] The image below illustrates heat-related fatalities between 2006 and 2010 as they compare between different populations. In this graphic, Philadelphia would qualify as a “large central metro” in the Northeast.[209]

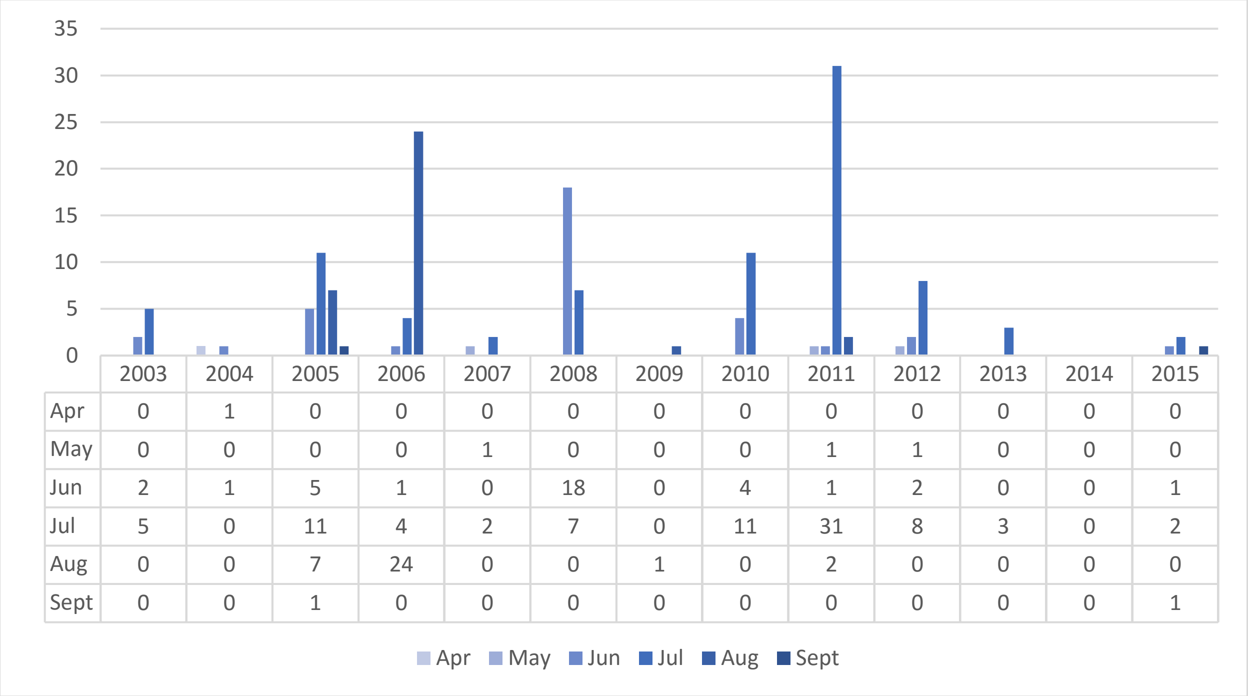


---

[208] Deaths Attributed to Heat, Cold, and Other Weather Events in the United States, 2006–2010. Jeffrey Berko, M.P.H., Deborah D. Ingram, Ph.D., National Center for Health Statistics; Shubhayu Saha, Ph.D., National Center for Environmental Health; and Jennifer D. Parker, Ph.D., National Center for Health Statistics. National Health Statistics Reports, Number 26. Retrieved March 30, 2016.

[209] Image: Ibid.

According to the Philadelphia Department of Public Health Medical Examiner's Office (PDPH-MEO), Philadelphia generally begins to experience heat-related fatalities when an excessive heat event lasts three days or more. In the past, however, shorter excessive heat spells led to heat-related deaths. Heat-related deaths vary from year-to-year depending on the frequency, severity, and length of excessive heat events. The table below depicts heat-related deaths within Philadelphia by month from 2003 to 2015. [210]



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Apr	0	1	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	1	0	0	0	1	1	0	0	0
Jun	2	1	5	1	0	18	0	4	1	2	0	0	1
Jul	5	0	11	4	2	7	0	11	31	8	3	0	2
Aug	0	0	7	24	0	0	1	0	2	0	0	0	0
Sept	0	0	1	0	0	0	0	0	0	0	0	0	1

The Philadelphia Department of Public Health Division of Disease Control (PDPH-DDC) receives de-identified emergency department chief complaint data on a daily basis as a part of an effort to conduct near-real time all hazards surveillance. PDPH-DDC also periodically requests data from 911 ambulance dispatches for heightened surveillance situations. During a heat emergency, PDPH-DDC examines this data for visits that may be due to excessive heat (i.e. heat exhaustion syndrome), as well as 911 dispatch data that is related to environmental exposures. This provides a near real-time citywide view into the impact of the heat wave on health care utilization.

---

[210] Data provided by the Philadelphia Department of Public Health (PDPH). PDPH specifically disclaims responsibility for any analyses, interpretations or conclusions.

4.3.6 ***Floods***

Flooding is the temporary condition of partial or complete inundation on normally dry land. Floods are one of the most common natural hazards in the United States. They can develop slowly over a period of days or develop quickly within hours resulting in disastrous effects that can be local (affecting a neighborhood or community) or regional (affecting entire river basins, multiple counties or states). Most communities in the United States have experienced some kind of flooding after spring rains, heavy thunderstorms, coastal storms, or winter snow thaws. According to the 2013 Pennsylvania Hazard Mitigation Plan, Pennsylvania is one of the most flood-prone states in the United States, with the southeastern region of the state being the most susceptible.

A flood is any high flow, overflow, or inundation by water that causes or threatens damage.[211] Floods are the result of a combination of meteorological and hydrological extremes as indicated in the table below. In most cases, human factors compound the effects of flooding. While diverse, these human factors generally tend to aggravate flood hazards by accentuating flood heights.[212]

---

[211] NWS Glossary. Retrieved on 14 December 2011.

[212] World Meteorological Organization. Associated Programme on Flood Management. Urban Risk Management. Retrieved 14 December 2011.

Factors contributing to flooding		
Meteorological Factors	**Hydrological Factors**	**Human Factors Aggravating Natural Flood Hazards**
▪ Rainfall ▪ Large-scale storms – hurricanes, tropical storms, mesoscale convective systems ▪ Small-scale storms – severe thunderstorms, cloudbursts, ▪ Temperature ▪ Snowfall and snowmelt ▪ Ice jams on waterways	▪ Soil moisture level ▪ Groundwater level prior to storm ▪ Natural surface infiltration rate ▪ Presence of impervious cover ▪ Channel cross-sectional shape and roughness ▪ Presence or absence of over bank flow, channel network ▪ Synchronization of runoffs from various parts of watershed ▪ High tide impeding drainage	▪ Land-use changes (e.g. surface sealing due to urbanization, deforestation) increase run-off and may be sedimentation ▪ Occupation of the floodplain obstructing flows ▪ Inefficiency or non-maintenance of infrastructure ▪ Climate change affects magnitude and frequency of precipitations and floods ▪ Urban microclimate may enforce precipitation events

Floodwaters washout a billboard in Stella Ling Park at Green Lane and Main Street in Manayunk.

Three types of flooding occur in Philadelphia due to these contributing factors:[213]

- Riverine floods;
- Surface floods; and
- Flash floods.

Riverine Flooding

Riverine floods, also called river floods, occur when the river run-off volume exceeds local flow capacities. Heavy rainfall or snowmelt in upstream areas can trigger river floods. In the case of the Delaware River, tidal influence from downstream can also trigger flooding. Ground conditions such as soil, vegetation cover, and land use have a direct bearing on the amount of run-off generated. Flooding from large rivers usually results from large-scale weather systems that generate prolonged rainfall over wide areas. Small rivers, streams and creeks are susceptible to flooding from more localized weather systems that cause intense rainfall over small areas.[214]

Surface Flooding

Surface floods result from increased volumes of water due to poor drainage capacity. Built environments like cities generate higher volumes of surface run-off that is in excess of local drainage capacity, thereby causing localized floods. Local drainage capacity refers to the local storm water management systems. Storm water management systems include components such as:

- Storm drainpipes,
- Curb inlets,
- Manholes,
- Minor channels,
- Roadside ditches, and
- Culverts

Storm water systems convey storm flows as efficiently as possible to the community's primary drainage system. However, debris can clog drainage grates, thus reducing drainage capacity. This leads to increasing surface runoff and back up effects and causes surface floods.

---

[213] Federal Emergency Management Institute. Types of Floods and Floodplains. Retrieved 16 December 2011

[214] Image: Manayunk Neighborhood Council. "Billboard washout in Stella Ling Park at Green Lane and Main". September 28-29, 2004. Retrieved January 15, 2016.

Flash Floods

Flash floods are a rapid and extreme flow of high water into a normally dry area, or rapid water level rise in a stream or creek above a predetermined flood level.[215] 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.

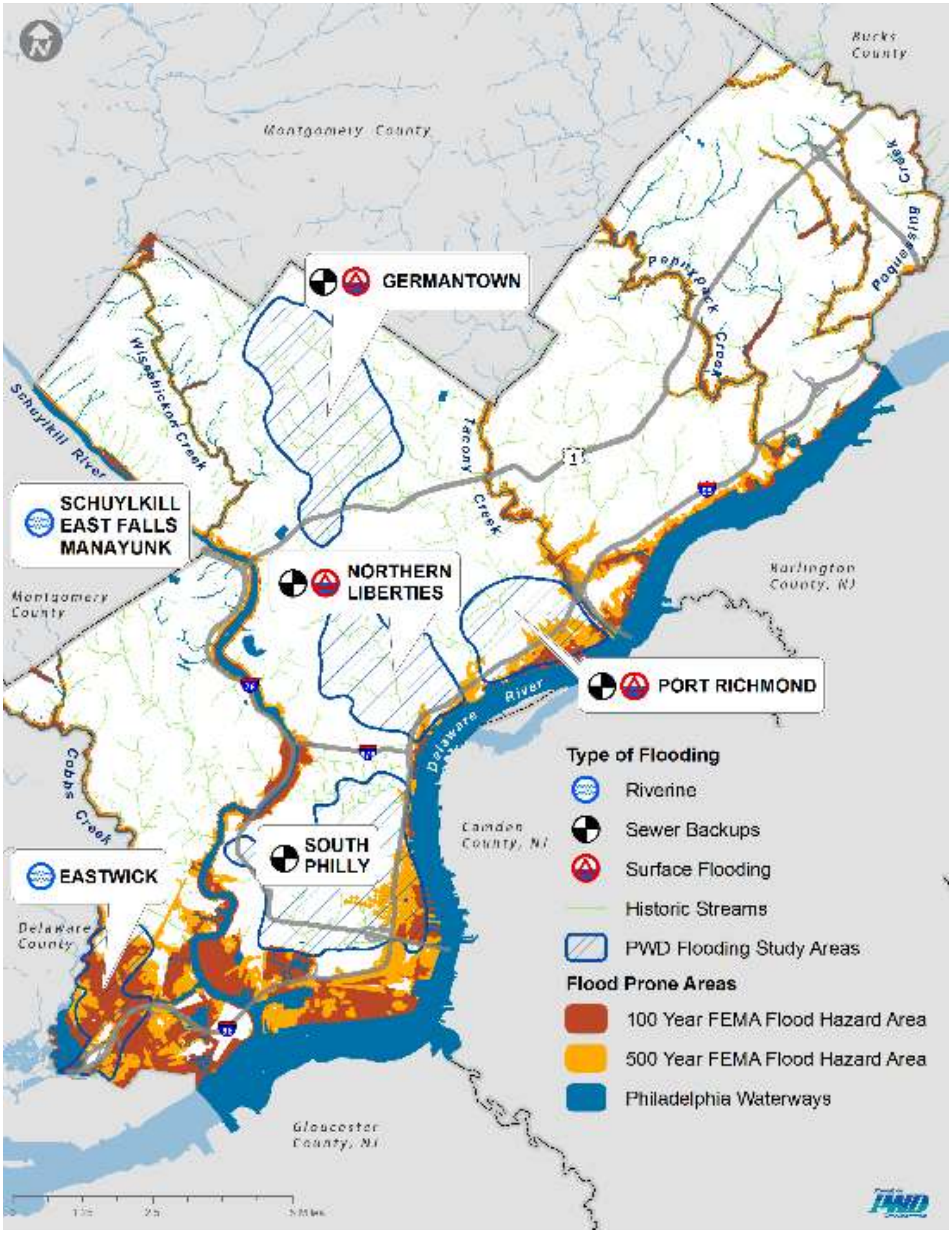
4.3.6.1 Location

The most damaging floods in Philadelphia appear to occur within the designated floodplains. A floodplain is the land adjoining the channel of a river, stream, ocean, lake or other body of water that floodwaters inundate during a flood event. The recurrence interval of flooding dictates the size of the floodplain.

The risk of flooding for a floodplain inversely relates to the size of the flood plain in the case of Philadelphia. A floodplain associated with a flood that has a 1.0 percent chance of occurring annually is smaller than the floodplain associated with a flood that has a 0.2 percent-annual-chance of occurring. In other words, the higher the percentage of a flood occurring annually, the smaller the area of the floodplain.

---

[215] Ibid



Note: 100 Year FEMA Flood Hazard Area in this image is the equivalent of the 1.0 percent floodplain and the 500 FEMA Flood Hazard Area is the equivalent of the 0.2 percent floodplain.

In addition to floodplain location impacts, flooding can occur more frequently on certain types of roadways. The table below looks at the roadways located in the 1.0 percent and 0.2 percent floodplains, and the percentage of those roads likely to incur flooding during a flood event.

Flood Risk For Philadelphia's Roadways, By Road Class[216]					
Road Class[217]		**Description**	**Total Miles**	**Percentage of Miles in Floodplain**	
				1.0% Floodplain	**0.2% Floodplain**
1	Expressway	Interstate highways and other limited access roads and primary thoroughfares. Principal routes through the city e.g., I-95, I-76, Roosevelt Expressway	110	30%	43%
2	Major	Semi-limited access road, typically multi-lane and usually divided. e.g., Roosevelt Blvd, West River Drive, Cheltenham Ave, Byberry Rd, Broad St	259	18%	21%
3	Arterial	Medium-high volume road, feeds traffic to and from limited or semi-limited access roads. Speed limit about 35 mph. e.g., Market St, 23rd St, Haverford Ave	362	6%	9%
4	Collector	Through streets in residential areas. e.g., Morris St, 60th St, Arch St in W. Philly	873	1%	3%
5	Local	Non-through streets in residential areas	1,122	4%	6%
6	Driveway	Common driveways	2	5%	18%
9	Low speed ramps	On- and off-ramps from expressways and major roads	19	28%	37%
10	High speed ramps	Interchanges; ramps connecting expressways	41	45%	63%
12	Non-travelable	Roads which cannot be driven on. e.g., Wissahickon Drive	42	65%	67%

---

[216] Growing Stronger: Toward a Climate-Ready Philadelphia. Pg. 36. Mayor's Office of Sustainability. Retrieved December 9, 2015.

[217] Road classes are as provided by the Philadelphia Streets Department.

4.3.6.2 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. Two general types of storm systems produce large amounts of precipitation: convective systems and non-convective systems. Convective events hit quickly, and produce heavy rainfall for one-to-two consecutive hours. Non-convective events produce steady rain events that can take place over the course of several hours and last as long as 24 hours.

The National Weather Service (NWS) uses Flood Categories to depict the degree of flooding experienced in an area following an event, and issues several different notifications prior to an event, as seen in the table below.

NWS Flood Categories

	Convective	**Non-Convective**
Minor Flooding *The NWS would issue an Urban and/or Small Stream Flood Advisory for this event.*	For Urbanized Areas: ▪ Rainfall rates of 0.5 inch per hour lasting more than one hour. Minimal or no property damage. Minimal risk to the public. For Rural Areas: ▪ Rainfall rates from .75 to 1.0 inch per hour lasting more than one hour. Minimal or no property damage. Minimal risk to the public.	▪ There is less of a distinction between urbanized and rural areas in non-convective events. ▪ Rainfall rates from 0.25 to 0.5 per hour depending on duration of event. ▪ A 0.5 inch rainfall rate over six hours can have similar impacts compared to a 0.25 inch rainfall rate over 12.0 hours. ▪ There is minimal or no property damage, and minimal risk to the public.

Moderate Flooding *The NWS would issue a Flood or Flash Flood Warning for this event.*	For Urbanized Areas: ▪ Rainfall rates of at least 1.0 inch per hour lasting more than one hour. Impacts include inundation of structures, road closures, evacuations of people and/or the transfer of property to higher ground. For Rural Areas: ▪ Rainfall rates from 1.25 to 1.50 inches per hour lasting more than one hour. Impacts include inundation of structures, road closures, evacuations of people and/or the transfer of property to higher ground.	▪ There is less of a distinction between urbanized and rural areas in non-convective events. ▪ Rainfall rates from 0.5 to .75 per hour depending on duration of event. ▪ A .75 inch rainfall rate over six hours can have similar impacts compared to a 0.5 inch rainfall rate over ten hours. ▪ Impacts include inundation of structures, road closures, evacuations of people and/or the transfer of property to higher ground.
Major Flooding *The NWS would issue a Flood or Flash Flood Warning for this event.*	For Urbanized Areas: ▪ Rainfall rates of at least 1.50 inches per hour lasting more than one hour. Impacts include extensive inundation of structures, road closures and a significant evacuation of people and/or transfer of property to higher ground. For Rural areas: ▪ Rainfall rates from 1.75 to 2.0 inches per hour lasting more than one hour. Impacts include extensive inundation of structures, road closures, and a significant evacuation of people and/or transfer of property to higher ground.	▪ There is less of a distinction between urbanized and rural areas in non-convective events. ▪ Rainfall rates from 0.75 to 1.0 per hour depending on duration of event. ▪ A 1.0 inch rainfall rate over six hours can have similar impacts compared to a 0.75 inch rainfall rate over eight hours. ▪ Impacts include extensive inundation of structures, road closures, and a significant evacuation of people and/or the transfer of property to higher ground.

The NWS issues the following products when conditions warrant.

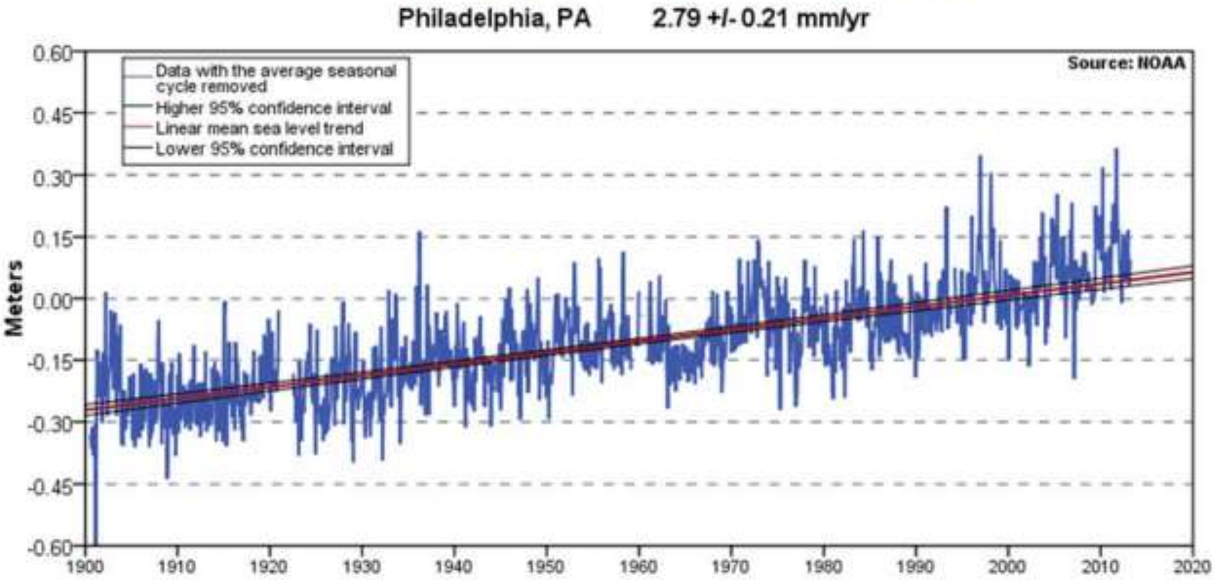
NWS Flood Products	
Products	**Description**
Urban and/or Small Stream Advisory	▪ Alerts the public to nuisance flooding, which is generally non-life-threatening. ▪ Issued when rain will cause flooding of streets and low-lying areas in both urban and rural settings. May be upgraded to a Flash Flood Warning if flooding worsens and poses a threat to life and property. ▪ Forecaster confidence is at least 80%.
Flash Flood Watch	▪ Usually associated with quick-hitting convective rain events. ▪ Indicates that 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. ▪ Issued 24 to 48 hours before a potential event. ▪ Forecaster confidence is approximately 50%.
Flood Watch	▪ 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. ▪ Issued 24 to 48 hours before a potential event. ▪ Forecaster confidence is approximately 50%.
Flash Flood Warning	▪ Usually associated with quick-hitting convective rain events. ▪ Indicates that flooding is occurring or is determined to be imminent within about a six-hour period from the start of the causative event. ▪ There is a serious risk to life and property. ▪ Typically issued several hours before flooding occurs. ▪ Forecaster confidence is at least 80%. ▪ Can also be issued for ice jams and dam breaks. ▪ If the flooding is expected to persist for more than several hours, the product may be converted to Flood Warning.
Flood Warning	▪ Usually associated with non-convective rain events. ▪ Indicates that flooding is occurring or is determined to be imminent and is expected to persist for more than a six hour period. ▪ There is a serious risk to life and property. ▪ Can be issued several hours before flooding occurs. ▪ Forecaster confidence is at least 80%.

4.3.6.2.1 Climate Change

According to the Environmental Protection Agency, “climate change refers to any significant change in the measures of climate lasting for an extended period of time.”[218] Changes include major deviations in temperature, precipitation, or wind patterns, among other fluctuations, that occur over several decades or longer.[219] The EPA states that the Earth's average temperature has risen by 1.5°F over the past century.[220] Climate data projects that the planet’s temperature will rise another 0.5 to 8.6°F over the next hundred years.[221] These seemingly small changes can translate to large and potentially dangerous shifts in climate and weather. For example, more intense and frequent storms will add to flooding risks, putting areas already at risk for flooding at a higher risk in the future.

Climate change increases the likelihood of flooding through sea level rise and elevated precipitation levels. Sea level rise trends show a steady rise in sea level over the past century. The image below depicts the mean sea level rise trend in Philadelphia from 1900 to 2014, with a projected trend line to 2020.[222]

Figure 5 – Mean Sea Level Trend in Philadelphia (NOAA Tides and Current, 2014)



This figure illustrates a mean sea level trend in Philadelphia of 2.79 millimeters/year with a 95% confidence interval of +/- 0.21 mm/yr based on monthly mean sea level data from 1900 to 2006 which is equivalent to a change of 0.92 feet in 100 years (for tidal gauge 8545240 Philadelphia, PA).

---

[218] Environmental Protection Agency. Glossary. Retrieved 5 October 2015.

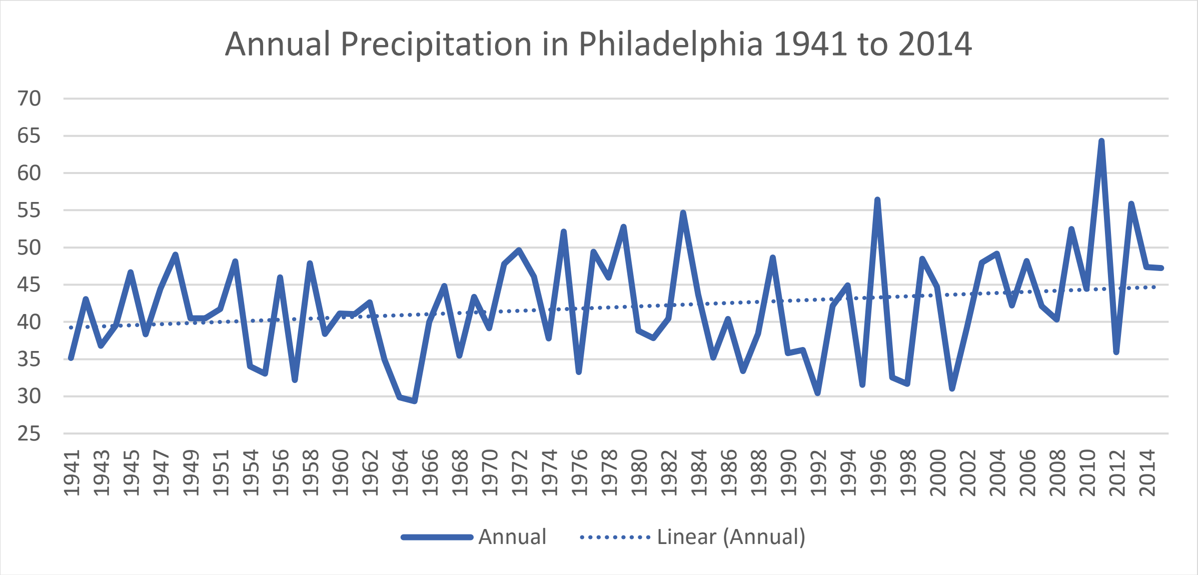
[219] Ibid.

[220] Environmental Protection Agency. Climate Change: Basic Information. Retrieved 6 October 2015.

[221] Ibid.

[222] ICF International. Useful Climate Information for Philadelphia: Past and Future. August 2014.

Climate change also means an increase in the level of precipitation. Weather officials track increases in precipitation in several ways. NOAA keeps record of monthly and annual precipitation data. This data includes both rain and snowfall. Tracked over time, there is an upward trend in annual precipitation. The graph below shows this increasing trend.[223] [224]



4.3.6.2.2 Worst-Case Scenario

The following worst-case scenario is derived from analysis of past flooding events in Philadelphia and takes into consideration flooding trends in the City.

Following a heavy snowfall in mid-March, a warm front moves in from the southwest, bringing widespread, heavy rain across the southeastern Pennsylvania region. The rapid snowmelt and heavy rainfall quickly overwhelm the ground's ability to absorb the rain, and instances of flash flooding occur along Kelly Drive and Martin Luther King Drive, trapping vehicles and their passengers in quickly rising waters.

Flooding occurs along the Schuylkill River as tributaries, snowmelt, and rainfall exacerbate already high water levels. High water and fast currents make evacuations and rescues on the river a challenge. Manayunk experiences extensive flooding along Main Street, requiring evacuations from homes, businesses, and schools in the area. East Falls floods to a lesser degree, affecting local roadways such as Kelly Drive and Midvale Avenue. Eastwick homes also experience extensive flooding, causing the

---

[223] NOWData – NOAA Online Weather Data. Philadelphia Int, PA: Monthly Summarized Data, Precipitation, Sum. Retrieved January 12, 2016.

[224] No data is available from NOAA for the year of 1953.

evacuation of homeowners to a local shelter. Flooding closes roadways along the Schuylkill for several days until floodwaters recede. Heavy rainfall triggers surface flooding in Germantown as wastewater systems quickly become overwhelmed. The water table in the area rises, causing sewage back flow into homes without a backflow valve.

Standing pools of water along I-95 and I-76 produce hazardous driving conditions. The storm also causes low visibility in the area, delaying numerous flights at the Philadelphia International Airport. Total rainfall measures five inches by the time the storm is over, and recovery is challenging due to floodwaters.

4.3.6.2.3 Environmental Impacts

Erosion

Typically, erosion results from stream flooding or flash flooding and can erode away stream banks and roadbeds, presenting a threat to roads, railroads, and bridges as well as trees and plant life. Larger levels of erosion can also result in ruined pipelines and undermine utility poles. In the past, erosion resulting from flooding has caused damage to roads, sidewalks, and railroads in Philadelphia.

Debris Flow

Heavy rains can cause debris flows along Kelly Drive.

Debris flows, also known as landslides or mudslides, result from the combination of moving water and loose mud, sand, soil, or rock. Similar to flash floods, debris flows can occur suddenly and without warning. The likelihood of a debris flow increases with the amount of loose debris that could become involved in such an event. Debris flows from Philadelphia stem from heavy rainfalls, such as those with a strong thunderstorm or tropical storm. Debris flow damages roadways through standing water that can degrade the road base or lead to pavement softening. Philadelphia has experienced small-scale debris flows that temporarily close and damage roads. Debris flows can also wash into local waterways, increasing the sediment and turbidity of the water.[225]

---

[225] Image: Philadelphia Water Department.

Contaminated Groundwater

Floodwaters can mix with household hazard wastes, pesticides, and heavy metals present in flooded areas. These floodwaters can then seep into the ground and affect groundwater.

An additional environmental concern is the flooding of Superfund sites. Floodwaters can contribute to the spread of contaminants, as seen in New Jersey following Hurricane Irene.[226] Philadelphia has four Superfund sites throughout the city. The table below shows sites designated as Superfund sites by the EPA. Contamination would require the EPA or other qualified agency to decontaminate affected sites.

Philadelphia Superfund Sites[227]

Site Name	Site Location	Size	Details
Metal Bank of America[228]	40.02416, -75.02778	10 acres	The Metal Bank of America, Inc., a former scrap metal and transformer salvage facility on the Delaware River, drained oil from used transformers to reclaim copper parts. Metal Bank's recycling operations released oil in various locations on the property with the majority of the contamination near an underground storage tank.
Franklin Smelting and Refining Corporation[229]	39.98319, -75.08388	3 acres	The site consists of a covered slag pile containing about 68,000 cubic yards of slag material – a byproduct from the copper smelter at the neighboring Franklin Smelting and Refining Corp. MDC, the operator of the site from the 1950s to 1999, had slag material migrating off the site in all directions. The slag previously covered the nearby rail line and area sidewalks, caked the inside of storm drains, and blew away from the site. EPA determined that the slag contains concentrations of lead. Additional sampling revealed concentrations of beryllium, copper and lead in the air near the pile. Investigations are under way to determine the nature and extent of contamination, and to identify appropriate cleanup actions.

---

[226] NPR. “Sandy Stirs Up Superfund Site in New Jersey”. November 20, 2012. Retrieved January 20, 2016.

[227] EPA. “Cleanups In My Community (CIMC)”.

[228] EPA. “EPA Superfund Program: METAL BANK, PHILADELPHIA, PA”. Retrieved January 20, 2016.

[229] EPA. “EPA Superfund Program: FRANKLIN SMELTING AND REFINING CORP, PHILADELPHIA, PA”. Retrieved January 20, 2016.

Publicker Industrial Site[230]	39.90805, -75.13528	40 acres	Located along the Delaware River near the Walt Whitman Bridge, Publicker Industries produced liquor and industrial alcohols from 1912 to 1985.
Enterprise Avenue Landfill[231]	39.885, -75.2125	57 acres	From 1971 through 1976, incineration residue, fly ash and bulky debris were disposed of on the site, which is located near Fort Mifflin. Several waste handling firms also buried drums containing industrial and chemical wastes on the property, which resulted in contaminated soil and groundwater. The EPA took the site off the Superfund program's National Priorities List (NPL) in 1986.

Mold and Fungi

Flooding also creates wet or damp conditions for an extended period, increasing the likelihood of mold and fungi. While some types of mold and fungi can be beneficial in assisting in breaking down fallen trees, other types of mold and fungi can kill plants and trees that help sustain the local ecosystem.

---

[230] EPA. "EPA Superfund Program: PUBLICKER IND SITE, PHILADELPHIA, PA". Retrieved January 20, 2016.

[231] EPA. "EPA Superfund Program: ENTERPRISE AVE LANDFILL, PHILADELPHIA, PA". Retrieved January 20, 2016.

4.3.6.3 *Past Occurrences*

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 table below summarizes the top five most expensive flooding events in terms of estimated property damage costs that occurred between 1996 and 2015[232] (specific areas noted where available). The flooding events annex lists flooding events from 1996 to 2015[233] as well as a list of Federal and Gubernatorial disaster declarations resulting from flooding.

Top Five Most Costly Flooding Events in Philadelphia 1996-2015

Date	Estimated Property Damage Cost
1/19/1996	$3 million
6/28/2006	$1 million
4/30/2014	$1 million
5/1/2014	$1 million
8/28/2011	$0.1 million

---

[232] Data available for this table is limited to 1996 to present due to source limitations. Only the years 1990 and forward are available for the National Climatic Data Center's Storm Events Database. Records resulted from the implementation of NWS Directive 10-1605.

[233] Data available for this table is limited to 1996 to present due to source limitations. Only the years 1990 and forward are available for the National Climatic Data Center's Storm Events Database. Records resulted from the implementation of NWS Directive 10-1605.

The table below summarizes the top ten historical crests on the Schuylkill.

Top Ten Highest Historical Crests: Schuylkill River in Philadelphia[234]

Crest	Date of Flood	Weather Comments
17.0 ft.	10/4/1869	On October 4, the "Saxby Gale" hurricane brought widespread heavy rain to the northeastern U.S., from Virginia to Maine. Eastern Pennsylvania collected more than 5 inches. Severe flooding occurred throughout the Mid-Atlantic and New England regions.
14.8 ft.	3/1/1902	A series of snowstorms followed by heavy rains caused flooding on the Lehigh and Delaware Rivers as well as the most destructive flood on the Susquehanna in the Wyoming Valley since 1865.
14.7 ft.	8/24/1933	A strong Category 1 storm, the Chesapeake-Potomac Hurricane brought more than 10 inches of rain to Maryland, Delaware, and Southern New Jersey. Other locations throughout the Mid-Atlantic measured more than four inches of rain.
14.65 ft.	6/23/1972	Hurricane Agnes made landfall over southeastern New York on June 22 and moved westward into Pennsylvania. Rainfall totals from June 20-25 ranging from 2-3 inches in the Upper Potomac to 18 inches near Shamokin, Pennsylvania.
14.57 ft.	6/2/1946	Weather summary unavailable.
14.32 ft.	11/25/1950	Record-breaking cold air spawned a coastal "bomb" that retrograded back to the lower Great Lakes underneath a deep closed vortex. Several inches of rain fell across the area.
14.32 ft.	8/19/1955	Hurricane Diane made landfall 5 days after Hurricane Connie. Hurricane Diane produced several inches of rain with locally heavier amounts of 10 to 20 inches.
14.10 ft.	9/17/1999	Hurricane Floyd produced heavy rainfall from Virginia to Long Island. Rainfall totals ranged from 12 inches in Delaware to 16.57 inches in Newport News, Virginia. Two dams burst in New Jersey and several flood records were broken in New Jersey.
14.1 ft.	7/9/1935	10 inches of rain fell at Cortland, NY, in 48 hours.
13.91 ft.	5/1/2014	A boundary between cold air and warm moist air produced heavy rainfall and flooding. Rain started on April 30, 2014 at noon. The NWS reported two inches of rainfall over a six-hour period.[235] Event precipitation totaled 4.81 inches at the Philadelphia International Airport.[236]

---

[234] Top Ten Highest Historical Crests: Schuylkill River at Philadelphia. NOAA. Retrieved December 3, 2015.

[235] Storm Events Database. NOAA: National Centers for Environmental Information. Retrieved April 13, 2016.

[236] Given the distance between Blue Marsh and Philadelphia, timeline and size of releases, and the magnitude of streamflow in Philadelphia, Blue Marsh Reservoir did not contribute to flooding in Philadelphia on April 30, 2014. On April 30, Blue Marsh Reservoir released water at a rate of approximately 1,500 CFS to lower pool elevation from 290 to 289 Ft and increase flood storage in preparation for forecasted severe precipitation. Release gates closed during the storm to allow the reservoir to capture water. Blue Marsh Reservoir began releasing flood storage nearly twenty-four hours after the Schuylkill River at Philadelphia had crested and floodwaters began to recede.

4.3.6.3.1 National Flood Insurance Program

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 administrator (Philadelphia City Planning Commission) to enforce these ordinances.

Philadelphia's ordinances ensure that new construction better withstands flooding and does not exacerbate existing flood hazards. For example:

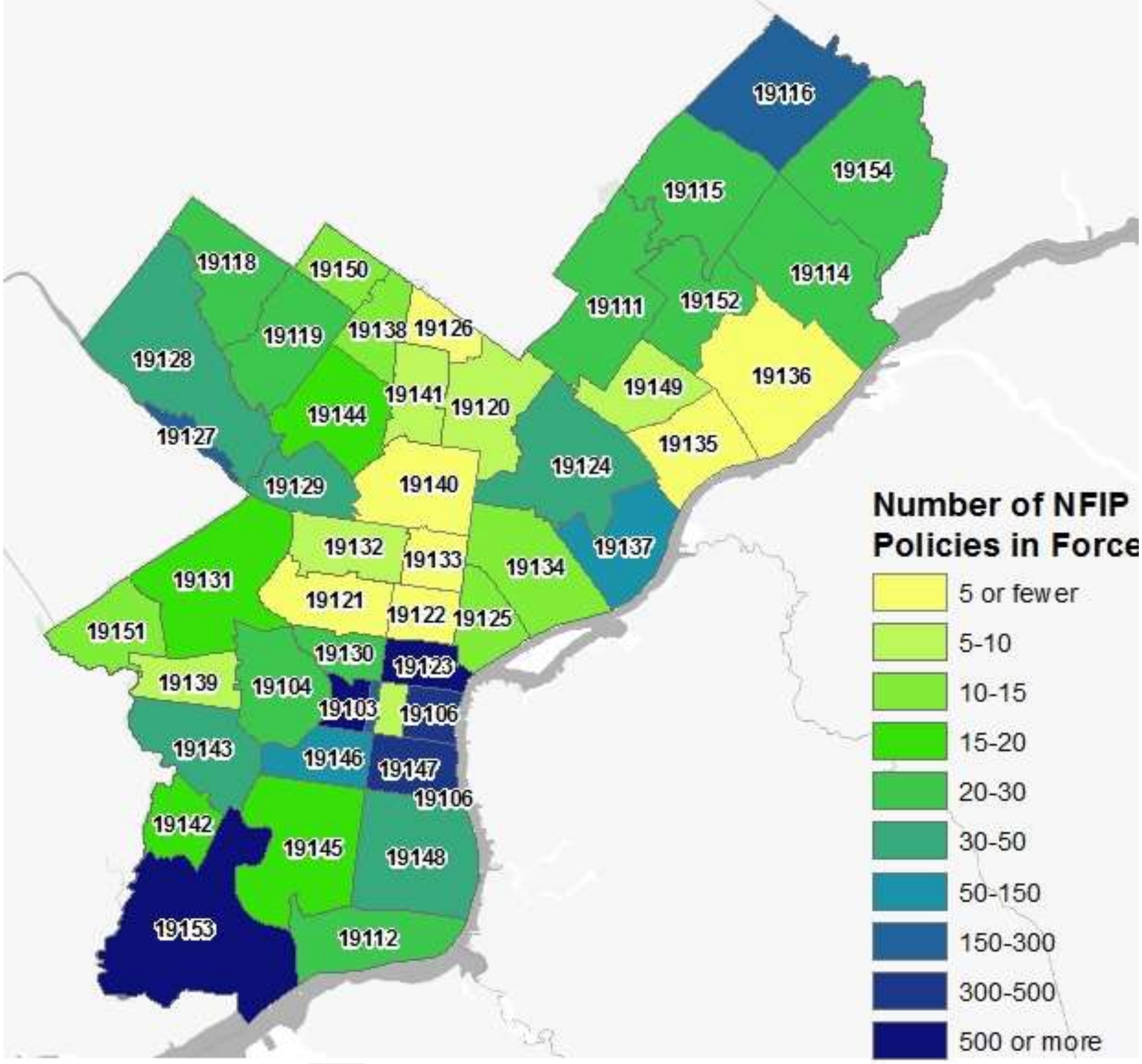
- Newly constructed structures must be 18 inches above the base flood elevation;
- New construction is prohibited within the floodway;
- Restrictions are placed on manufactured mobile homes; and
- Certain hazardous chemicals are not stored within floodplains.

Philadelphia has also established Flood Insurance Rate Maps (FIRMs) that depict floodways, the 1-percent annual chance flood zones, and the 0.2-percent annual chance flood zones. Though FEMA sets the FIRM floodplain determinations, the Philadelphia City Planning Commission (PCPC) has the authority to determine the base flood elevation in Zone A, those areas most prone to flooding. As FEMA updates FIRM maps, PCPC conducts public outreach on the availability and value of flood insurance. The City adopted the latest FIRM map update in November 2015.

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. Repetitive loss insurance claims indicate areas where floodplain occupancy continues in spite of repeated inundation. 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 10-year period since 1978. FEMA considers a property as a severe repetitive loss property when there are at least four losses each exceeding $5,000, or when there are two or more losses where the cumulative building payments exceed the property value.

NFIP data helps indicate the location of potential flood events. The following map identifies the number of NFIP policies in Philadelphia by zip code. The table on the following page details the number of losses and the amount in USD of payouts resulting from those losses. Repetitive loss properties are a high priority for flood mitigation for federal, state, and local mitigation partners.

National Flood Insurance Program (NFIP) Policies in Force as of January 2016



Life and Economic Loss Data by Zip Code in Philadelphia					
Location	**Losses and Costs for Repetitive Loss Properties 1980 to 2015[237]**			**Rescues and Deaths 2005 to 2014[238]**	
Zip Code	**Number of Losses**	**Total Paid**	**Average Paid Per Loss**	**Flooding-Related Rescues**	**Flooding-Related Deaths**
19127	75	$9,217,051.58	$125,955.83	1	0
19153	188	$2,989,137.49	$16,840.97	1	0
19113	5	$571,413.53	$114,282.71	0	0
19128	32	$451,136.99	$14,043.02	1	0
19103	4	$119,383.65	$29,845.92	1	0
19152	13	$103,213.05	$6,533.95	0	1
19122	6	$94,895.25	$15,776.61	0	0
19116	10	$67,649.06	$7,035.94	0	0
19106	4	$64,941.15	$16,235.29	3	0
19149	5	$60,886.36	$10,814.40	0	0
19135	2	$57,840.68	$28,920.34	2	0
19123	4	$43,608.71	$10,902.18	0	0
19130	5	$36,327.62	$6,539.94	2	2
19112	4	$29,745.95	$7,436.49	0	0
19138	5	$28,847.93	$5,066.95	0	0
19145	2	$25,764.91	$12,882.46	0	0
19147	5	$24,238.49	$4,648.83	0	0
19129	2	$22,000.12	$11,000.06	0	2
19136	3	$18,534.85	$6,178.28	3	1
19134	2	$14,621.99	$7,311.00	0	0
19148	4	$14,016.62	$3,504.16	0	0
19119	2	$13,142.43	$6,571.22	0	0
19141	2	$12,939.73	$6,469.87	0	0
19114	2	$5,239.87	$2,619.94	2	0
19154	2	$4,991.25	$2,495.63	0	0
19120	2	$2,521.94	$1,260.97	0	0
Total	**390**	**$14,094,091.20**	**$18,506.65**	**16**	**6**

---

[237] Data provided by the Federal Emergency Management Agency. Up to date as of November 2015.

[238] Data provided by the Philadelphia Fire Department. Data set limited to 2005 to 2014 based on available data

4.3.6.4 Future Occurrences

The probability of future flooding in Philadelphia is high, especially for communities located in the 1.0-percent annual chance zone. This probability increases with the compounding effects of climate change. Several circumstances resulting from climate change—such as higher sea levels and increased rainfall–could raise 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), and increase the depth and extent of flooding in and around the city from storm surges. [239] [240] An increase in rainfall, as local climate data projects, could result in more frequent and intense rainfall events.[241]

4.3.6.5 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 March 2016 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.

OEM created a floodwater depth grid for the 1-percent annual chance flood zones and associated base flood elevations and cross sections from the National Flood Hazard Layer (NFHL), which comes from on the 2007 and 2015 updates of FEMA's Digital Flood Insurance Mapping (DFRIM). Mapping used this data in conjunction with the SFHA data and BFE information. Data was overlaid with a 2015 digital elevation model (DEM) at approximately five-foot resolution. This floodwater depth grid is only riverine, and does not account for storm water drainage issues that may occur in urban areas.

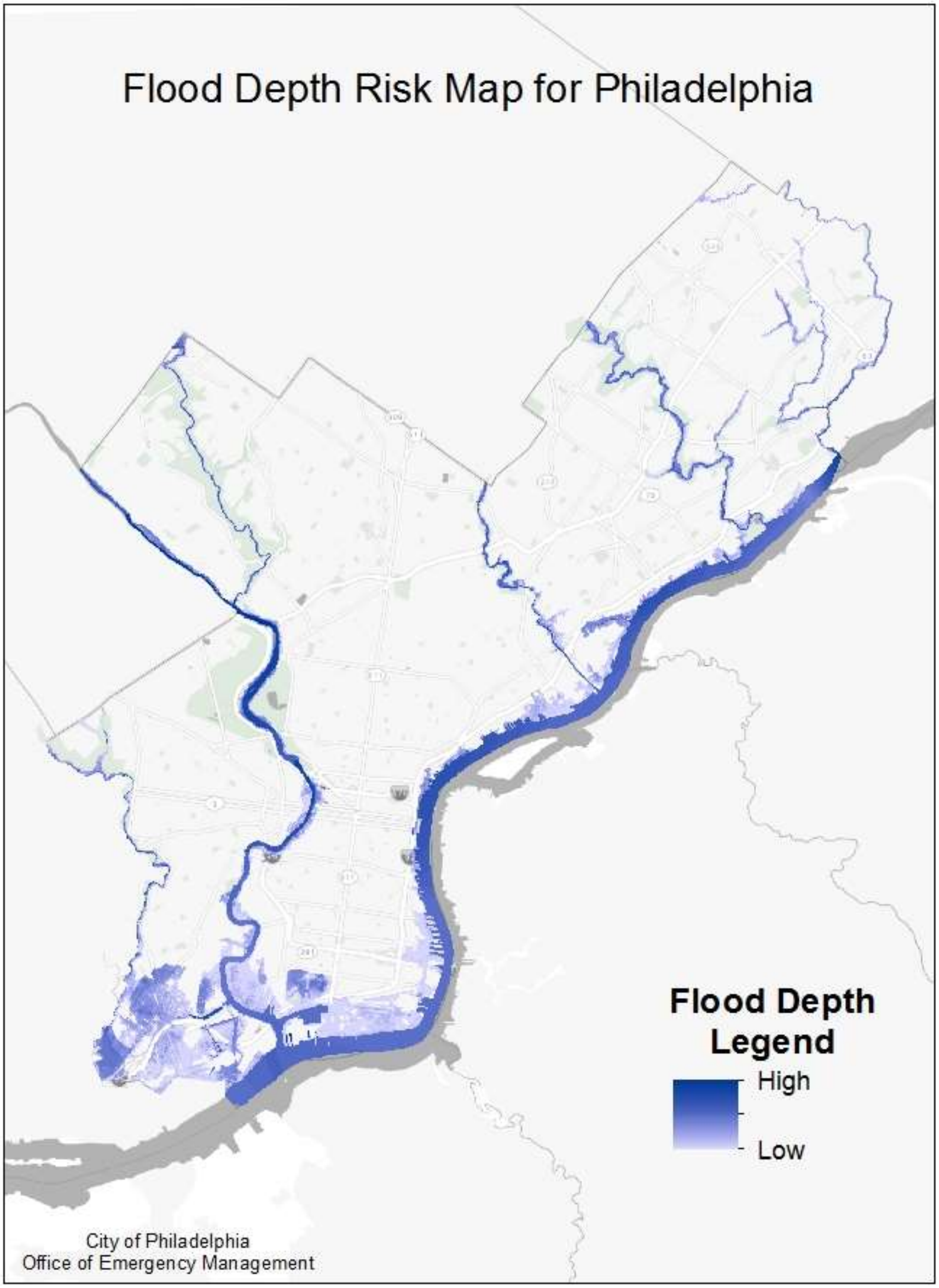
The 1-percent annual chance of flood area covers an area of 18.8 square miles, including a portion of all 24 police districts within the City of Philadelphia. The image below is a basic representation of the City of Philadelphia's 1-percent annual chance area. This map provides a general reference of the areas of Philadelphia vulnerable to flooding during a 1-percent annual chance flood event. Elevation and depth of flooding affects the extent of flooding and related flood damages. The map on the following page shows the extent and depth of flooding that may occur in a 1-percent annual flood event.

---

[239] Growing Stronger: Toward a Climate-Ready Philadelphia. Mayor's Office of Sustainability. Pg 5. Retrieved December 9, 2015.

[240] Ibid.

[241] Growing Stronger: Toward a Climate-Ready Philadelphia. Mayor's Office of Sustainability. Pg 6-5. Retrieved December 9, 2015.



Flooding can cause structural losses within the city of Philadelphia, including homes, businesses, and critical facilities. According to the March 2016 OPA tax account data, there are an estimated 579,912 properties in Philadelphia, an increase from the estimate of 530,000 properties included in the 2012 Hazard Mitigation Plan. Approximately 3,902 of those are located within the 1-percent annual chance area, an increase from 3,600 properties estimated in the 2012 Hazard Mitigation Plan. Some of these properties are critical facilities. A critical facility is a facility that provides services and functions essential to a community, especially during and after a disaster.[242] These properties include a number of critical facilities, listed in the table below.

Critical Assets Located in the 1-percent Annual Chance Floodplain

Critical Asset	Total Number in City	Number in Floodplain
Rail Stations	48	3
Subway/Subsurface Trolley Stations	57	1
Airports	2	1
Police Stations	22	1
Fire/EMS Stations	62	3
Emergency Operations Center	1	0
Schools	438	2
Colleges/Universities	30	0
Hospitals	31	0
Dialysis Centers	43	1
Nursing Homes	51	0
Water/Wastewater Treatment Facilities	6	1
Electric Substations	Number Unknown	2+
Hazardous Material Reporting Facilities	405	42

---

[242] FEMA: Federal Insurance and Mitigation Administration. “Critical Facilities and Higher Standards”. Retrieved April 27, 2016.

The table below provides the estimated building damage count and extent of damage by occupancy type based on the HAZUS analysis for a 1-percent annual flood event.[243] The HAZUS software calculated that in a 1-percent annual flood event, the most significant damages would occur in residential properties with some commercial and industrial properties damaged. HAZUS analysis calculated that no fire stations, hospitals, or police stations would sustain substantial damages in a 100-year flood.

Number of Buildings by Range of Damage

	None	1 to 10	11 to 20	21 to 30	31 to 40	41 to 50	Substantial	Total
Government	0	0	0	0	0	0	0	0
Residential	29	167	560	641	402	126	193	2118
Commercial	1	5	39	0	0	2	1	48
Religious	0	0	2	0	0	0	0	2
Agricultural	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0
Industrial	0	3	2	0	1	0	0	6

Please note that the total number of buildings in the 1-percent annual chance area is different from the number of buildings potentially damaged by flooding. Damage estimates take into account elevation and depth of flooding, not just location within the floodplain. As a result of structural damages, HAZUS estimates this flooding scenario will generate 39,052 tons of debris.[244]

---

[243] Data generated using HAZUS-MH's "Building by General Occupancy" report for a return period of 100 for Census tracts within Philadelphia. Report run on May 2, 2016.

[244] Data generated using HAZUS-MH's "Debris Summary Report" for a return period of 100 for Census tracts within Philadelphia. Report run on May 2, 2016.

In addition to building loss, the City of Philadelphia may also experience highway bridge damage and functional losses in a 100-year flood. HAZUS calculations show a total of seven bridges could experience 0.16 percent damage.[245] No light rail bridges, railroad bridges, or potable water systems would sustain damages in this flooding scenario. A 100-year flood event could damage one waste water facility according to HAZUS analyses. The facility would sustain 40 percent damage, with a total loss of $29,038,000.[246]

The table below breaks down the total direct economic loss citywide that may result from a 100-year flood event as calculated by HAZUS. Total direct economic loss due to flooding includes not only building and content loss but also projected loss of income, worker wages, and inventories. This increases potential losses in commercial or industrial areas, where larger numbers of jobs may be unavailable because of flood damage. The table below includes both 2012 and 2017 estimates calculated through HAZUS for comparison. As shown in the divergence in the 2012 Philadelphia HMP model and the 2012 HMP Model, the Hazus-MH modeling used in the 2017 Philadelphia modeling produced numbers much higher than the model used five years ago, potentially due to more accurate inundation mapping, updated Hazus-MH software, and more accurate loss estimates.

Direct Economic Loss from a 100-Year Flood Event

Type of Loss	Dollar Amount ($)	
	2017	2012
Building Loss	$425,512,000	$211,514,000
Contents Loss	$524,679,000	$340,797,000
Inventory Loss	$13,864,000	$81,646,000
Relocation Cost	$733,000	$1,213,000
Capital Related Loss	$1,515,000	$2,859,000
Rental Income Loss	$421,000	$941,000
Wage Loss	$1,632,000	$4,226,000
Total Loss	**$986,356,000**	**$643,196,000**

The image below shows the spatial distribution of this economic loss throughout the City in terms of percentage of total loss based on full replacement values. The areas with the highest potential loss include several blocks on the east and west ends of Center City adjacent to the Delaware and Schuylkill Rivers, as well as blocks in Manayunk along the

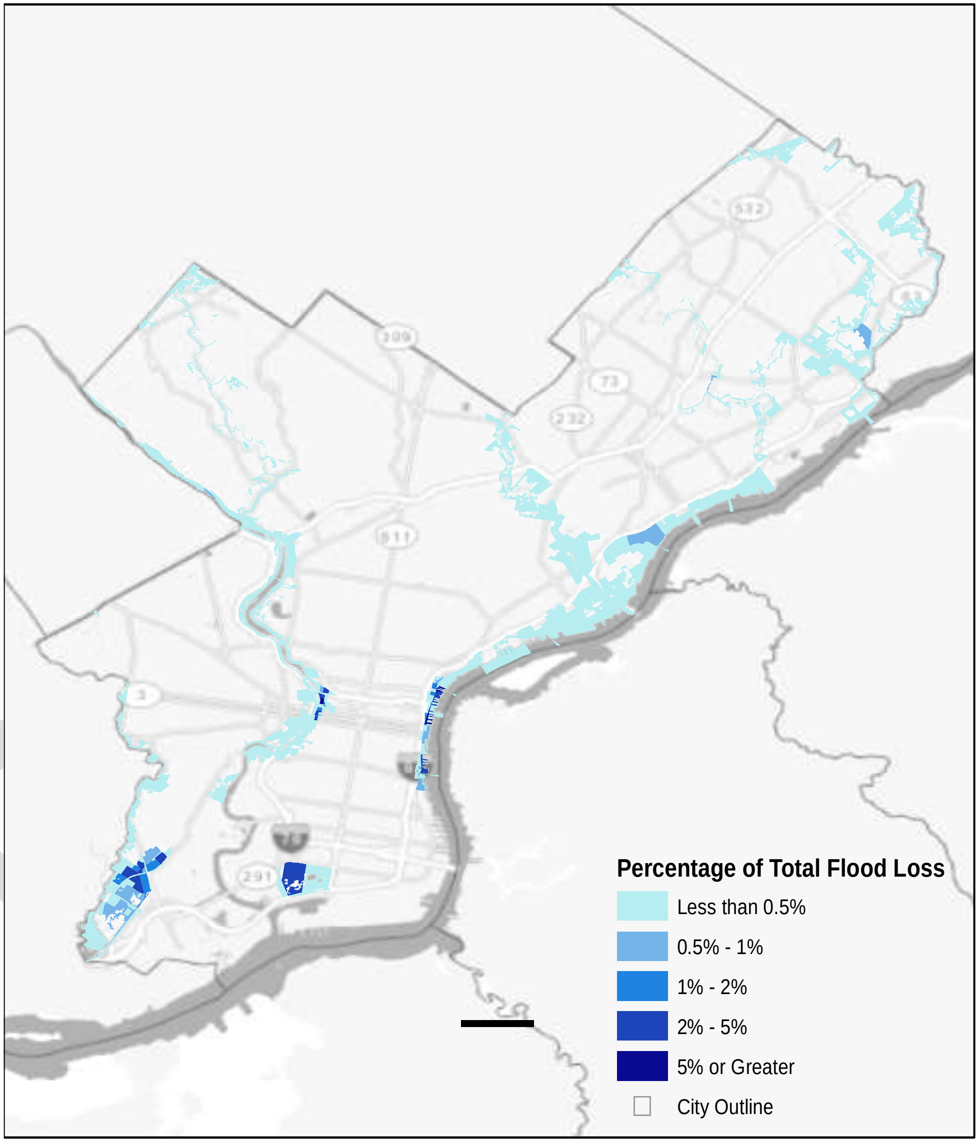
---

[245] Data generated using HAZUS-MH's "Highway Bridge Damage and Functionality" report for a return period of 100 for Census tracts within Philadelphia. Report run on May 2, 2016.

[246] Data generated using HAZUS-MH's "Waste Water Facility Damage" report for a return period of 100. Report run on May 2, 2016.

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.

Direct Economic Losses for Depreciated Replacement Costs Due to Flooding



Source: HAZUS-MH
May 2, 2016

This model might not accurately assess damages to larger, high replacement cost facilities located in the floodplain. In particular, the model may not correctly assess the damages to Philadelphia International Airport and PES Refinery, which cover significant geographic areas that may experience varying extents of flood damage throughout.

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 13,703 individuals, with 12,539 people needing short-term shelter. HAZUS calculates displaced persons as anyone who would evacuate if 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.

4.3.6.5.1 Repetitive Loss Areas and Structures Summary

In order to protect personal information, this section summarizes repetitive loss data by zip code. Data for the number of losses, payments, and number of policies in force came from FEMA Region III. NFIP policy counts are accurate as of January 1, 2016, while the total number of losses and amounts paid through the NFIP are accurate as of 2015. The following table reviews the number of repetitive losses and resulting payments. This table only covers payments from the NFIP. Data on other insurance payments received in conjunction with NFIP policy money, such as private policy reimbursements or payments is not available and is beyond the scope of this document. The table also captures the number of NFIP policies in force in the zip codes where there are repetitive losses reported. This is not the total number of NFIP policies in the city and only captures those policies in repetitive loss areas.

Loss and Insurance Data for Repetitive Loss Properties in Philadelphia

Zip Code	Number of Losses	Total Paid	Average Paid Per Loss	NFIP Policies in Force
19103	4	$ 119,383.65	$ 29,845.92	669
19106	4	$ 64,941.15	$ 16,235.29	170
19112	4	$ 29,745.95	$ 7,436.49	13
19113	5	$ 571,413.53	$114,282.71	1
19114	2	$ 5,239.87	$ 2,619.94	31
19116	10	$ 67,649.06	$ 7,035.94	250
19119	2	$ 13,142.43	$ 6,571.22	37
19120	2	$ 2,521.94	$ 1,260.97	6
19122	6	$ 94,895.25	$ 15,776.61	6
19123	4	$ 43,608.71	$ 10,902.18	503
19127	75	$ 9,217,051.58	$125,955.83	173
19128	32	$ 451,136.99	$ 14,043.02	39
19129	2	$ 22,000.12	$ 11,000.06	38
19130	5	$ 36,327.62	$ 6,539.94	28
19134	2	$ 14,621.99	$ 7,311.00	8

19135	2	$ 57,840.68	$ 28,920.34	4
19136	3	$ 18,534.85	$ 6,178.28	7
19138	5	$ 28,847.93	$ 5,066.95	22
19141	2	$ 12,939.73	$ 6,469.87	16
19145	2	$ 25,764.91	$ 12,882.46	19
19147	5	$ 24,238.49	$ 4,648.83	349
19148	4	$ 14,016.62	$ 3,504.16	39
19149	5	$ 60,886.36	$ 10,814.40	10
19152	13	$ 103,213.05	$ 6,533.95	23
19153	188	$ 2,989,137.49	$ 16,840.97	848
19154	2	$ 4,991.25	$ 2,495.63	41
Totals	390	$14,094,091.20	$ 18,506.65	3,350

4.3.7 <u>Hazardous Materials Train Derailment</u>

Train derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[247]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive, inhalation, and/or contaminant threats to the community.

4.3.7.1 Location

Location information is proprietary and considered for official use only. For more details, please refer to the Vulnerability Assessment section of this hazard profile.

4.3.7.2 Magnitude

The extent of effects of a train derailment involving hazardous materials is variable. Physical damage to infrastructure and the built environment from the derailment would be limited to areas directly adjacent to the rail right-of-way. The effects of a hazmat release and/or explosion from a derailment would depend upon the quantity and type of material present and the weather conditions at the time of the incident. A crude oil spill and explosion typically require an evacuation radius of one-half mile. The magnitude of the explosion could affect a large number of built structures.

Spilled, non-combusting hazardous material could reach waterways, leading to environmental contamination. Non-liquid hazardous materials could form a plume, extending the area that would require evacuation or sheltering in place. The hazard

---

[247] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

could persist for days to a week. Rail equipment would require cranes and other industrial vehicles to be re-railed. Fire crews may not be able to extinguish fires easily because of the potential for a large amount of combustible fuel to be present. Spilled hazardous materials and damage to property from contamination or thermal and explosive impacts could take months depending on the scale of derailment and materials involved.

4.3.7.2.1 Worst-case Scenario

Information included in the worst-case scenario is proprietary and considered for official use only. For more details, please refer to the Vulnerability Assessment section of this hazard profile.

4.3.7.2.2 Environmental Impact

The effects of a derailment of a train carrying hazardous materials depends on the quantity of hazardous material released as well as the type of material or materials involved. The release of hazardous materials can affect groundwater supplies and waterways should the material be absorbed into the groundwater or washed into a waterway. Certain materials could prove dangerous to fish and wildlife through exposure or consumption. Non-liquid hazardous materials could result in a plume that may affect the surrounding environment.

4.3.7.3 Past Occurrences

The table below lists those incidents where a train carrying hazardous materials derailed, resulting in a release of said materials. For a full list of derailments of trains carrying hazardous materials, including those that did not result in a release, please see Annex. Data is limited by the Federal Railroad Agency records, and includes incidents between 1975 and 2015.

Derailments of Hazardous Material Carrying Trains in Philadelphia 1975 to 2015[248]

Date	Speed at Time of Derailment	Number of Cars Derailed
3/11/1983	20 mph	22
11/19/1999	8 mph	2
12/21/2000	18 mph	12

4.3.7.4 Future Occurrences

Several factors contribute to the likelihood of future occurrences. Recent data analysis shows a steady rate or downturn in several hazardous materials transported in and around the region. The annual quantity of hazardous waste the state generates has

---

[248] Federal Railroad Administration Office of Safety Analysis. “3.18 Accident by State/Railroad”. January 1975 to December 2015. Retrieved on May 19, 2016.

declined by 23 percent over the past 10 years.[249] Additionally, the greater southeastern Pennsylvania region contains refineries, chemical processing plants, and storage facilities that continue to store and transport potentially hazardous materials throughout the City. These amounts fluctuate based on market demands and operational capacities. Exact amounts transported and received are considered proprietary information. Numerous pieces of federal legislation regulate facilities' reporting requirements.[250] Reported information informs preparedness and planning efforts.

High-hazard flammable unit trains are subject to speed restrictions in urban areas,[251] such as the City of Philadelphia, further reducing the risk of a derailment. [252] Additionally, "high-hazard flammable unit trains" require a more stringent braking standard that reduces the risk of "pile up." This standard will be fully implemented by 2021.[253]

4.3.7.5 Vulnerability Assessment

The City of Philadelphia Office of Emergency Management recently conducted hazardous material risk and vulnerability assessments with a private vendor. The assessments evaluated the transportation and storage of chemicals throughout the region. Chemical facilities voluntarily supplied proprietary information in support of this study. Due to the proprietary nature of the information, and concerns surrounding potential theft and terror activities, the hazardous materials train derailment vulnerability assessment is available as an annex for official use only.

---

[249] 2014 Report Card for Pennsylvania's Infrastructure. American Society of Civil Engineers.

[250] For a full listing of federal reporting requirements for hazardous materials. Refer to the Environmental Protection Agency website for a full listing of federal reporting requirements for hazardous materials.

[251] DOT 42-15: DOT Announces Final Rule to Strengthen Safe Transportation of Flammable Liquids by Rail. U.S. Department of Transportation. May 1, 2015. Retrieved January 29, 2016.

[252] Image: DOT 117 Specification Car. DOT Announces Final Rule to Strengthen Safe Transportation of Flammable Liquids by Rail. U.S. Department of Transportation. May 1, 2015. Retrieved January 29, 2016.

[253] DOT 42-15: DOT Announces Final Rule to Strengthen Safe Transportation of Flammable Liquids by Rail. U.S. Department of Transportation. May 1, 2015. Retrieved January 29, 2016.

4.3.8 Hurricane/Tropical Storm

A tropical cyclone is a general term for large thunderstorm complexes rotating around an area of low-pressure that has formed over warm tropical or sub-tropical ocean water. These complexes go by a variety of names depending on their intensity and location. The NOAA Hurricane Research Division classifies tropical cyclones as follows:[254] [255]

- Tropical Disturbance: A discrete tropical weather system of apparently organized convection - generally 200 to 600 km (100 to 300 nmi) in diameter - originating in the tropics or subtropics, having a non-frontal migratory character, and maintaining its identity for 24 hours or more. It may or may not be associated with a detectable perturbation of the wind field. Disturbances associated with perturbations in the wind field and progressing through the tropics from east to west are also known as easterly waves.
- Tropical Depression: A tropical cyclone in which the maximum sustained wind speed (using the U.S. one minute average standard) is up to 33 kts (38 mph, 17 m/s). Depressions have a closed circulation.
- Tropical Storm: A tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1 minute average standard) ranges from 34 kts (39 mph,17.5 m/s) to 63 kts (73 mph, 32.5 m/s). The convection in tropical storms is usually more concentrated near the center with outer rainfall organizing into distinct bands.
- Hurricane: When winds in a tropical cyclone equal or exceed 64 kts (74 mph, 33 m/s) it is called a hurricane (in the Atlantic and eastern and central Pacific Oceans). Hurricanes are further designated by categories on the Saffir-Simpson scale.

Flooding in Manayunk during Hurricane Ivan

A tropical disturbance must meet several conditions to reach hurricane status:[256]

- Warm tropical waters must be at least 80°F, ideally to the depth of a few hundred feet. Warm water means plenty of evaporation, which leads to water vapor fueling a thunderstorm. (Water temperatures off New Jersey and Delaware rarely get this warm for long periods of time and over a large area. Consequently, for a tropical system to affect Philadelphia, it has to form farther south and move northward).

---

[254] Hurricane Research Division. Frequently Asked Questions: What is a tropical disturbance, tropical depression or tropical storm? NOAA. Retrieved 10 December 2011.

[255] Image: Manayunk Neighborhood Council. “Hurricane Ivan--September 18 2004”. Retrieved January 15, 2016.

[256] Hurricane Research Division. Frequently Asked Questions: How do tropical cyclones form? NOAA. Retrieved 10 December 2011.

- The mid-troposphere (approx. three miles up from the earth's surface) must be relatively moist (high dew points), to allow the continuing development of widespread thunderstorm activity.
- The wind speed and direction must not vary greatly from lower to higher levels in the atmosphere (low values of vertical wind shear). Strong high-altitude winds or winds that change direction with height tend to blow tops of thunderstorms, interrupting development.
- A tropical disturbance must be at least 300 miles from the equator. This insures non-negligible amounts of the Coriolis force (a fictitious force used to account for the apparent deflection of a body in motion with respect to the earth) to provide circulation within the system.

Atlantic hurricanes form off the coast of Africa, in the Caribbean Sea, or in the Gulf of Mexico. Hurricanes can produce violent winds, tornadoes, powerful waves and storm surge, and torrential rains and floods. By the time most tropical systems reach Pennsylvania, they do not have hurricane-force winds.

The official hurricane season for the Atlantic Basin (the Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico) is from June 1 to November 30. Most hurricanes in Philadelphia have occurred in August and September.[257] However, deadly hurricanes can occur any time during the year.[258]

4.3.8.1 Location

Philadelphia is located about 80 miles inland from the mouth of the Delaware Bay (30 miles inland from where the Delaware River meets the Bay), and approximately 60 miles from the Atlantic Coast. As such, Philadelphia is located in an area where tropical cyclones could track inland causing heavy rain and strong winds. Tropical cyclones are regional events that can affect an area hundreds of miles long; therefore, all neighborhoods within Philadelphia are equally subject to the impacts of these storms.

4.3.8.2 Magnitude

Meteorologists classify hurricanes by their wind speed on a damage-potential scale developed by Herbert Saffir, a consulting engineer, and Robert Simpson, a NWS meteorologist, in the 1970s. The Saffir-Simpson Scale divides storms into five categories based on the highest one-minute average wind speed in the storm, as seen in the table below. A hurricane's category typically changes as it intensifies or weakens. Meteorologists describe Category 3 through Category 5 hurricanes as major hurricanes. The chart on the following page provides details on the Saffir-Simpson Scale and its damage descriptions.

---

[257] "Historical Hurricane Tracks". NOAA, National Ocean Service. Retrieved April 14, 2016.
[258] National Hurricane Center. Tropical Cyclone Climatology. National Weather Service. Retrieved December 10, 2011.

Saffir-Simpson Hurricane Scale [259]				
Category	**Storm Surge**	**Winds**	**Damage**	**Damage Description**
1	6.1 – 10.5 ft.	74-95 mph	Moderate	▪ Damage primarily to trees and unanchored homes ▪ Some damage to poorly constructed signs ▪ Coastal road flooding
2	13.0-16.6 ft.	96-110 mph	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 ft.	111-130 mph	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 ft.	131-155 mph	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 floors of structures near the shore
5	Not predicted	>155 mph	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 close to shore

---

[259] NOAA. The Saffir-Simpson Hurricane Wind Scale. The Saffir-Simpson Hurricane Wind Scale Team. Retrieved December 2, 2015.

Wind speeds in most hurricanes diminish exponentially once they make landfall; their wind speed typically halves within about seven hours after the storm crosses the coastline.[260] However, hurricanes occasionally do not lose their strength and transition to become extratropical cyclones, cyclones in the middle or high latitudes often associated with an extensive cold front. In 1954, Hurricane Hazel made landfall in North Carolina, yet maintained close to 100mph winds when entering the Philadelphia region.

4.3.8.2.1 Environmental Impact

Hurricanes and tropical storms can cause high winds and flooding. For more information on the environmental impacts of flooding, see the Flooding environmental impacts section in this risk assessment.

Hurricanes and tropical storms are also associated with both wind gusts and sustained winds that may affect the environment. Winds can cause damage to trees. Felled 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 top soil if the soil is dry or loose enough. Additionally, a tropical storm or hurricane winds can spread trash and debris over a large area, complicating cleanup efforts.

4.3.8.2.2 Worst-case scenario

The following worst-case scenario is based off past occurrences, projections from the National Oceanic and Atmospheric Administration, and climate change/storm surge modeling.

A late summer hurricane with a track initially similar to that of Hurricane Sandy of 2012 moves northwest up the Delaware Bay at high tide. The eye of the storm tracks west of the Delaware Bay and the storm makes landfall as a Category 3 hurricane near Lewes, Delaware, skirting the Delaware coast before turning north near Wilmington, Delaware. This track causes a maximum storm surge up the Delaware River and its tributaries, and the storm produces hurricane force winds across the Philadelphia region. Building collapses result due to the strong sustained winds. As the storm weakens to a tropical storm and then depression, and stalls over central eastern Pennsylvania, severe riverine flooding occurs across much of the southeastern region of the state, including the Delaware and Schuylkill Rivers, and Frankford and Pennypack Creeks. Critical infrastructure, homes, and businesses are flooded along waterways.

---

[260] Keller, Blodgett. Natural Hazards: Earth’s Processes as Hazards, Disasters, and Catastrophes. Second Edition.2008.

4.3.8.3 Past Occurrences

The following table lists the ten most destructive hurricanes and tropical storms in terms of damage estimates and loss of life with centers of circulation occurring within 65 miles of Philadelphia.[261]

Ten Most Deadliest and Most Destructive Hurricanes/ Tropical Storms Passing Within 65 Statute Miles of Philadelphia

Year	Event	Peak Intensity	Strength In/ Near Philadelphia	Damage Notes
1999	Floyd	Category 4 Hurricane	Tropical Storm	Caused eight deaths in Pennsylvania Produced 2.8 ft. storm surge 3,500 homes were flooded and 1,000 residents were evacuated
1878	Unnamed	Category 2 Hurricane	Tropical Storm	Caused seven deaths in Philadelphia Caused $2 million in damage Destroyed several buildings Peak winds at 72 mph
1972	Agnes	Category 1 Hurricane	Tropical Storm	Caused three deaths in Philadelphia Highest flooding on record at Fairmont Dam
2012	Sandy	Category 3 Hurricane	Category 1 Hurricane	Caused 2 deaths in Philadelphia Caused $20 million dollars in damage in Pennsylvania Left 850,000 customers without power Refineries within the city could not operate at full capacity because of power outages All SEPTA and Amtrak service suspended Interstates 95, 76, 476 and 676 as well as Route 1 closed during the storm Caused flooding along the Delaware River on Delaware Avenue and Columbus Boulevard

---

[261] Save for the storms of 1878 and 1933, very few details concerning loss of life and property are available for storms prior to 1945.

2011	Lee	Tropical Storm	Tropical Storm	Caused one death in Philadelphia Caused rockslide in the vicinity of the Conshohocken Curve, flooding near Belmont Avenue and a mudslide by Girard Avenue on the Schuylkill Expressway Caused widespread flash flooding, as well as flooding in Manayunk and on Kelly Drive Regionally, Lee destroyed 22 homes and businesses, 201 structures suffered major damage, 672 received minor damage and 1,217 were affected
2011	Irene	Category 2 Hurricane	Tropical Storm	Manayunk and Lincoln Drive flooded Caused the collapse of seven buildings and damage to thirteen other structures within the city The Schuylkill and Delaware rivers crested at 13.5 ft. and 9.77 ft. respectively, in Philadelphia Estimated 11,800 flights cancelled at PHL, grounding 650,000 passengers More than 500 trees fell in the city and twenty roads were closed The storm surge of 3 to 5 feet caused moderate tidal flooding along tidal sections of the Delaware River Three shelters opened in Philadelphia
1933	Unnamed	Category 4 Hurricane	Tropical Storm	Pennsylvania Highway Department estimated $800,000 in damages to streets and bridges in Southeastern Pennsylvania Caused the third highest crest on the Schuylkill River at 14.7 feet Widespread flooding occurred along the Schuylkill River
1954	Hazel	Category 4 Hurricane	Tropical Storm	Caused widespread destruction - most of the damage caused by wind 94 mph gusts recorded in Philadelphia
1955	Connie	Category 1 Hurricane	Tropical Storm	Many people evacuated (exact number unknown), including 800 scouts from Camp Delmont Flooding caused along Delaware River
1955	Diane	Category 1 Hurricane	Tropical Storm	Flooding caused along Delaware River Heavy runoff from northeastern rivers caused extensive flooding downstream Occurred a week following Connie

4.3.8.4 Future Occurrences

General scientific consensus suggests that tropical storms may decline in number globally, but increase in the number of Category 3, 4, and 5 storms.[262] There is some suggestion 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.[263]

Taking into additional considerations by NOAA's Hurricane and Research Division's North Atlantic hurricane season classifications, Philadelphia can expect the following seasonal means and ranges for a below-normal, near-normal, and above-normal season.[264]

Season Type	Mean # of Tropical Storms	Range of Tropical Storms	Mean # of Hurricanes	Range of Hurricanes	Mean # of Major Hurricanes	Range of Major Hurricanes
Above-Normal	16.5	12 to 28	9.7	7 to 15	4.8	3 to 7
Near-Normal	12.3	10 to 15	6.3	4 to 9	2.3	1 to 4
Below-Normal	6.7	4 to 9	3.3	2 to 4	1	0 to 2
All Seasons	12.1	4 to 28	6.4	2 to 15	2.7	0 to 7

4.3.8.5 Vulnerability Assessment

High winds and flooding are the primary hazards associated with tropical cyclones. High winds often result in power outages, disruptions to transportation corridors and equipment, loss of workplace access, significant property damage, injuries and loss of life, and the need to shelter and care for individuals impacted by these events. A large amount of damage can be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, vehicles, and, in some cases, individuals.

Additionally, tropical cyclones can bring heavy rains and storm surge, which can cause significant flooding. Storm surge is an abnormal rise in sea level accompanying an intense storm, whose height is the difference between the observed level of the sea

---

[262] Growing Stronger Toward a Climate-Ready Philadelphia. Mayor's Office of Sustainability. Retrieved December 11, 2015.

[263] Climate of the Southeast United States: Variability, Change, Impacts, and Vulnerability. Pg 35. Keith T. Ingram, Kirstin Dow, Lynne Carter, and Julie Anderson. Retrieved December 11, 2015.

[264] Table: Background Information: The North Atlantic Hurricane Season. National Weather Service: Climate Prediction Center. Retrieved April 14, 2016.

surface and the level that would have occurred in the absence of the storm.[265] In general, storm surge is greatest in the right forward quadrant of the storm as it makes landfall. In simple terms, the right forward quadrant includes the area of the storm that is in front of the storm’s eyewall and on the right side of the storm. The height of the surge is generally greatest near the time of maximum wind speed and is greater if landfall takes place at high tide. In addition, the shape of the coastline affects storm surge. In a narrow Bay, such as the Delaware Bay, storm surge may increase as water sloshes back and forth in the partially enclosed body of water. Therefore, a worst-case scenario for Philadelphia would include a high magnitude hurricane moving up the Delaware Bay during high tide with the center of the storm slightly to the west of Philadelphia.

Due to Philadelphia’s mid-latitude, inland location, by the time most storms reach the area, they fail to satisfy the definition of a hurricane or tropical storm. However, the City has experienced flooding in association with hurricanes and tropical storms in the past. The Flood Hazard Profile within this plan addressed flooding due to heavy rains, but this section covers storm surge related flooding.

Two computer models were used to assess the two primary impacts associated with hurricanes: SLOSH for storm surge and HAZUS for hurricane winds.

NOAA’s Sea, Lake, and Overland Surge from Hurricanes (SLOSH) Display Package estimates storm surge heights for different hurricane scenarios and can be used to assess potential flooding and need for evacuation. The SLOSH analysis presented here is based on maximum storm surge heights at high tide for all hurricanes of a given category. NOAA’s SLOSH Maximum of Maximum inundation maps for hurricane categories one through three were overlaid with flood depth grids and Census data to estimate the impact of hurricanes within the SLOSH zones.

HAZUS is FEMA's methodology for estimating potential losses from disasters, and contains a hurricane module that focuses on hurricane winds and estimates related effects on population and infrastructure. This model was applied using the same general building stock data compiled for the flood hazard analysis. No additional modifications were made to the hurricane model, as reliable data was not readily available.

The likelihood for hurricane-strength winds in Philadelphia is relatively low because of its northern, inland location. Wind speeds of 74 mph and higher are generally considered hurricane-strength. Philadelphia has approximately a one percent chance of experiencing this in any given year. The following table shows the peak wind gusts that Philadelphia could experience associated with a hurricane and the related probability of occurrence.

---

[265] Ibid

Peak Wind Gusts Associated with Hurricanes in Philadelphia		
Return Period	Likelihood of Exceeding in any Given Year	Peak Wind Gust
10-Year	10%	37 - 40 mph
20-Year	5%	49 – 53 mph
50-Year	2%	63 – 68 mph
100-Year	1%	73 – 78 mph
200-Year	0.5%	81 – 86 mph
500-Year	0.2%	92 – 96 mph
1000-Year	0.1%	98 – 103 mph

The environmental impacts associated with tropical cyclones in Philadelphia are consistent with those described for flood hazards and wind hazards within the respective vulnerability sections of each hazard profile.

Structural and economic damages come from both wind and flood damages in a hurricane scenario. The table below details building damages associated with hurricane winds. No building damage or economic loss is associated with the 10 or 20-year return periods. Thus, the likelihood of experiencing building damage or economic loss due to hurricane winds in Philadelphia is approximately 2 percent in any given year, although total destruction of buildings is less likely.

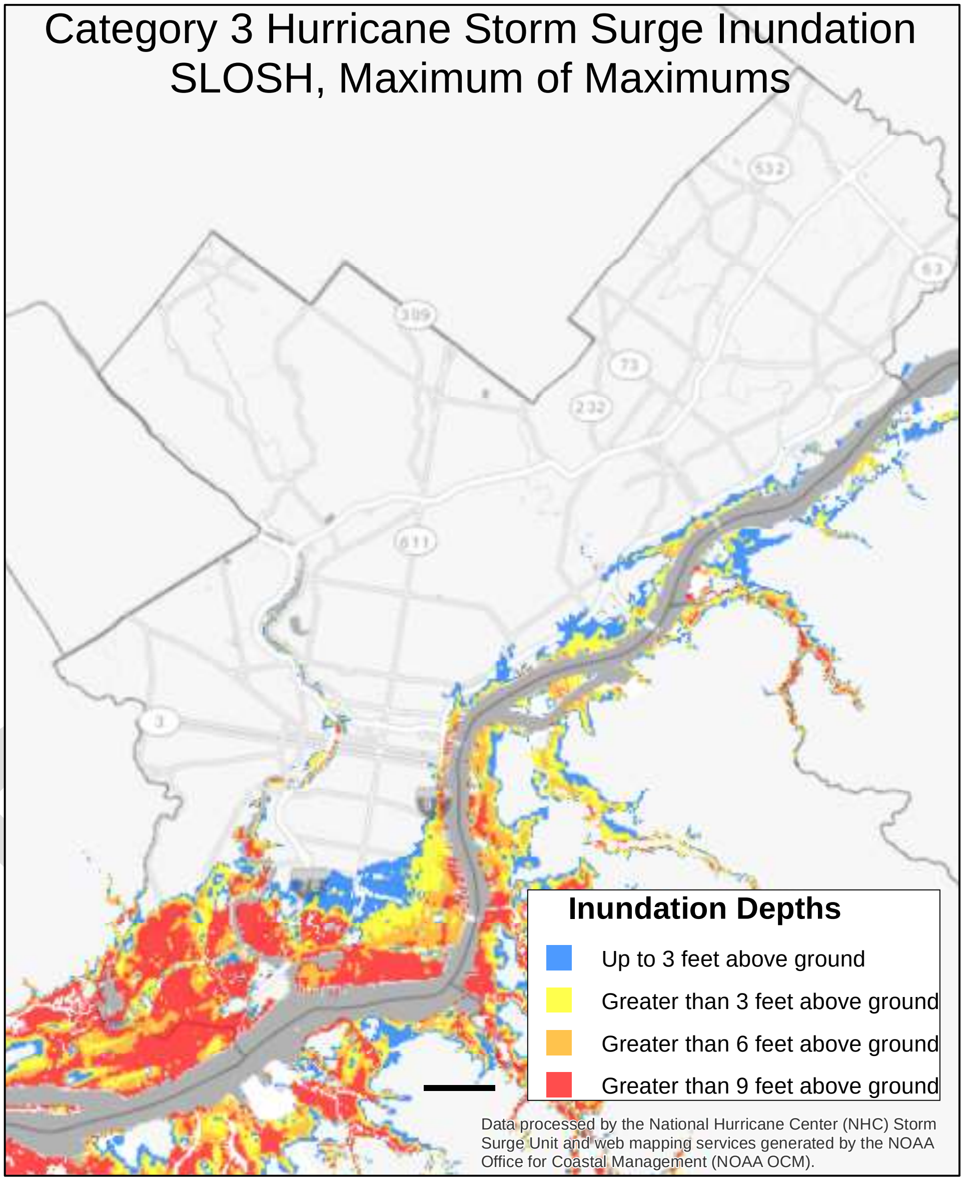
Building Damage Counts due to Hurricane Winds (Probabilistic)				
Return Period	Minor Damage	Moderate Damage	Severe Damage	Destruction
10-Year	0	0	0	0
20-Year	0	0	0	0
50-Year	449	12	0	0
100-Year	1,682	67	0	0
200-Year	6,297	356	10	0
500-Year	24,896	2,106	34	10
1000-Year	46,044	5,097	103	49

Direct Economic Loss (in Dollars) due to Hurricane Winds (Probabilistic)			
Return Period	**Total Losses**	**Capital Stock Losses**	**Business Interruption (Income) Losses**
10-Year	$ -	$ -	$ -
20-Year	$ -	$ -	$ -
50-Year	$ 18,430,000.00	$ 18,406,000.00	$ 24,000.00
100-Year	$ 86,166,000.00	$ 85,445,000.00	$ 721,000.00
200-Year	$ 230,673,000.00	$ 219,177,000.00	$ 11,496,000.00
500-Year	$ 603,453,000.00	$ 565,247,000.00	$ 38,206,000.00
1000-Year	$ 1,064,123,000.00	$ 966,695,000.00	$ 97,428,000.00
Annualized	$ 6,232,000.00	$ 5,715,000.00	$ 517,000.00

The table below provides more specific information on economic losses associated with a 100-year return period or hurricane winds with a 1 percent chance of occurring in any given year in Philadelphia. In contrast to flooding, damages related to hurricane winds would more significantly affect the exterior and structure of buildings themselves, as opposed to building contents and inventory, particularly because total destruction of buildings is not expected during a 100-year event.

Direct Economic Losses for Buildings in a 100-Year Hurricane Event (All values are in thousands of dollars)		
Capital Stock Losses	Cost Building Damage	$84,572
	Cost Contents Damage	$873
	Inventory Loss	$ -
Income Losses	Relocation Loss	$369
	Capital Related Loss	$ -
	Wages Losses	$ -
	Rental Income Loss	$352
Total Loss		$86,166

In addition to wind damage, there is a possibility for flood damage from hurricane storm surge and a different subset of population and infrastructure that may be affected or further impacted. The table below shows the SLOSH zones associated with a Category 3 hurricane in Philadelphia, the worst-case scenario for a hurricane. SLOSH zones represent areas that may experience flooding from hurricane storm surge. Though SLOSH zones and floodplains may overlap, these are different.



Data processed by the National Hurricane Center (NHC) Storm Surge Unit and web mapping services generated by the NOAA Office for Coastal Management (NOAA OCM).

Source: NOAA NHC
Category 3 Hurricane Storm Surge Inundation
May 2, 2016

As a Category 3 hurricane is the worst-case scenario for Philadelphia, modeling using SLOSH inundation data for such an event layered with 2014 American Community Survey population data can provide displacement and sheltering estimates. Using block group level population data, those block groups whose centroids fell within a SLOSH feature based on the Category 3 maximum of maximums (show in the map above) would be temporarily displaced. The table below calculates the displaced population, as well as sheltering and access and functional needs for the affected population using percentages from FEMA guidance.

Displaced Population in a Category 3 Hurricane	
Displaced population	111,348
Displaced population with access and functional needs	22,270
Displaced population requiring shelter	14,475
Displaced population requiring shelter with access and functional needs	2,895

Of particular concern are critical facilities located within the SLOSH zones that potentially could be damaged by storm surge flooding or may require special consideration during an evacuation. The table below lists the critical assets located in the Category 1, 2, and 3 SLOSH zones.

Critical Assets in the SLOSH Zones in Philadelphia

Critical Asset	Total Number	Number in SLOSH Zone 1	Number in SLOSH Zone 2	Number in SLOSH Zone 3
Rail Stations	48	0	2	0
Subway/Subsurface Trolley Stations	57	0	0	0
Airports	2	0	1	0
Police Stations	22	0	0	0
Fire/EMS Stations	61	0	1	1
Emergency Operations Center	1	0	0	0
Schools	438	0	1	4
Colleges/Universities	30	0	0	0
Hospitals	31	0	0	0
Dialysis Centers	43	0	0	1
Nursing Homes	51	0	0	1
Water/Wastewater Treatment Facilities	6	0	1	1
Electric Substations	Total Unknown	0	1	4
Hazardous Material Reporting Facilities	398	1	19	56

4.3.9 ***Improvised Explosive Device (IED)***

An IED attack is the "use of a "homemade" bomb and/or destructive device to destroy, incapacitate, harass, or distract".[266] 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. The majority of terrorism-related attacks worldwide use explosives.[267] Shrapnel material, propellant, or additional hazardous materials can worsen the impact of an IED.

4.3.9.1 Location

Locations at the greatest risk for IED attack 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 a criteria include, but are not limited to museums, government buildings with a public interface, landmarks, and festivals. As seen in the 2015 attacks in Paris, terrorists may target numerous locations and types of facilities at the same time.

4.3.9.2 Magnitude

The IED's construction, composition, and location control the explosive's effects on both the population and the built environment. The type and quantity of explosive determines the extent of the damage. Primary impacts of an IED are generally limited to the area of detonation. Immediate health effects resulting from an IED include:

- Overpressure damage: Overpressure is the pressure caused by a shock wave. Organs such as the lungs and ears are pressure-sensitive.
- Fragmentation injuries: Shrapnel from the bomb and objects around it can cause serious harm as they fly through the air.
- Impact injuries: Impact injuries occur when a person or object launches into another person or object, causing bodily harm.
- Thermal injuries: These include burns internally and externally as a result of the explosion.[268]

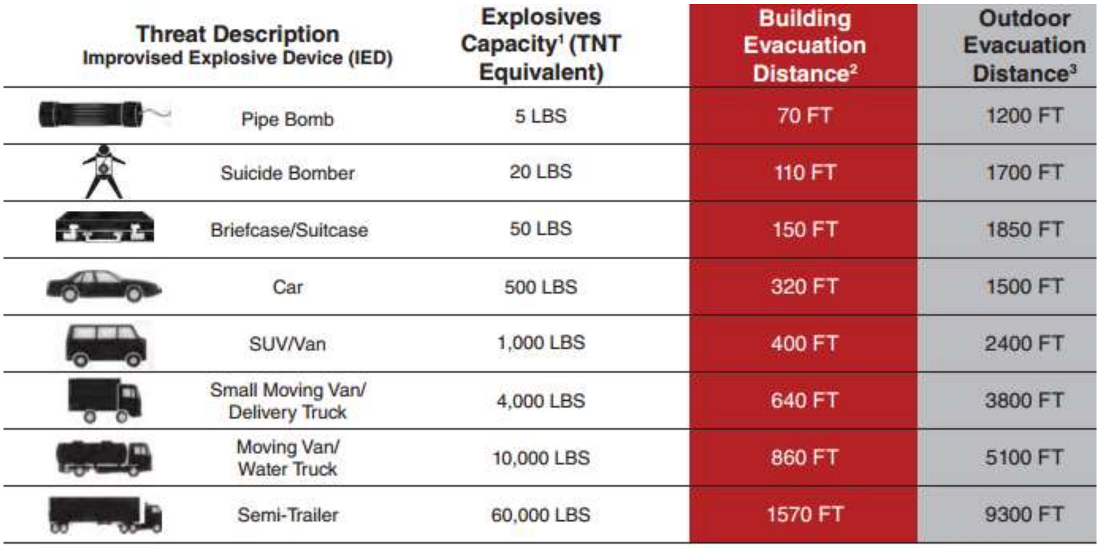
---

[266] "IED Attack Improvised Explosive Devices". Department of Homeland Security. News & Terrorism Communicating in a Crisis. Retrieved 6 October 2015.

[267] Ibid.

[268] Ibid.

The chart below illustrates the primary impact range surrounding an explosive device.[269]



Threat Description Improvised Explosive Device (IED)	Explosives Capacity[1] (TNT Equivalent)	Building Evacuation Distance[2]	Outdoor Evacuation Distance[3]
Pipe Bomb	5 LBS	70 FT	1200 FT
Suicide Bomber	20 LBS	110 FT	1700 FT
Briefcase/Suitcase	50 LBS	150 FT	1850 FT
Car	500 LBS	320 FT	1500 FT
SUV/Van	1,000 LBS	400 FT	2400 FT
Small Moving Van/ Delivery Truck	4,000 LBS	640 FT	3800 FT
Moving Van/ Water Truck	10,000 LBS	860 FT	5100 FT
Semi-Trailer	60,000 LBS	1570 FT	9300 FT

Secondary effects may exist, depending on the built environment surrounding the area of the blast. Built environment secondary impacts include structural collapse of damaged buildings. Secondary effects may also include psychological effects, eye injuries, and abdominal injuries that can manifest hours or even months later.

4.3.9.2.1 Worst-case scenario

The following worst-case scenario is derived from analysis location projections and trends in terrorist attacks.

In the late summer, a domestic terror group targets a private celebration taking place in the early afternoon at the Philadelphia Constitution Center. The group detonates a single IED at the nearby Liberty Bell, causing the Center and the surrounding attractions to evacuate. As tourists and workers from nearby businesses stream towards the exits, the terrorists detonate two IEDs inside the Constitution Center. Simultaneously, the terrorists detonate a vehicle borne IED located between tour buses parked alongside the Center, causing additional casualties and partially blocking access to the Center for emergency vehicles.

4.3.9.2.2 Environmental Impacts

The environmental impact of an IED would largely depend on the location and size of the detonation. Given that the most likely areas targeted would be largely urban, environmental impact would be minimal. In the event of an IED attack, damage would be limited to the immediately surrounding trees and vegetation. If an attack occurs along

---

[269] Bomb Threat Stand-Off Chart. Department of Homeland Security. Retrieved March 23, 2016.

a waterway and causes structural collapse, larger pieces of debris in a waterway could also disrupt flow and local currents, leading to sediment build-up and increases in turbidity.

4.3.9.3 Past Occurrences

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.[270]

4.3.9.4 Future Occurrences

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 addresses suspicious devices and activities as swiftly and safely as possible.[271]

4.3.9.5 Vulnerability Assessment

The loss estimations for an explosive device incorporates data from the 2015 THIRA.

The impact of an explosive device largely depends on the material, location, and size of the device. This vulnerability assessment assumes a large, vehicle-borne improvised explosive device at a heavily attended public event.

The human impact of the improvised explosive device in this scenario would be large. The City could expect 210 fatalities and over 1,216 casualties resulting from the detonation, debris projectiles, and partial building collapses in the immediate area. Local hospitals and medical services implement surge procedures and disaster plans, requesting additional resources as needed. The evacuation of all spectators at an event would result in potentially 65,000 people or more requiring short term sheltering. If any surrounding hotels or homes are affected, an additional 1,000 displaced residents and hotel guests may require medium-stay sheltering. Of the affected population, approximately 45% will seek some type of health or social services.

An explosive device attack at a landmark or near a stadium would result in large 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. Over 800 tons of debris must be cleared from around bombed sites. Officials or site operators may close major cultural venues indefinitely because of an attack, affecting schedules of concerts,

---

[270] Global Terrorism Database. Retrieved January 14, 2016.

[271] Image: “Philadelphia Police Ordinance Disposal Unit-Bomb Squad 2”. Phillycop. March 18, 2009. Retrieved February 5, 2016.

sporting events, and other cultural activities. Short and long term economic consequences could occur within travel, tourism, and entertainment industries.

An improvised explosive device attack would also affect access and transportation. Ingress/egress routes would close to the immediate area of the site, except to allow first responders priority access to arenas. SEPTA would close mass transit lines through the affected area are closed until it is determined there is no longer a threat.

4.3.10 Infrastructure Failure

Infrastructure may collapse if a natural or human-made hazard compromises a structure's integrity. Older or weak construction, as well as structures that do not meet building codes, are more susceptible to hazards. This section takes into consideration three types of structural infrastructure failures or collapses:

- Bridge failures,
- Dam failures, and
- Building collapses.

Bridge Failure

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 –** Oxidation occurs when an iron or an alloy that contains iron is exposed to moisture and oxygen for an extended period. The resulting rust causes degradation of the integrity of structures. Additionally, because rust has a much higher volume than the iron or alloy it originated from, rust build up can occur and cause failure of adjacent parts.
- **Concrete deterioration –** Concrete deterioration can result from numerous causes, the most common of which results from the corrosion of reinforcing steel through unchecked oxidation.[272] Other causes include carbonation, exposure to chloride ions such as in deicing salts, freeze-thaw deterioration, and abrasion/erosion.
- **Repetitive stress fractures –** Stress fractures can result from repetitive traffic loads that cause fatigue cracking in the top and bottom of a pavement. Repetitive wear from tires or rail loads causes cracks along the top of the pavement, while repetitive tensile stresses (the continuous bending of the pavement layers from vehicle loads) causes cracks along the bottom of the pavement.[273]
- **Harmonic vibration-** Harmonic vibration occurs when a bridge, or any other structure, oscillates or vibrates at a regular rate. Heavy traffic, heavy foot loads, or machinery can cause vibrations. If the vibrations happen at a system's resonance frequency, or the natural frequency of an object determined by the materials used and construction type, the oscillation increases the amount of energy stored. When this stored energy exceeds an object's load limit, it will lose structural integrity.
- **Excessive traffic loads-** Engineers and regulating agencies will often rate bridges for a load rating. A load rating evaluates the capability of various

---

[272] Portland Cement Association. "Concrete Information: Types and Causes of Concrete Deterioration". Retrieved January 14, 2016.

[273] S.M.J.G. Erkens and J. Moraal. "Cracking in asphalt concrete". Delft University of Technology. Retrieved January 14, 2016.

structural parts to carry moving vehicles, foot traffic, and other loads. When a bridge experiences excessive traffic loads in excess of the load rating, there is the risk for structural damage.
- **Wind load –** Wind load refers to the push and pull of wind, which can cause undue stress for those bridges not reinforced to withstand excessive wind loads.[274]

Dam Failure

A dam failure is the systematic failure of a dam structure, resulting in the uncontrolled release of water. In the event of a dam failure, the energy of the stored water behind even a small dam can cause significant property damage if structures exist downstream. Flash flooding events can occur when a dam fails, resulting in fast-moving waters, uprooted trees, and damaged bridges and roads. Dam failures can result from natural events, accidental or intentional human causes, or a combination of the two. FEMA lists reasons for dam failure as one or a combination of the following:

- Overtopping caused by floods that exceed the capacity of the dam;
- Deliberate acts of sabotage;
- Structural failure of materials used in dam construction;
- Movement and/or failure of the foundation supporting the dam;
- Settlement and cracking of concrete or embankment dams;
- Piping and internal erosion of soil in embankment dams;
- Inadequate maintenance and upkeep.[275]

Failures and breaches can occur without warning, or happen over a span of days to weeks, such as in result of debris jams, the accumulation of melting snow, or by the buildup of water pressure on a dam.

Building Collapse

Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

When the internal load bearing structural elements of a building fail—because of overall structural integrity, construction, or similar activity—the building will collapse into itself. If

---

[274] LSU College of Agriculture. "What's a wind load?" Retrieved January 14, 2016.
[275] Why Dams Fail. FEMA. Retrieved January 29, 2016.

natural forces such as weather or an explosion cause the structural failure, the building may collapse in an outward direction, resulting in a more dispersed debris field.[276]

4.3.10.1 Location

4.3.10.1.1 Bridge Failure Locations

Structurally deficient bridges are at a higher risk for collapse than those not graded as such. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[277] [278] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. Safety is always the City's and State's top priority, and if officials find a bridge is unsafe, it is closed.

Reports cite that Pennsylvania has the greatest absolute number of structurally deficient bridges in the United States.[279] Of these structurally deficient bridges, nine out of 10 of the most travelled in Pennsylvania are located in the Philadelphia area.[280] Philadelphia has 422 State, city, and privately owned bridges.[281] Of these bridges, regulating agencies identified 63 as structurally deficient.[282] As seen in the graph below, structurally deficient bridges make up 15 percent of the bridges in Philadelphia.

Clusters of structural deficiencies exist along the following routes:

- Interstate 95, from Interstate 676 to Bucks County;
- Schuylkill River crossings between Interstate 676 and Walnut Street;
- 34th Street Bridge; and
- The length of the Glenwood and Sedgley Avenue Conrail/Amtrak rail lines.

---

[276] "Structural Collapse Guide". Occupational Safety & Health Administration, Safety and Health Guides. Retrieved April 14, 2016.

[277] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[278] Ibid.

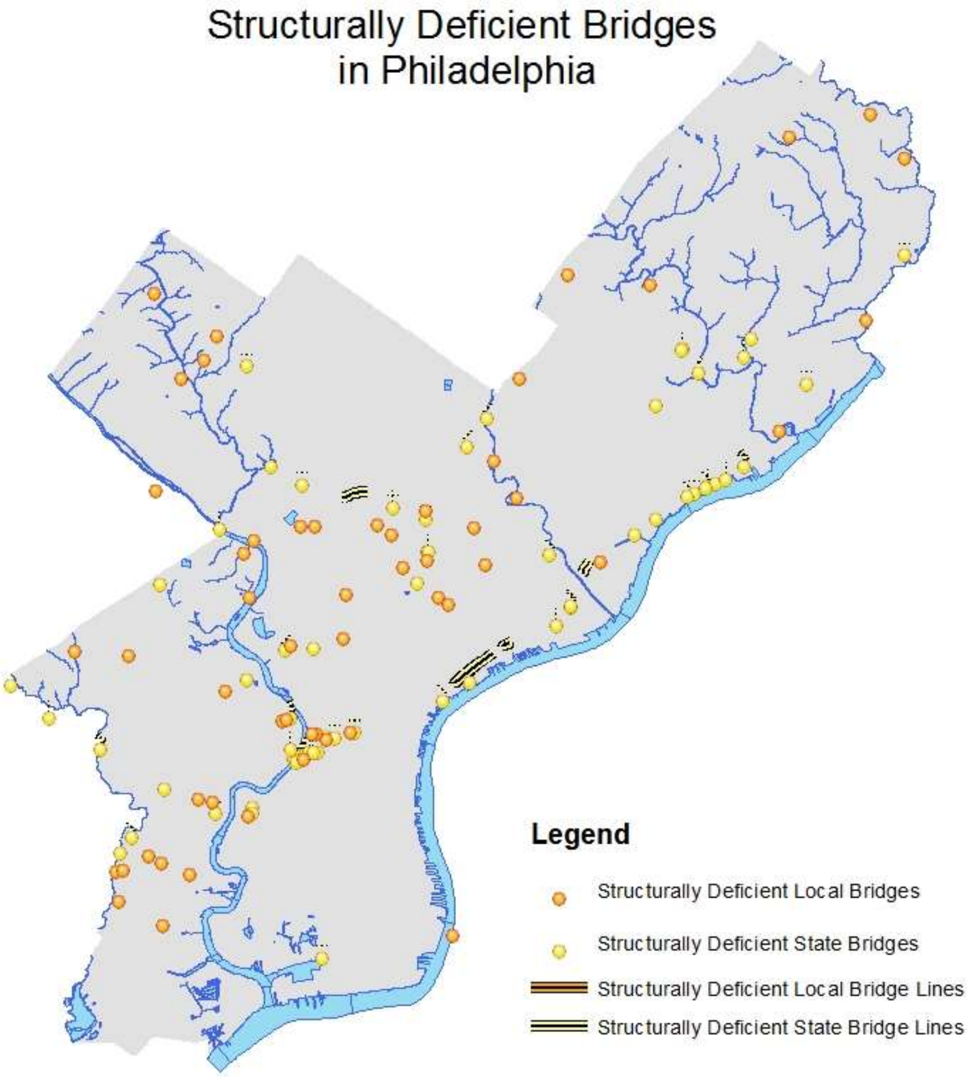
[279] American Society for Civil Engineers (ASCE). Report Card for Pennsylvania's Infrastructure 2014: Bridges. Retrieved March 23, 2016.

[280] City of Philadelphia Threat and Hazard Identification and Risk Assessment. 2014. Retrieved January 14, 2016.

[281] Pennsylvania Department of Transportation. Bridge Information. Retrieved January 14, 2016.

[282] City of Philadelphia Threat and Hazard Identification and Risk Assessment. 2014. Retrieved January 14, 2016.

The map below shows the location of structurally deficient bridges in the Philadelphia area.



4.3.10.1.2 Dam Failure Locations

The City of Philadelphia has 17 dams within its borders, each governing different amounts of water from the waterways that pass through the city. Philadelphia and the surrounding region originally used dams as a way to manage water for numerous different uses such as preventing brackish water in the Delaware River from mixing with fresh water, as in the case of the Fairmount Dam. Other uses included flood mitigation and drinking water control.

Regulating agencies can classify dams as "high-hazard" depending on dam failure consequences. A high-hazard dam is one that will result in the loss of at least one human life if the dam fails. The Army Corps of Engineers works with FEMA and state regulatory offices to collect the data that leads to a high-hazard classification. The table on the following page lists the location of these high-hazard dams, along with all other dams in Philadelphia.[283]

A view of the Fairmount Dam.

---

[283] "Philadelphia Dams". PASDA, City of Philadelphia. Retrieved March 24, 2016.

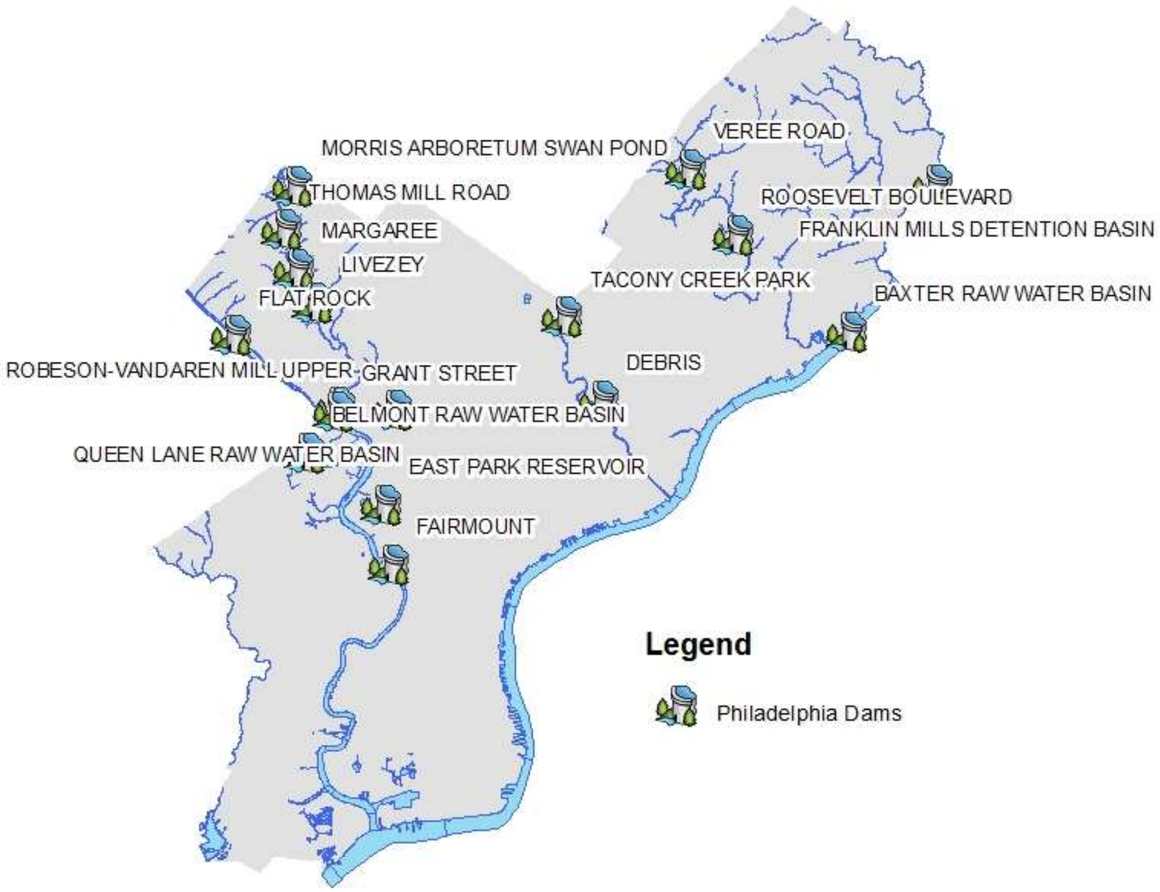
Dams in Philadelphia[284]				
Dam Name	**High-Hazard Dam**	**Permittee**	**Waterway**	**Dam Number**
Flat Rock	Yes	DEP	Schuylkill River	51-001
Fairmount	No	Philadelphia Water Department	Schuylkill River	51-002
Tacony Creek Park	No	City Of Philadelphia	Tacony Creek	51-006
Debris	No	City Of Philadelphia	Tacony Creek	51-008
Margaree	No	City Of Philadelphia	Wissahickon Creek	51-009
East Park Reservoir	Yes	Philadelphia Water Department	Watershed Schuylkill River	51-012
Franklin Mills Detention Basin	Yes	Franklin Mills Associates Limited Partnership	Poquessing Creek	51-013
Veree Road	No	City Of Philadelphia	Pennypack Creek	51-015
Queen Lane Raw Water Basin	Yes	Philadelphia Water Department	Watershed Schuylkill River	51-016
Belmont Raw Water Basin	Yes	Philadelphia Water Department	Watershed Schuylkill River	51-017

---

[284] Image: "Fairmount Water Works Dam" by Ben Franske - Own work. Licensed under GFDL via Wikimedia Commons. Retrieved January 29, 2016

Robeson-Vandaren Mill Upper	No	City Of Philadelphia	Wissahickon Creek	51-018
Grant Street	No	City Of Philadelphia	Wissahickon Creek	51-019
Thomas Mill Road	No	City Of Philadelphia	Wissahickon Creek	51-020
Livezey	No	City Of Philadelphia	Wissahickon Creek	51-021
Baxter Raw Water Basin	No	Philadelphia Water Department	Watershed Delaware River	51-023
Morris Arboretum Swan Pond	No	Morris Arboretum	Wissahickon Creek	51-024
Roosevelt Boulevard	No	City Of Philadelphia	Pennypack Creek	51-026

Dams in Philadelphia



In addition to those dams located in Philadelphia, dams outside the area also affect waterways in the city. Although this document focuses strictly on infrastructure within Philadelphia, it is important to note that dams outside of the City's jurisdiction may affect Philadelphia. Dam releases upstream may affect the water levels of Philadelphia tributaries. Dam collapses upstream produce similar effects as a riverine flooding event. However, upstream dam collapses would not create the same levels of debris or infrastructure loss than if the dam collapse occurred in Philadelphia. To learn more about riverine flooding and its consequences, see the Flooding hazard profile. The table below details those dams that may impact Philadelphia in the event of a dam failure.

Regional Dams that may Affect Philadelphia in the Event of a Breach		
Dam Name	**County**	**High Hazard?**
Blue Marsh[285]	Berks	Yes
Pine Grove	Chester	Yes

4.3.10.1.3 Building Collapse Locations

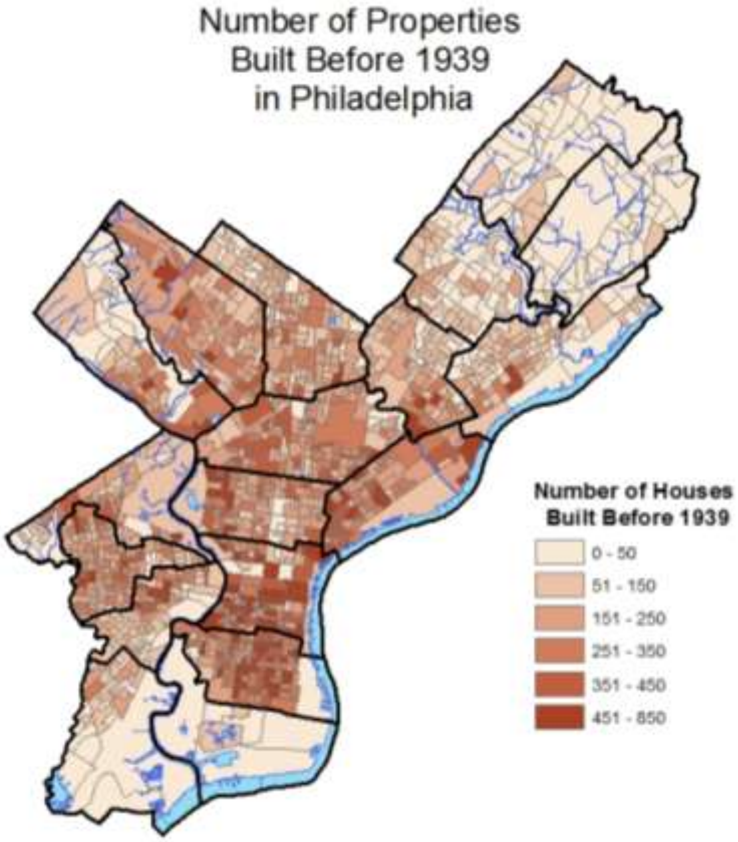
Three factors contribute to the collapse of buildings in Philadelphia, and can assist in identifying those areas at greater risk for building collapses. These three factors are:

- Building age;
- Vacancy rates; and
- Imminently dangerous property designation.

---

[285] The maximum controlled reservoir release rate from the flood control gates at Blue Marsh is 5,400 CFS. Uncontrolled releases in excess of 5,400 CFS are possible, however, only when the pool elevation exceeds the spillway elevation at 307 Feet. Uncontrolled spillway releases have only happened twice since the installation of Blue Marsh Reservoir in the mid-1970s. During high streamflow conditions on the Schuylkill River, releases from Blue Marsh take approximately 1-2 days to reach Philadelphia. During normal to low streamflow conditions, releases from Blue Marsh take approximately 2 -3 days to reach Philadelphia.

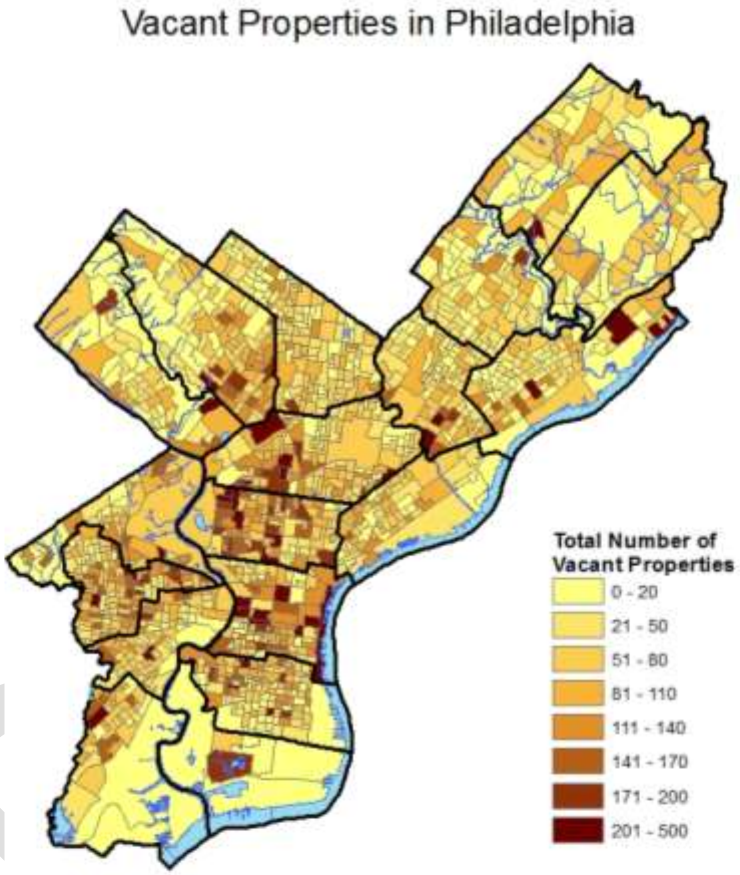
Building age and ongoing maintenance affect the risk of building collapse. Older, vacant and under-maintained structures are at particular risk. Thirty-nine percent of Philadelphia's housing units were built prior to 1939.[286] The image below shows the number of properties built prior to 1939. As the image shows, many of the older homes are located in the central area of Philadelphia and in the residential areas along the Delaware River.



---

[286] Physical Housing Characteristics for Occupied Housing Units: Philadelphia County, Pennsylvania. American Factfinder. United States Census. Retrieved April 8, 2016.

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 13.3 percent of properties vacant as of 2013 census estimates.[287]

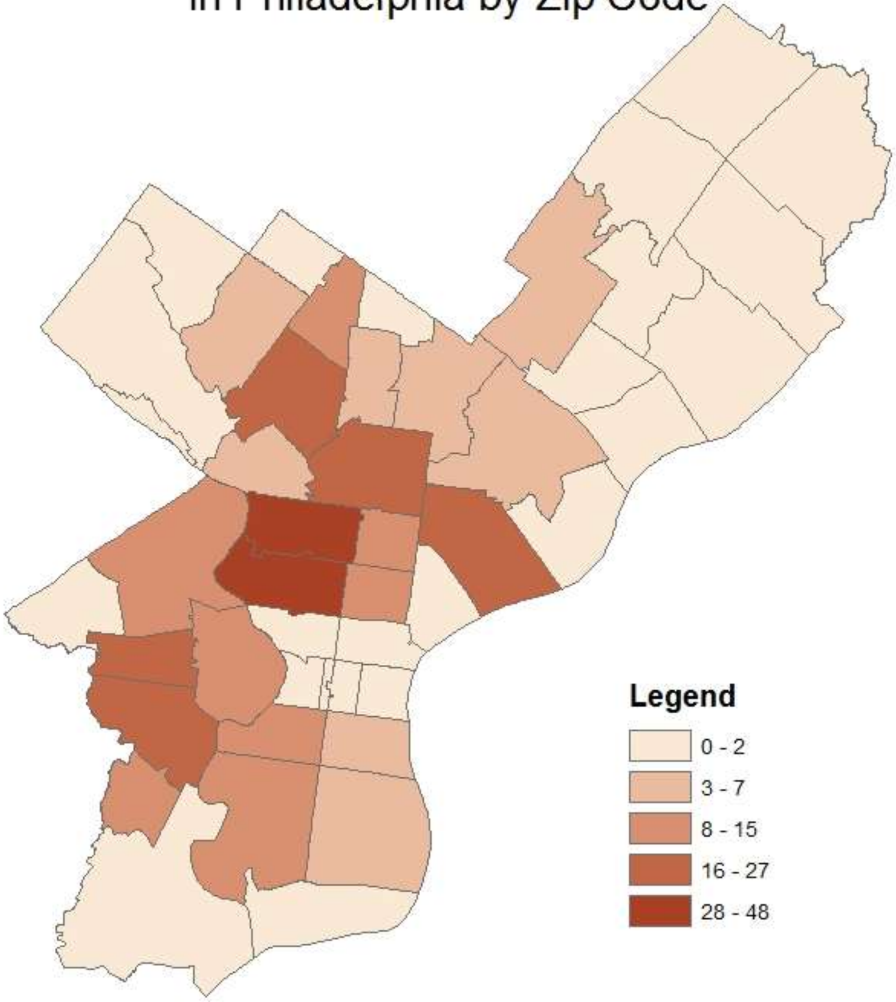


---

[287] Vacancy Status: Philadelphia County, Pennsylvania. American Factfinder. United States Census. Retrieved April 8, 2016.

Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. The map below shows the location of imminently dangerous structures at a zip code level. These locations have a higher risk of building collapses.

Number of Imminently Dangerous Structures in Philadelphia by Zip Code



Immimently Dangerous Structures
Data Source: Philadelphia Licenses and Inspections
Data accurate as of May 12, 2016

4.3.10.2 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 the case of a dam failure, flooding is also a higher risk than for a bridge or building collapse. The magnitude and extent of the flooding depends on the size and location of the dam.

4.3.10.2.1 Worst-Case Scenarios

4.3.10.2.1.1 Bridge Failure

The following worst-case scenario is derived from analysis of bridge collapses elsewhere in the nation and the bridge traffic in Philadelphia.

During a snowy weekday rush hour, a section of the Delaware Expressway over Palmer-Cumberland streets collapses on to the under-passing roadway. The incident involves cars, a semi-truck, and their passengers on both the bridge and underpass. The collapse traps drivers in crushed vehicles and under debris. Severe traffic back-ups occur as a result, complicating extrication and rescue efforts.

4.3.10.2.1.2 Dam Failure

The following worst-case scenario is derived from analysis of City dam inundation maps and local demographics and geography.

After an unusually heavy rain and prolonged lack of maintenance, the eastern wall of the East Park Reservoir fails, releasing water at a rapid rate. Swift-moving water covers the immediate area of 33rd and 32nd Streets. The water picks up and carries cars along 33rd Street by the reservoir. The release sweeps up pedestrians walking nearby. Several injuries result.

Water washes away unsecured items, leaving the streets littered with propane grills, trashcans, bikes, and debris after the water recedes. The damaged area spans 51 blocks in total, with varying levels of damage, ranging from significant to minor flooding in the basement. The majority of the structures affected are residential, but two area schools are reporting significant damage. Floodwaters impact a local PECO substation, knocking out power for the area. Debris litters rail lines running through the area, and the rail bed receives some water damage. As a result, SEPTA and other rail companies suspend transit through the area until the crews can clear and repair tracks and rail beds. SEPTA redirects all bus traffic around the area until water recedes.

4.3.10.2.1.3 Building Collapse

The following worst-case scenario is derived from analysis of the collapse of the Salvation Army Thrift Store on June 5, 2013.

An unoccupied, four-story building underwent demolition by a private construction firm over several weeks. As demolition progressed, demolition crews left an unsupported brick wall standing next to an adjacent one-story Salvation Army Thrift Store. At 10:43 AM, the building under demolition fell onto the Salvation Army store, causing the collapse of both buildings. Debris covered the street, and a thick dust cloud moved down 22nd Street. Emergency workers responded to the scene to conduct search and rescue operations, with work carrying on into the night. Six people died as a result of the collapse and responders rescued 14 others from the rubble. Adjacent streets remained closed as officials conducted investigations.

4.3.10.2.2 Environmental Impacts

4.3.10.2.2.1 Bridge Failure

The collapse of a bridge above a waterway can have additional effects through the destruction of costal habitats. Larger pieces of debris in a waterway could also disrupt flow and local currents, leading to sediment build-up and increases in turbidity.

4.3.10.2.2.2 Dam Failure

Environmental impacts of a dam collapse largely depend on the size and location of the dam. In a dam collapse, there is the risk of flooding which can lead to erosion or contaminated ground water. For more information on the effects flooding can have on the environment, see the Environmental Impact section of the Flooding hazard profile. Additionally, the structure itself impacts waterway habitats for fish and wildlife. Larger dams could result in pieces of debris in the waterway, which can disrupt flow and local currents. This disruption leads to sediment build-up and increases in turbidity.

4.3.10.2.2.3 Building Collapse

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.

4.3.10.3 Past Occurrences

The following table details the available data on those building collapses in Philadelphia which resulted in five or more deaths. These collapses do not take into account those collapses that are a direct result of structural fires. Data is currently only available from 1997 to 2015[288]. There are numerous building collapses annually, with the full count and detail beyond the scope of this document.

Location	Date	Structure Type	Details
2138 - 2140 Market Street	5-Jun-13	Construction site and Commercial	As a result of the collapse, six people died and 14 were injured.

There have been no bridge or dam 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. One re-inspected, those bridges re-opened since repairs reduced the risk for collapse. For example, PennDOT found significant bridge damage in March 2008 beneath Interstate 95. PennDOT contractors observed a large crack in a support column, resulting in the closure of the road for several days until emergency repairs were completed.

---

[288] An additional building collapse of note which caused mass casualties occurred in 1903 when Philadelphia Baker Bowl’s top left field balcony collapsed during a game, resulting in twelve deaths and 232 injuries.

4.3.10.4 Future Occurrences

4.3.10.4.1 Bridge Failure

The failure rate for bridges is one out of 4,700 annually according to predictive modelling using national data.[289] The failure rate data set shows that the causes for bridge collapse are:

- 52 percent hydraulic,
- 20 percent collision,
- 12 percent overload,[290] and
- 7 percent deterioration.[291]

There is a correlation between structurally deficient bridges and bridge collapses. Structurally deficient bridges have an increased risk of collapse with an elevated risk level of 1/1,100 annually.[292] With 63 structurally deficient bridges in Philadelphia, there is an elevated risk of bridge collapse compared to other areas in the nation.

4.3.10.4.2 Dam Failure

Shifting weather patterns due to climate change may put more strain on dams. As a result, Philadelphia may see an increased risk of dam failure in the future. As precipitation increases, the risk of overtopping increases. Maintenance and upkeep failures can also increase dam failure risks. FEMA reports “the number of high-hazard dams is increasing at a significant rate”, displaying a trend towards a higher risk of impactful dam failure in the future.[293]

4.3.10.4.3 Building Collapse

Philadelphia continues to have a high vacancy rate and aging housing stock. As these factors persist, or in the case of aging housing stock, increase, there is the ongoing risk for building collapses in the future.

4.3.10.5 Vulnerability Assessment

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 through the City of Philadelphia. The list on the following

---

[289] Cook, Wesley, "Bridge Failure Rates, Consequences, and Predictive Trends" (2014). Utah State University. Paper 2163. Retrieved January 29, 2016.

[290] Research shows that the risk for an overload-related bridge collapse on a bridge that is load restricted is 1/2,800 annually. (Cook, Wesley, "Bridge Failure Rates, Consequences, and Predictive Trends" (2014). Utah State University. Paper 2163. Retrieved January 29, 2016.)

[291] Cook, Wesley, "Bridge Failure Rates, Consequences, and Predictive Trends" (2014). Utah State University. Paper 2163. Retrieved January 29, 2016.

[292] Ibid.

[293] FEMA. Summary of Existing Guidelines for Hydrologic Safety of Dams: United States Dam Inventory Data. Retrieved March 24, 2016.

page covers the location of structurally deficient bridges in the City, as well as the year the bridge was built.

Structurally Deficient Bridges in Philadelphia

Bridge Name	Location	Year Built
AMTRAK (32ND), SEPTA, F	N.30TH ST.STATION	1964
AMTRAK(NEC)	NR Expressway & 31 St	1964
Amtrak and Conrail, Montgomery Avenue		1913
Indian Creek, Sherwood Avenue	W of 66th Street	1918
SEPTA, 49th Street	S of Chester Ave	1894
CONRAIL (Richmond Bridge), Mascher Street	N of Indiana Ave	1931
Pennypack Creek, Krewstown Road	Krewstown Rd	1907
AMTRAK (NE corridor), 2nd Street	North of Venango Street	1926
CONRAIL, Cambria & "A" Sts	Cambria & "A" Sts	1916
Abandoned CONRAIL, Cayuga Street	West of Fifth St	1930
Wissahickon Creek, Bell's Mill Road	Bells Mill Rd	1820
Delaware Expy (I-95), Ashburner Street	West of State Road	1964
SEPTA (AHSL), 70th Street	South of Lindbergh Blvd	1980
Abolished Conrail, 15th Street	North of Callowhill	1898
SEPTA (Norristown Br), Calumet Street	West of Cresson St	1925
CONRAIL (Fairhill Bridge), Hunting Park Ave	West of G St	1930
Schuylkill River, Falls Bridge	Falls Bridge	1895
Valley Green Road, Cherokee Street	West Springfield Ave	1960
Tacony Creek, Fisher's Lane	Fisher's Lane	1801
Tacony Creek, Tabor Road	Tabor Rd	1957
AMTRAK (Hsbg Branch), 41st Street	South of Poplar	1928
AMTRAK (NE Corridor), G Street	North of Venango St	1914
SEPTA, Glenwood Avenue	15th Street	1912
SEPTA (AHSL), 61st Street	South of Eastwick Ave	1928
AMTRAK and SEPTA, 59th Street	North of Lancaster Ave	1926
Frankford Creek (Former), Margaret & Lefevre	Gaul St	1941
AMTRAK (NE Corridor), 62nd Street	South Paschall Ave	1910
AMTRAK, Margie Street	Nineteenth St	1919
CONRAIL, Sedgley Avenue	West of Seventh St	1907
SEPTA, Willow Grove Ave.	North of Martins Ln	1883
AMTRAK (NE Corridor), 72nd Street	South Paschall Ave	1913
SEPTA (NEWTOWN BRANCH), Pine Road	Pine Rd	1964
CSX, 68th Street	Kingseesing	1926
CONRAIL (Richmond Br), Lycoming Street	West of Broad St	1929
Poquessing Creek, Red Lion Rd	PA-13	1845
Poquessing Creek, Old Lincoln Hwy	US 1	1805

Using inflation calculators and cost estimates for already existing bridges in Philadelphia, the direct economic structural loss of a traffic bridge would be between $6,302,079.19 and $37,103,76.00. Taking into consideration that bridges may also have economic losses because of loss of revenue through tolls, such as in the case of the Benjamin Franklin Bridge, economic losses could incur an additional $250,000 to $750,000 per day given current traffic estimates and toll rates. Indirect loss of revenue from public transportation service suspension may also occur. Whereas SEPTA can redirect or add additional bus routes, certain public transportation routes, such as the PATCO lines on the Benjamin Franklin Bridge, may be affected to a greater degree. Using daily ridership estimates on PATCO lines and fares, a suspension of services on the Benjamin Franklin Bridge alone would cost $56,000 per day.

Due to sensitivity issues, the dam vulnerability assessment and failure impacts can be found in the Dam Failure Vulnerability Annex.

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

Imminently Dangerous Structures by Zip Code in Philadelphia

Zip Code	Imminently Dangerous Structures	Zip Code	Imminently Dangerous Structures
19103	1	19133	15
19104	13	19134	18
19107	1	19138	9
19111	3	19139	27
19119	7	19140	24
19120	2	19141	6
19121	42	19142	12
19122	10	19143	22
19123	1	19144	22
19124	7	19145	12
19129	2	19146	15
19130	2	19147	3
19131	12	19148	3
19132	49	19150	2
		19152	1

4.3.11 Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[294] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders.

4.3.11.1 Location

The prevalent contributing factors to urban conflagration occur because of another natural or human caused event. Natural disasters that could cause a conflagration include flooding, tropical storms or hurricanes, severe weather, and earthquakes.[295] 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.

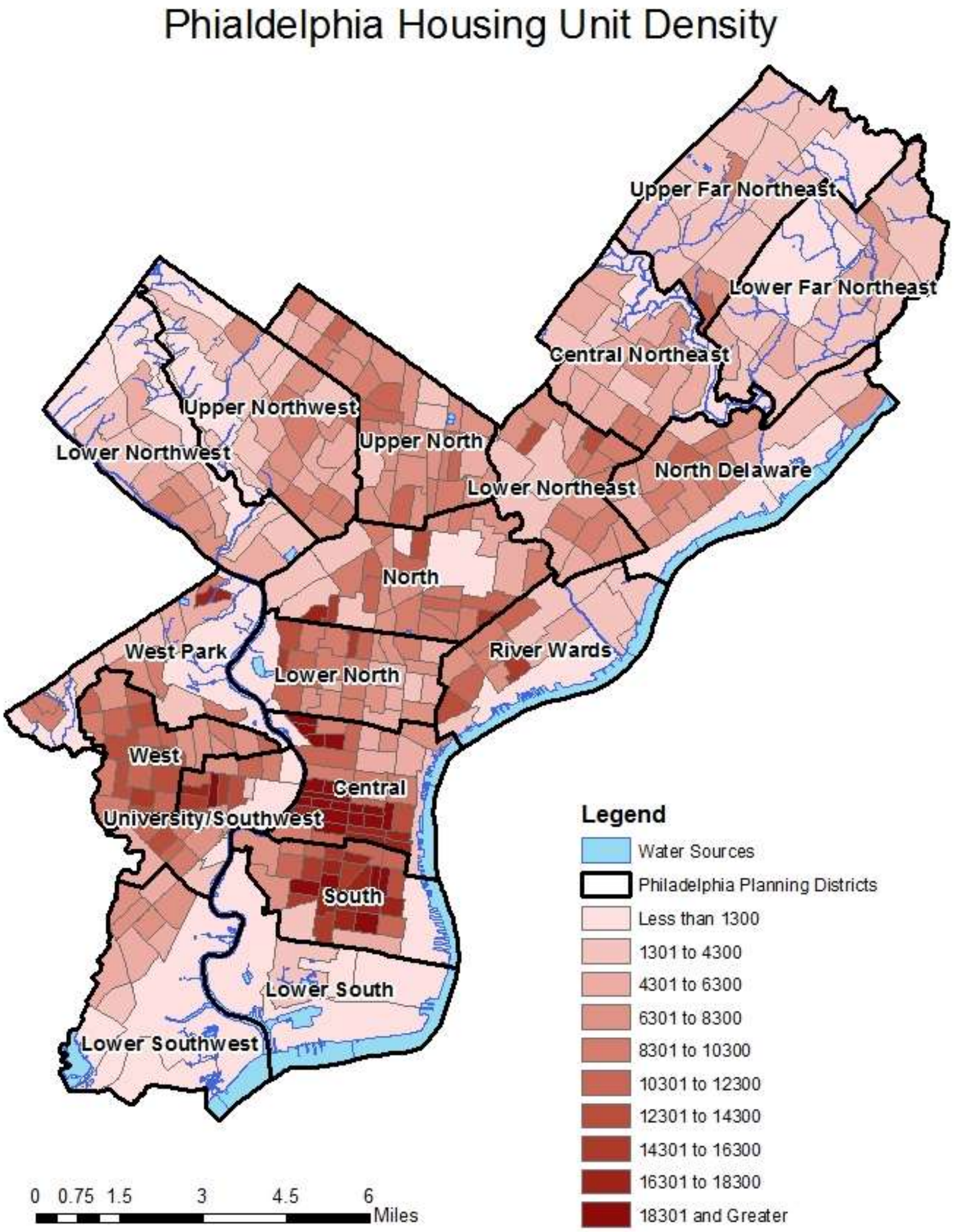
Several factors contribute to an increased risk for widespread fires. Densely built urban environments pose several risks for conflagration, including assisting in the spread of fire through shared roofs. Narrow separations between homes also increases the risk of fire spread. Density mapping assists in the identification of densely built environments. The map below uses the most recent housing unit density information from the United States Census to demonstrate where the greatest concentration of buildings exists.[296] The map shows that those areas where housing density is the greatest are in the Central and South districts of the City. These locations are therefore at a greater risk for widespread fire, and in turn, urban conflagration.

---

[294] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.

[295] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.

[296] United States Census. “Population, Housing Units, Area, and Density: 2010 - Philadelphia”. Retrieved January 11, 2016.


Phialdelphia Housing Unit Density

Narrow streets that enable fire to spread easily from one building to another also pose risks. Buildings not built up to code, or those that do not follow National Fire Protection Agency (NFPA) regulations, also pose a risk to residents and those homes surrounding them. Philadelphia has numerous alleys and narrow streets throughout the City, with many concentrated in the Old City neighborhood, such as the one in the image.[297]

Past national studies[298] have categorized urban conflagration into five general types:

1. **Those involving hazardous materials where there is inadequate means for confining or extinguishing fires.** An example of such an event is the 1973 fire in Chelsea, Massachusetts, which burned 18 acres, including 300 buildings[299]. Philadelphia has numerous hazardous materials stored, processed, and moved within the City at any given time. The ongoing presence of hazardous materials at a site would increase the risk of that site for a fire, such as at refineries or chemical processing facilities. Philadelphia has several of these facilities throughout the City. Means for confining or extinguishing fires vary by event and location, but the City's hydrant system provides access to water throughout Philadelphia.

2. **Those occurring in closely built-up residential sections containing combustible houses, particularly those with wood shingle roofs and a high number of vacant dwellings**. All combustible residential construction falls under this type of urban conflagration.[300] Two examples of this type of conflagration are a 1983 apartment building conflagration in Dallas, Texas and a fire in 1989 in the Westwood section of Los Angeles that caused more than $25 million in damage.[301] As previously shown, the City of Philadelphia has several closely built areas in the Lower South, Central, and South areas of the City. Philadelphia also has a high

---

[297] Image: "Philly Street Commons" by Jawny80 at English Wikipedia - Transferred from en.wikipedia to Commons. Licensed under Public Domain via Commons.

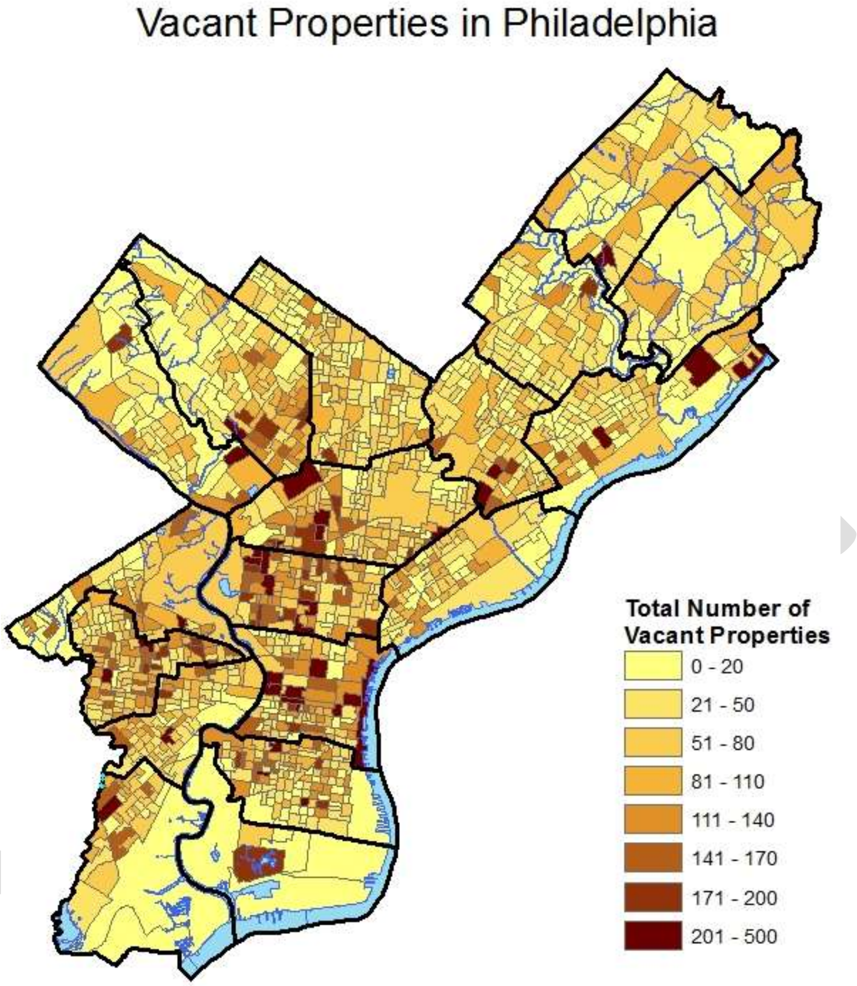
[298] William Michael Kramer. "Disaster Planning and Control". Fire Engineering. Retrieved January 11, 2016.

[299] Ibid.

[300] William Michael Kramer. "Disaster Planning and Control". Fire Engineering. Retrieved January 11, 2016.

[301] Paul Feldman and Kristina Lindgren. "U.S. Agents Join Westwood Fire Probe". December 27, 1989. Retrieved January 11, 2016.

number of vacant properties. As seen in the image below, clusters of large numbers of vacant dwellings exist in the central portions of Philadelphia. [302]



3. **Wild land, forest, or brushfires that move in to developed areas.** Widespread fires resulting from wild land and brush fires are common in certain portions of the United States. However, due to the limited dead vegetation accumulation and a moister environment, Philadelphia is not prone to widespread wild land fires. Although brush fires occasionally occur, they are typically easily contained and extinguished.

4. **Conflagrations due to explosions.** One example of a conflagration resulting from an explosion are the widespread fires in West, Texas in 2013 that started after an ammonium nitrate explosion at a local fertilizer plant.[303] Explosions have occurred in the past in Philadelphia, including the recent gas main explosion in January 2011,

---

[302] Data for map: U.S. Census: American Fact Finder. Vacancy, Philadelphia, 2013. Retrieved April 14, 2016.

[303] Chemical Safety Board. "West Fertilizer Explosion and Fire". Retrieved January 11, 2016.

which despite sending a 50-foot flame into the sky[304], did not result in widespread destruction.

5. **Fires occurring in numerous areas because of a widespread event, such as an earthquake or civil unrest.** Such a case occurred in 1992 in Los Angeles following civil unrest in the city, resulting in the burning of 10,000 businesses and costing over one billion dollars.[305] More often than not, civil unrest takes the form of nonviolent protests that serve to address specific issues. Only those instances that result into destructive or violent behavior are at risk for causing urban conflagration. In the past, Philadelphia has had instances of civil disorder that resulted in destruction, including the 1964 riots.

All homes built in Philadelphia must comply with the Philadelphia Fire Code, decreasing the risk of fire in new construction.

4.3.11.2 Magnitude

The determination of whether or not a fire is an urban conflagration depends heavily on the damage and destruction the fire causes. Urban conflagration destroys a block or more of buildings, and results in large monetary loss.[306] Urban conflagrations may or may not include loss of life or injuries.[307] These types of fires often require large responses from fire companies.

An urban conflagration would also likely trigger multiple alarms during response. On a normal fire response, if an incident requires fire apparatus or personnel, the Fire Department can dispatch additional units or companies. If the incident escalates further, the incident commander can issue multiple alarms, dispatching additional units to the scene of the fire both to relieve units and to aid in firefighting efforts. The incident commander can add alarms until sufficient personnel and equipment are available for incident stabilization. An urban conflagration would have multiple alarms across a

---

[304] Maanvi Singh. "Gas explosions have plagued Philadelphia in the past" July 29, 2013. Retrieved January 11, 2016.
[305] Daniel Wood. "L.A.'s Darkest Days". April 29, 2002. Retrieved January 11, 2016.
[306] William Michael Kramer. "Disaster Planning and Control". Fire Engineering. Retrieved January 11, 2016.
[307] William Michael Kramer. "Disaster Planning and Control". Fire Engineering. Retrieved January 11, 2016.

widespread area, requiring a large number of units and personnel to be involved in suppression efforts, potentially draining resources quickly as the incident continued.

4.3.11.2.1 Worst-Case Scenario

The following worst-case scenario is derived from analysis of past conflagration incidents in the United States as well as past fires and responses in Philadelphia.

By late February, Philadelphia is experiencing a prolonged dry spell. Snowfall is far below average. A cold front enters the region, bringing with it high wind speeds that drop wind chills to ten below zero. Two days later, a dwelling fire in a West Philadelphia rowhome occurs, quickly spreading through roofs on either side of the structure. High winds complicate suppression activities, spreading the flames quickly across narrow alleyways. Local hydrants have frozen in the extreme cold. Icy conditions worsen on the scene as firefighting efforts continue. Filled hoses freeze when not in use, further hindering fire department activities. The one lane road the fire starts on limits staging and access for the fire department. The fire quickly escalates, reaching the fifth alarm in the first hour. By the time the Fire Department declares the fire under control, a full block of homes is destroyed, and surrounding buildings have received moderate to heavy damage. Damages displace over 50 families. Several injuries and four deaths occur, predominantly believed to be due to the lack of working smoke alarms in several of the structures.

4.3.11.2.2 Environmental Impacts

Urban conflagration can affect greenspace in the City should the fire spread to one of the City’s parks. Widespread fire can destroy habitats and ecosystems, and decrease the total nutrient pool available for plants through a combination of oxidation, volatilization, ash transport, leaching, and erosion.[308] After a conflagration, soil is at an increased risk for erosion because of decreased soil porosity.[309]

Urban conflagrations 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.

---

[308] Fire Effect on Soil: Fire Effects on Soil Nutrients. Northern Arizona University.

[309] Ibid.

4.3.11.3 Past Occurrences

The table below details a list of the most damaging and deadly conflagrations in Philadelphia where a fire damaged at least a block of homes or businesses and killed at least five.[310]

Date	Extent of Damage
May 13, 1985	The fire killed 11 people, destroyed 65 houses, and left 250 displaced.
August 17, 1975	Hydrocarbon vapors and crude oil involvement at the Gulf Refinery, which took up over 700 acres on the east bank of the Schuylkill. The fire killed 8 people, and injured 16 others. Costs of damage unknown.
February 12, 1865	Burning oil was listed as the source of the fire in a newspaper at the time. The fire killed six people, and burned 51 houses.
July 9, 1850	Saltpeter and sulfur explosions. The fire killed 10, extent of damage unknown, but started at a warehouse on North Water Street and spread through the densely populated area surrounding in the building.

---

[310] Image: “Fire – 13th and Market Street, January 1897”. PhillyHistory.org.

4.3.11.4 *Future Occurrences*

Vacant properties, closely built housing, the storage of flammable and hazardous materials in businesses and homes suggest that there is an ongoing risk for situations that would lead to a conflagration. However, Philadelphia's extensive network of fire hydrants, the ongoing and extensive training of the Philadelphia Fire Department, and temperate climate do reduce this risk. [311]

13th and Market Streets following the conflagration of 1897. The fire started burned down 59 buildings between 13th and Juniper Streets, Market and Filbert Streets. No casualties were reported.

4.3.11.5 *Vulnerability Assessment*

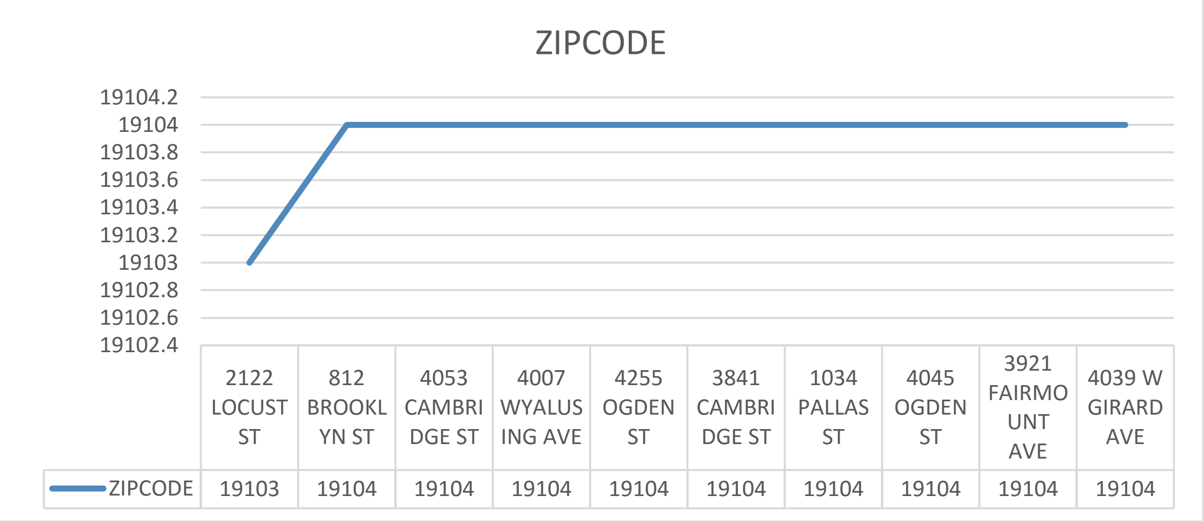
Urban conflagration would have a greater impact on the economy more than a single dwelling fire, which typically have minimal impact to the citywide economy. Urban conflagration can affect a larger area of business or commercial districts if the fire occurs includes these structures. Average loss per structure has remained relatively unchanged since 1977, with costs on average losing $19,500 per structure in 2015

---

[311] "Art Museum area" by GooseGoddessS from Philadelphia - Flickr. Licensed under CC BY-SA 2.0 via Commons. Retrieved January 29, 2016.

dollars.[312] In the event of an urban conflagration, this loss would be higher, however, since this estimate is an average and not a total loss scenario. Using the recent widespread fires in Breezy Point during Hurricane Sandy as a model, it can be assumed that 15 percent of structures in a conflagration would be damaged, and the remaining 85 percent destroyed. The 15 percent of homes damaged would correlate closer to the national averages, while the remaining 85 percent would be a total loss. To calculate total structural loss estimates in the event of an urban conflagration, estimates focused on areas where there is a higher housing density and higher prevalence of vacant properties, and therefore a higher risk of urban conflagration. Using OPA data on property market values, it can be estimated that the structural loss costs for the total loss of a single block of homes in these areas would be over $1,867,300.

There is the potential for loss of life and injuries in any structural fire for both first responders and property owners. Despite this risk, an urban conflagration would cause a low level of fatalities and injuries. Fire fatalities in Philadelphia have declined over the past ten years, with 2015 declining by 63 percent since 2014. The chart below displays this decline between 2006 and 2015. While the risk for loss of life remains, and is potentially higher in a conflagration, recent local trends suggest that the number of fatalities would be minimal.



Absent catastrophic events, the City possesses sufficient resources to respond to routine events. As a comparison point from another major east coast urban area, while fire departments in New York City were busy in the aftermath of Superstorm Sandy, they were able to bear the load with no significant injuries or fatalities due to a lack of search and rescue resources.

---

[312] Haynes, Hylton. “Fire Loss in the United States”. National Fire Protection Association. September 2015. Retrieved April 22, 2016.

4.3.12 Wind Storms and Tornado

Windstorm

A windstorm is a wind that is strong enough to cause at least light damage to trees and buildings and may or may not be accompanied by precipitation. Typically, wind speeds in a windstorm exceed 34 miles per hour (mph). Gusts, or short bursts of high-speed winds, as well as longer periods of sustained winds can both cause damage in a windstorm. Although tornadoes also produce wind damage, this profile classifies them separately for the purposes of this plan.[313] The table below provides descriptions of the different types of windstorms.

Types of Windstorms	
Downburst	A downburst is a strong downdraft of air from a cumulonimbus cloud, often associated with intense thunderstorms. Downdrafts produce damaging winds at the earth's surface, which at times can be stronger than tornado winds. The NWS classifies downbursts according to their size, as either a microburst or a macroburst. A microburst is a convective downdraft with an affected outflow area of less than 2.5 miles wide and peak winds lasting less than five minutes. Microbursts may induce dangerous horizontal/vertical wind shears, which can adversely affect aircraft performance, and cause property damage. A macroburst is a convective downdraft with an affected outflow area of at least 2.5 miles wide with peak winds lasting between five and 20 minutes. Intense macrobursts may cause tornado-force damage of up to an EF3 intensity (explained in detail below).
Straight-line Wind	Generally, a straight-line wind is any wind that is not associated with rotation, used mainly to differentiate them from tornadic winds. A straight-line wind is different from a downburst in that there is a difference in damage from a downburst, which lacks significant curvature and tornado damage, which has significant curvature.

Derecho	A derecho is a widespread and usually fast-moving windstorm associated with convection. Derechos include any family of downburst clusters produced by an extratropical system, and can produce damaging straight-line winds over areas hundreds of miles long and more than 100 miles across. The NWS categorizes types of derechos by the storm they derive from. Multiple bow echoes, (radar echoes that are linear but bent outward in a bow shape) embedded in an extensive squall line (a line of active thunderstorms) produce a serial derecho. This type of derecho typically is associated with strong migratory low-pressure system and can be hundreds of miles long. A progressive derecho is associated with a relatively short line of thunderstorms that may take the shape of a single bow echo. A third type of derecho is a hybrid derecho, and has the characteristics of both serial and progressive derechos.
Gustnado (or Gustinado)	A gustnado is a small, whirlwind that forms as an eddy in thunderstorm outflows. Gustnadoes do not connect with any cloud-base rotation and are not tornadoes. Since their origin is associated with cumuliform clouds, the NWS classifies gustnadoes as thunderstorm wind events.

Tornado

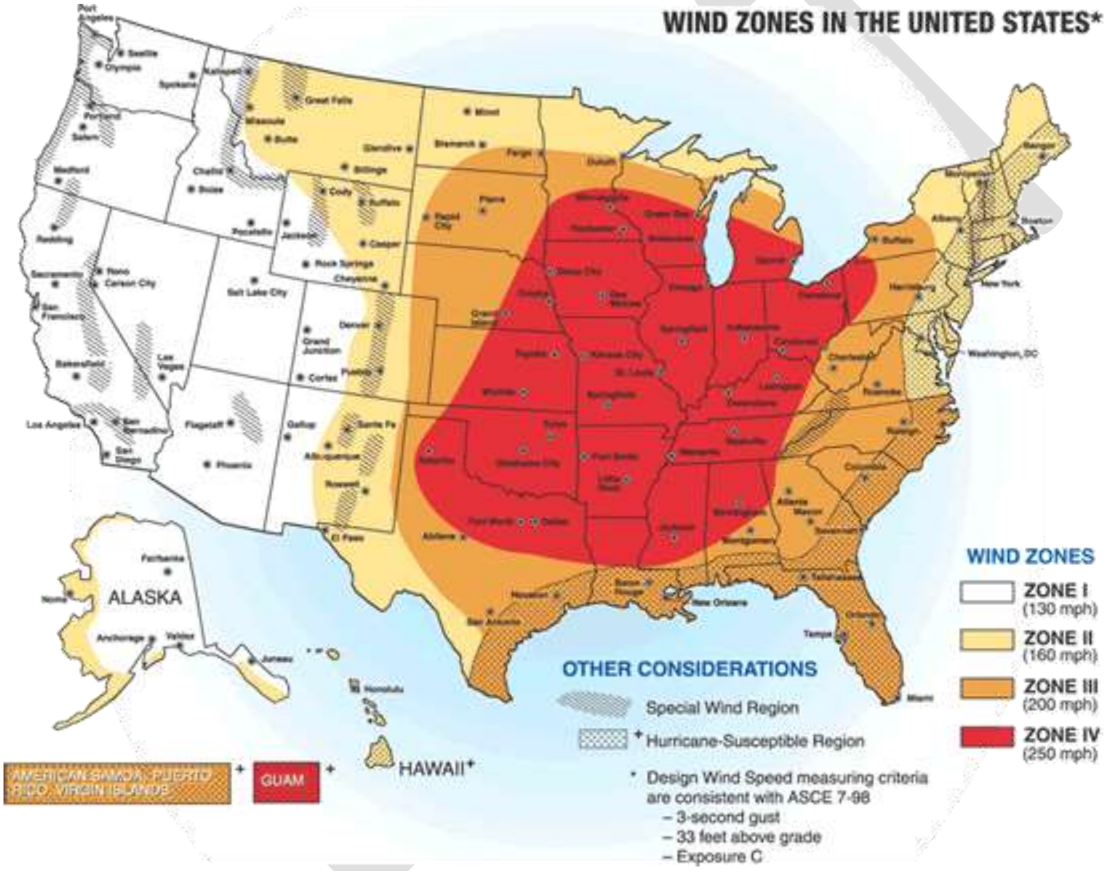
According to the glossary of meteorology, a tornado is “a violently rotating column of air, in contact with the surface, pendant from a cumuliform cloud, and often (but not always) visible as a funnel cloud.”[314] When tornadoes do occur without any visible funnel cloud, debris at the surface is usually the indication of the existence of an intense circulation in contact with the ground. On a local scale, the tornado is the most intense of all atmospheric circulations. Its vortex, typically a few hundred meters in diameter, usually rotates cyclonically with wind speeds as high as 300mph.

---

[314] Glossary of Meteorology: Tornado. Retrieved 20 December 2012.

4.3.12.1 Location

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 different wind zones in the United States.[315]



4.3.12.2 Magnitude

4.3.12.2.1 Wind

Differences in atmospheric pressure causes wind. Air moves from a higher-pressure area to a lower-pressure area, causing different types of wind speeds. Globally, the major causes of large-scale wind patterns are the heating of the equator and poles, and

---

[315] Wind Zones of the United States. FEMA 2010. Retrieved March 23, 2016.

the rotation of the planet. These all cause differentials in pressure: the higher the differential, the greater the wind speed.

The Beaufort Wind Scale classifies wind speed using speed measurements and descriptions of appearances on both bodies of land and water. The table below provides descriptions on the Beaufort Wind Scale as well as the appearance of the wind effects.[316]

Beaufort Wind Scale				
Force	**Wind (Knots)**	**WMO Classification**	**Appearance of Wind Effects**	
			On the Water	*On Land*
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft. taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway

---

[316] Beaufort Wind Scale. NOAA. Accessed 13 October 2015.

6	22-27	Strong Breeze	Larger waves 8-13 ft., whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-19 ft., white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Moderately high (18-25 ft.) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Twigs breaking off trees, generally impedes progress
9	41-47	Strong Gale	High waves (23-32 ft.), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (29-41 ft.) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (37-52 ft.) waves, foam patches cover sea, visibility more reduced	
12	64+	Hurricane	Air filled with foam, waves over 45 ft., sea completely white with driving spray, visibility greatly reduced	

4.3.12.2.2 Tornado

Tornadoes form where there are large differences in atmospheric pressure over short distances, as often results during a major storm, such as a supercell or a severe thunderstorm. 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.[317] The Enhanced F-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, summarized in the typical damages section in the table on the following page.[318]

Wind caused several damages to trees in a windstorm in November 2010.

---

[317] Storm Prediction Center: The Enhanced Fujita Scale (EF Scale). Retrieved 13 October 2015.
[318] Fujita and Operational EF Scales, NOAA, Retrieved 13 October 2015.

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 blown 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 the 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, as listed in the table below.

NWS Tornado Products[319]

Product	Criteria
Tornado Watch	The NWS issues a Tornado Watch when conditions are favorable for the development of tornadoes in and close to the watch area. Their size can vary depending on the weather situation. The NWS issues a Watch for a duration of four to eight hours. NWS issues Watches well in advance of the actual occurrence of severe weather. During the watch, people should review tornado safety rules and be prepared to move to a place of safety if threatening weather approaches.
Tornado Warning	NWS issues a Warning when a radar shows a tornado or trained spotters sight imminent conditions. People in the affected area should seek safe shelter immediately. NWS can issue Warnings without a Tornado Watch being already in effect. Warnings typically last for a shorter period, around 30 minutes. After NWS issues a Tornado Watch, the affected National Weather Field Office will send periodic updates through Severe Weather Statements. These statements will contain updated information on the tornado. Field Offices will also let the public know when the warning is no longer in effect.
Tornado Emergency	An exceedingly rare tornado warning issued when there is a severe threat to human life and catastrophic damage from an imminent or ongoing tornado. The NWS reserves this designation for when a reliable source confirms a tornado, or there is clear radar evidence of the existence of a damaging tornado, such as the observation of debris.

---

[319] Tornado Products. NWS Glossary 2015. Retrieved December 2, 2015.

4.3.12.2.3 Worst-Case Scenario

The following worst-case scenario is derived from analysis of an EF2 tornado that occurred in Philadelphia on June 1, 1998.[320]

A tornado touched down outside of Philadelphia is Upper Moreland Township as an F1 in the early morning of June 1, 1998. As the tornado progressed into Philadelphia, it intensified into an EF2. As the tornado moved through the area, it split and knocked down trees. Fallen trees cause extensive damage to 10 homes around Byberry Road, McNulty Road, Roosevelt Boulevard, and Southampton Road. The damage within Discontinuous damage suggested that the tornado did not remain on the ground the entire time it was in the City. Damage assessments estimated $1.8 million dollars in structural damages. Because the buildings were unoccupied, no injuries occurred.

The worst damage occurred within the unoccupied Byberry Industrial Park as the tornado reached its strongest intensity. Of the 35 commercial buildings damaged, nine sustained severe damages and declared "imminently dangerous". Winds tossed five-ton air conditioning units from the buildings. Winds threw roof slabs 200 yards. Some buildings lost entire sides, had buckled steel beams, shattered windows, and crushed equipment. The tornado plucked around 20 utility poles from the ground and damaged numerous others. If the tornado occurred later in the morning with the buildings in the Park occupied, the injury count would have been higher.

Damage south of the industrial park became sporadic as the tornado turned toward the southeast. It lifted just before the Bucks County border near Woodhaven Road just to the southeast of the Franklin Mills Mall. Its path length was about 5.6 miles and path width was about 200 yards.

PECO Energy reported that 34,000 customers in Philadelphia lost power. Five thousand still did not have power the evening of June 1. According to PECO's lightning detection system, there were 7,000 cloud to ground lightning strikes in their service area as this line of thunderstorms moved through.

---

[320] Details for this narrative come from NOAA National Climatic Data Center's Storm Events Database.

4.3.12.2.4 Environmental Impacts

Both windstorms and tornados pose a threat to trees. Gusts and sustained winds can cause damage to trees through felling and downed limbs. Felled 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 top soil if the soil is dry or loose enough. Additionally, high winds can spread trash and debris over a large area, complicating clean-up efforts.

Windstorms and tornados 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.

4.3.12.3 Past Occurrences

Windstorm events may be the result of thunderstorms, hurricanes, tropical storms, winter storms, or nor'easters. Between 1950 and 2015, there were 2,074 wind-related events with wind speeds greater than 30 knots. These windstorms have injured individuals, damaged buildings and vehicles, downed trees and power lines, and disrupted transportation, communication and power services. The table below details the top ten wind events in Philadelphia by wind speed.[321]

Top Ten Wind Events in Philadelphia by Wind Speed

Wind Speed	Date	Event Type
87 kts.	8/11/1992	Thunderstorm Wind
82 kts.	8/17/1988	Thunderstorm Wind
70 kts.	8/21/1971	Thunderstorm Wind
70 kts.	7/31/1985	Thunderstorm Wind
69 kts.	10/7/1987	Thunderstorm Wind
69 kts.	11/16/1989	Thunderstorm Wind
65 kts. MG	6/24/2010	Thunderstorm Wind
63 kts. MG	6/23/2015	Thunderstorm Wind
63 kts.	1/14/1992	Thunderstorm Wind
62 kts. MG	4/22/2015	Thunderstorm Wind

---

[321] National Climatic Data Center, NCDC, Storm Events, Pennsylvania, Philadelphia County, Wind. Retrieved March 23, 2016.

Since reliable record keeping began in 1950, eight tornadoes have touched down in Philadelphia, all being classified an EF2 or weaker. The table below lists the tornado events that have occurred in Philadelphia between 1950 and 2015.

Historic Occurrences of Tornadoes [322]		
Date	Location	Description
5/18/2011	Northeast Philadelphia (Intersection of Red Lion Rd and Northeast Ave)	▪ EF0 tornado* ▪ Property damage $50K ▪ Fatalities 0/ Injuries 2 ▪ Roof collapses
1/18/1999	South Philadelphia – Macaroni Plaza	▪ F0 tornado ▪ Length 0.2 miles ▪ Width 20 yards ▪ Property damage $2.5K ▪ Fatalities 0/ Injuries 18 ▪ 1,000 PECO customers without power ▪ 20 AMTRAK, SEPTA and NJ Transit trains stranded
6/1/1998	Northeast Philadelphia	▪ F2 tornado ▪ Length 5.6 miles ▪ Width 200 yards ▪ Property damage $1.8M ▪ Fatalities 0/ Injuries 0
8/3/1991	Moved from Montgomery County into Northwest Philadelphia	▪ F1 tornado ▪ Length 2.0 miles ▪ Width 100 yards ▪ Property damage $2.5K ▪ Fatalities 0/ Injuries 0
6/9/1989	Society Hill	▪ F2 tornado ▪ Length 0.5miles ▪ Width 50 yards ▪ Property damage $25.0K ▪ Fatalities 0/ Injuries 1

---

[322] National Climatic Data Center, NCDC, Storm Events, Pennsylvania, Philadelphia County Tornadoes. Retrieved 10 December 2015.

7/31/1985	Northwest Philadelphia (West Mount Airy, Chestnut Hill)	▪ F1 tornado ▪ Length 1.5 miles ▪ Width 20 yards ▪ Property damage $2.5K ▪ Fatalities 0/ Injuries 1
6/7/1978	Southwest Philadelphia (Kingessing Area)	▪ F1 tornado ▪ Length 0.5miles ▪ Width 100 yards ▪ Property damage $25.0K ▪ Fatalities 0/ Injuries 0
7/14/1958	Southeast Philadelphia	▪ F2 tornado ▪ Length 9.8miles ▪ Width 27 yards ▪ Property Damage $2.5K ▪ Fatalities 0/ Injuries 0
*NWS moved from the F-Scale to the EF-Scale in 2007		

4.3.12.4 Future Occurrences

Windstorms are a common occurrence in Philadelphia, making them a highly probable hazard in the future. Philadelphia experiences high-wind events at least five times a year based on documented windstorms between 1969 and 2015.[323]

Tornadoes are infrequent occurrences in Philadelphia. Over the past 61 years, eight tornadoes have hit Philadelphia, six of which were scaled EF/F0 or EF/F1. Based on limited data of historic frequency, an estimated 13 tornadoes will occur in Philadelphia every 100 years.[324]

4.3.12.5 Vulnerability Assessment

Severe wind storms 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

---

[323] This was reached averaging the number of wind events on NCDC/NOAA records by numbers of years using data between 1969 and 2015.

[324] Frequency determined using the data available on past instances of tornadoes in the greater Philadelphia area.

construction materials, cranes, scaffolding, and other building appurtenances 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 between 135,000 street trees located within Philadelphia.

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 one percent. 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).

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. The table below depicts Philadelphia's potential losses due to tornadoes and windstorms, as estimated in the 2013 Pennsylvania Hazard Mitigation Plan.

Philadelphia's Potential Losses due to Windstorms[325]					
Critical Facilities		**Total Number of Impacted Buildings**		**Dollar Value of Exposure, Buildings and Contents**	
2017	**2012**	**2017**	**2012**	**2017**	**2012**
105	423	675,707	384,331	$ 176,337,295.00	$ 178,799,846.00

---

[325] Pennsylvania 2013 Standard State All-Hazard Mitigation Plan. "Tornado, Windstorm: Jurisdictional Loss Estimation". Retrieved April 27, 2016.

4.3.13 Winter Storms

Winter storm events consist of cold temperatures, heavy snow or ice and sometimes-strong winds. In Pennsylvania, winter storms begin as low-pressure systems that either move through the state following the jet stream or develop as extra-tropical cyclonic weather systems over the Atlantic. In North America, severe winter storms generally form in one of four places:

- Eastern Colorado
- Central Alberta, Canada
- Along the coast of North Carolina or
- In the northern Gulf of Mexico

Storms formed in Colorado or along the coast producer heavy snowfall. In contrast, fast-moving storms forming east of the Canadian Rockies in Alberta, called Alberta Clippers, are generally drier with less snow and extremely cold temperatures.[326] [327]

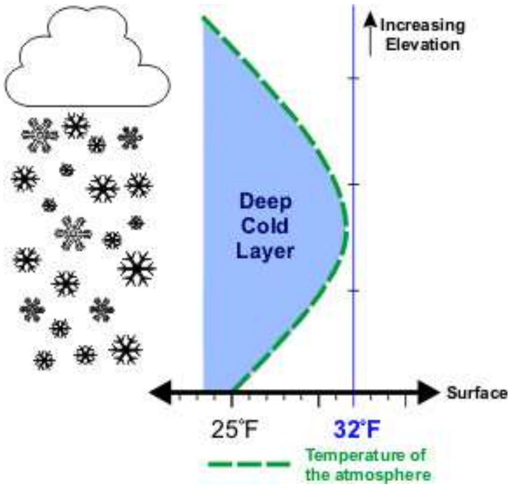
A winter storm blankets Rittenhouse Square in snow.

---

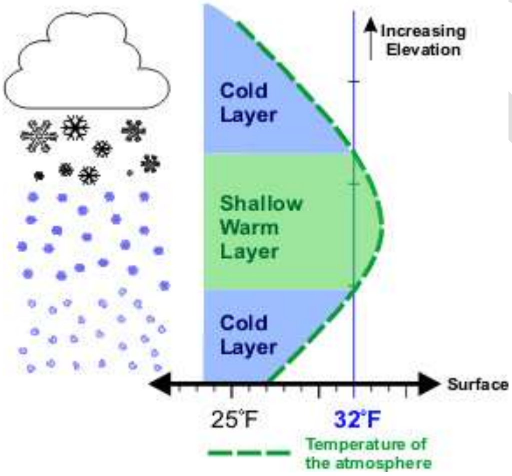
[326] The Philadelphia Area Weather Book. Jon Nese, Glenn Schwartz, Edward G. Rendell. Pgs. 79-85. Retrieved December 11, 2015.

[327] Image: Kevin Burkett. “Philly Snow Storm, Dec. 19, 2009: Rittenhouse Square in Center City Philadelphia during the snow storm of Dec. 19, 2009.” Creative Commons License. Retrieved February 5, 2016.

In winter storms, the thickness of cold air at the surface determines the type of precipitation.



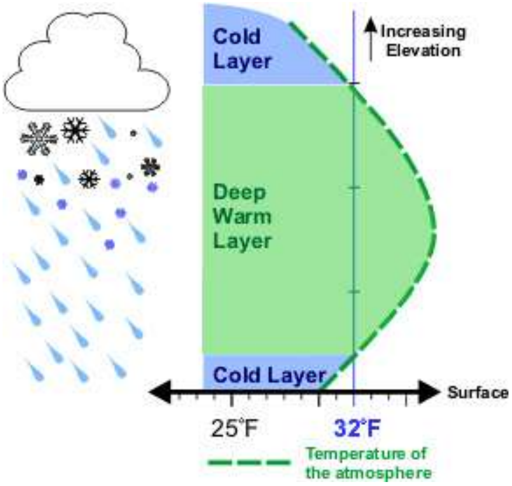
Snow is produced when temperatures are cold both aloft and at the ground. The snow does not melt as it falls and temperatures at or below 32 degrees near the ground allows it to accumulate. [328]



Sleet is defined as pellets of ice composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes, and is formed when temperatures at or slightly above freezing aloft produce rain that freezes to ice pellets, as it falls into a cold layer of air. Sleet usually bounces when hitting a surface and does not stick to objects. However, it can produce a "sand like" accumulation like snow. [329]

---

[328] Image: Snow Profile. National Weather Service. Retrieved December 11, 2015.
[329] Image: Sleet Profile. National Weather Service. Retrieved December 11, 2015.



Freezing rain forms when warm temperatures aloft, generally several degrees above freezing, produce rain that falls onto a surface with temperatures below 32 degrees, causing the liquid rain to freeze on impact forming a coating or glaze of ice. [330]

---

[330] Image: Freezing Rain Profile. National Weather Service. Retrieved December 11, 2015.

Several winter storm hazards are possible, including heavy snow (snowstorms), blizzards, sleet, freezing rain, and ice storms. Additionally, though they can occur during any time of year, most-extra-tropical cyclones, particularly Nor'easters, generally take place during the winter months and considered as a winter storm hazard for the purposes of this Hazard Mitigation Plan. Types of winter storms include:

- ***Heavy Snowstorm***: A heavy snowstorm is a snow event generally accumulating four inches or more in depth in 12 hours or less, or snowfall accumulating 6 inches or more in depth in 24 hours or less. A 'snow squall' can occur during a snowstorm. A snow squall is an intense, but short, period of moderate to heavy snowfall, with gusty surface winds. Snow squalls can accompanied by lightning (also known as thundersnow). Squalls can result in significant accumulation.
- ***Blizzard***: Blizzards are characterized by low temperatures, wind gust of 35 mph or more, and falling and/or blowing snow that reduces visibility to 0.25 miles or less, all prevailing for an extended period of time (three or more hours).
- ***Sleet or Freezing Rain***: Heavy sleet is a relatively rare event defined as an accumulation of ice pellets covering the ground to a depth of 0.5 inches or more. Freezing rain is rain that falls as liquid but freezes into glaze upon contact with the ground.
- ***Ice Storm***: An ice storm is used to describe occasions when damaging accumulation of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. Significant ice accumulations are usually accumulations of .25 inches or greater.
- ***Nor'easter***: Nor'easters, named for the strong northeasterly winds blowing in ahead of the storm, are a type of extra-tropical storms (mid-latitude storms or Great Lakes storms). A nor'easter is a macro-scale (large in size) extra-tropical cyclone whose winds originate from the northeast, especially in coastal areas of the Northeastern United States. Wind gusts associated with these storms can exceed hurricane force in intensity. Nor'easters contain a cold core of low barometric pressure from forming over mid-latitudes. The strongest winds are close to the earth's surface.
- Nor'easters can cause heavy snow, rain, gale force winds, and oversized waves (storm surge) that can cause flooding, structural damage, power outages and unsafe human conditions. Nor'easters that track offshore are more devastating than ones that track inland. Offshore Nor'easters result in heavy snow, blizzards, ice, and strong winds, whereas those that track inland produce mostly rain events. If a significant pressure drop occurs within a Nor'easter, this change can turn an extra-tropical cyclone storm. These events include a pressure drop of at least 24 millibars (units of atmospheric pressure) within 24 hours. This is similar to the rapid intensification of a hurricane.

4.3.13.1 Location

Snow accumulation in Old City during a 2010 winter storm.

Historically Philadelphia is prone to winter weather, and particularly snowstorm events due to its northern location and proximity to the Atlantic Ocean. Winter weather has started as early as October in the past in Philadelphia. However, the frequency and intensity of winter weather events strengthens starting typically in December when winter temperatures average between 20°F and 40°F. All areas of the City are susceptible to winter storms. However, roads and bridges are especially vulnerable because of transportation accidents and disruptions related to severe winter storms.[331]

4.3.13.1.1 Magnitude

The magnitude or severity of a winter weather storm depends on several factors including temperatures, 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 extent of a winter storm can be classified by meteorological measurements and by evaluation 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.[332]

---

[331] Image: Kevin Burkett. "Scenes from the Old City and Society Hill sections of Philadelphia after a major snow storm on Feb. 6, 2010." February 6, 2010. Retrieved January 15, 2016.

[332] Kocin, Uccellini: A Snowfall Impact Scale Derived from Northeast Storm Snowfall Distributions. Retrieved 4 January 2012.

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. This 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. The raw score correlates with one of the five NESIS categories.

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	4-5.9	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	6-9.9	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	10+	These storms represent those with the most extreme snowfall distributions, blanketing large areas and population with snowfalls greater than 10-inch accumulations. The storms effects exceed 200 x 103mi^2 and impact more than 60 million people.

The Dolan-Davis Nor'easter Intensity Scale categorizes the magnitude, severity and/or intensity of a Nor'easter. This scale primarily deals with beach and coastal deterioration, which does not apply to Philadelphia. Though this scale is not commonly used, it does allow the comparison of various Nor'easters by using the duration and height of the waves produced at the coast.[333]

Dolan/Davis Nor'easter Intensity Scale			
Storm Class	Average Wave Height	Average Duration	Impact
1	6 ft.	8 hr.	Minor beach erosion
2	8 ft.	18 hr.	Some beach erosion and property damage
3	11 ft.	34 hr.	Extensive beach erosion, significant dune loss, many structures lost
4	16.5 ft.	63 hr.	Severe beach erosion and recession, wider scale of building loss

A 2010 snowstorm covers the area around City Hall.

---

[333] Ibid

5	23 ft.	96 hr.	Extreme beach erosion, massive over wash, extensive property damage

Finally, the NWS issues the following winter weather products for Philadelphia, as conditions warrant:

NWS Winter Weather Products	
Winter Storm Outlook	
Winter Storm Outlook	Issued prior to a Winter Storm Watch. The Outlook is given when forecasters believe winter storm conditions are possible and are usually issued 3 to 5 days in advance of a winter storm. Winter Storm Outlooks are contained in the Hazardous Weather Outlook product available on the NWS Website at www.weather.gov/phi.
NWS Watches	
Blizzard Watch	Issued when sustained winds of 35 MPH or greater are possible (50 percent chance or higher), resulting in blowing snow that reduces visibility to ¼ mile or less. The NWS strives to issue Blizzard Watches 36 to 48 hours prior to the actual onset of blizzard conditions. Blizzards are very rare in Philadelphia.
Winter Storm Watch	Alerts the public to the possibility of a blizzard, heavy snow, heavy freezing rain, or heavy sleet. Winter Storm Watches are usually issued 12 to 48 hours before the beginning of a Winter Storm.
Wind Chill Watch	Issued when air temperatures, real or apparent, could drop to minus 25 degrees Fahrenheit or lower (50 percent chance or higher).
NWS Advisories	
Winter Weather Advisory	Issued when winter weather conditions are expected to cause significant inconvenience and may be hazardous if proper caution is not exercised. Winter Weather Advisories can be issued for any of the following weather events: two to four inches of snow, blowing snow, trace to ¼ of ice from freezing rain, and wind chill

	for apparent temperatures between minus 10 and minus -25 degrees Fahrenheit.
Wind Chill Advisory	Issued when wind chill temperatures are expected to be a significant inconvenience to life with prolonged exposure, and, if caution is not exercised, could lead to hazardous exposure.
NWS Warning	
Blizzard Warning	Issued for sustained or gusty winds of 35 mph or more, and falling or blowing snow creating visibilities at or below ¼ mile; these conditions should persist for at least three hours.
Heavy Snow Warning	Issued when snow accumulations of 4 inches or more are expected in a 12-hour period (80 percent chance or higher), or when 6 inches or more are possible in a 24-hour period. The NWS strives to issue Heavy Snow Warnings 12 to 24 hours prior to the onset of actual heavy snow conditions.
Ice Storm Warning	Issued when ¼ inch or more of ice due to freezing rain is expected (80 percent chance or higher), resulting in fallen trees and powerlines, as well as very slippery road conditions. The NWS strives to issue Ice Storm Warnings 12 to 24 hours prior to the onset of actual ice conditions.
Winter Storm Warning	Issued when hazardous winter weather in the form of heavy snow, heavy freezing rain, or heavy sleet is imminent or occurring. NWS issues Winter Storm Warnings 12 to 24 hours before the event is expected to begin.
Wind Chill Warning	Issued when the NWS expects wind chill temperatures to be hazardous to life within several minutes of exposure.
Note: Forecasters have discretion to issue any of the above warnings for slightly less severe conditions in order to account for extenuating circumstances. For example, if 3 inches of snow are expected on an extremely busy travel day (Wednesday before Thanksgiving, for instance), or when 2 or 3 inches of snow are expected very early or very late in the season when snow is normally NOT a major concern.	

4.3.13.1.2 Worst case scenario

The following worst-case scenario is derived from analysis of storms Philadelphia has experienced in the past, such as those in 1996, 2010, and 2016.

A major mid-winter storm system tracks eastward from the upper South, drawing in Pacific moisture from a southern jet stream. At the same time, a dome of bitter cold Artic high-pressure air blankets the mid-Atlantic and a coastal low-pressure system tracks north from the Carolinas. The storms merge to form a massive winter nor'easter similar to the blizzards of 1996, 2010, and 2016, with snowfall ranging from 24 to 48 inches in the greater Philadelphia area, including all of Southeastern Pennsylvania. High-sustained winds and gusts complicate the plowing efforts, as snow covers the roads again shortly after plowing. Weather conditions disrupt air and rail service to the region for four days. Major local highways such as I-76 and I-95 are impassable for a several days, with regional roads shut down for nearly a week. Record power outages affect the region. Southeastern Pennsylvania continues to experience record cold temperatures after the storm, making recovery difficult.

4.3.13.1.3 Environmental Impacts

Winter storms have the potential to cause significant damage to trees, felling both limbs and entire 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 can be beneficial in assisting in 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 the Floods section of this document.

4.3.13.2 Past Occurrences

Philadelphia averages 22.3 inches of snowfall annually based on NOAA data from 1921 to 2015. Historically, seasonal totals range from just a trace during the 1972/1973 season to 78.7 inches during the 2009/2010 season.[334] The table below depicts the 10 greatest snowstorms in terms of snowfall for Philadelphia. For a full list of disaster

---

[334] Ibid

declarations and recorded snow events in Philadelphia, see the Snow Declarations and Events Annex.

Top Ten Snow Storms in Philadelphia

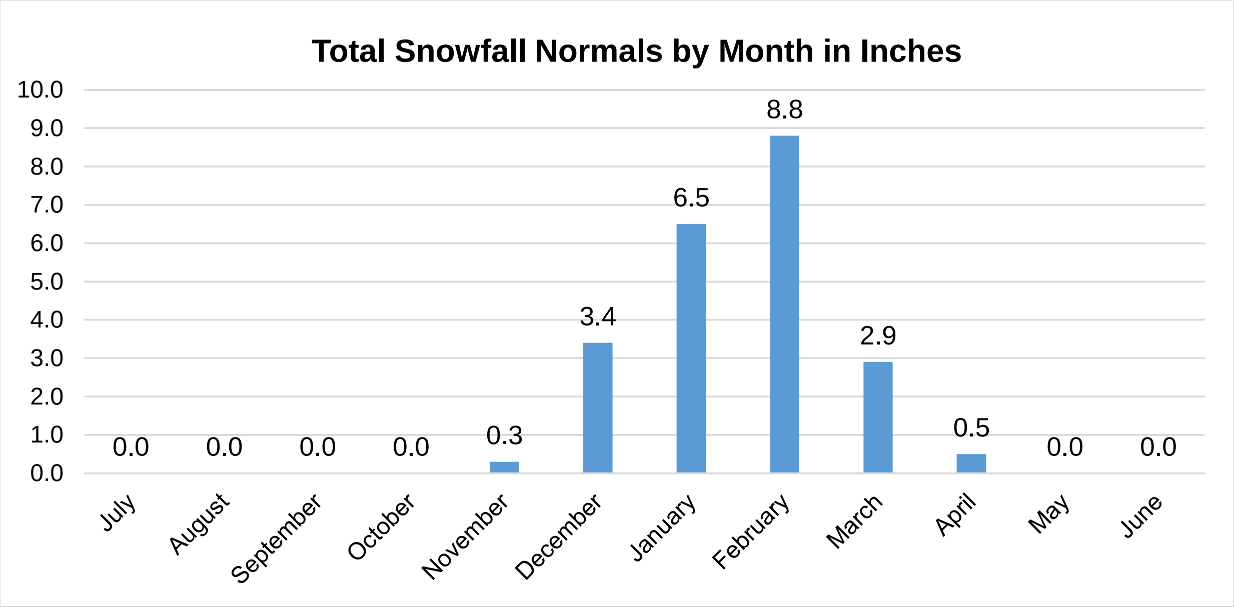
Total Inches recorded at PHL	Date	Details
30.7 inches	January 7-8, 1996	▪ Named the Blizzard of ‘96, even though based on the strict definition, the storm was not a blizzard ▪ Parts of nine states, from Virginia to Massachusetts, received 2 ft. or more of snow ▪ Mayor declared a State of Emergency – only essential emergency vehicles were allowed on roadways ▪ PennDOT operations took two days to clear streets and main arteries. ▪ PFD experienced access problems due to unplowed streets ▪ Philadelphia schools closed for a week ▪ Snow loads were dumped into the Schuylkill River, damming the River ▪ Schuylkill River near Manayunk froze, causing ice flows to dam river and cause flooding ▪ SEPTA shutdown ▪ PHL airport closed for 3-day period
28.5 inches	February 5-6, 2010	▪ 28.5 inches recorded at PHL, 22.0 inches at Roxborough ▪ Statewide Disaster Emergency declared by Governor ▪ Snow Emergency declared by Mayor ▪ Amtrak and SEPTA suspended services ▪ PHL canceled flights in and out of Philadelphia on the February 6th ▪ Philadelphia schools were closed for one day ▪ Trash pick-ups delayed

23.2 inches	December 19-20, 2009	▪ 23.2 inches recorded at PHL, 10.5 inches at Somerton ▪ 77% of flights canceled from PHL, those that were not experienced six hour delays – delays continued into the 21st ▪ Retail shops and malls closed early ▪ NFL – Eagles game delayed until 4pm ▪ Trash pick-ups delayed ▪ SEPTA reported suspensions and delays along bus and regional rail service
22.4 inches	January 22-24, 2016	▪ 22.4 inches recorded at PHL ▪ 19.4 inches of snow that fell January 23 at Philadelphia International Airport set a record for the date, last set at 11.9 inches in 1935 ▪ Trash pick-ups delayed ▪ SEPTA bus and regional rail temporarily halted ▪ All PHL flights cancelled for January 24 ▪ Schools closed January 25-26 following the event
21.3 inches	February 11-12, 1983	▪ Named the Megalopolitan Snowstorm because 20 inches or more fell on the major four cities of the Mid-Atlantic ▪ Winds of 25-35 mph were recorded with gusts over 40 mph ▪ Transportation services were delayed or suspended for PHL, Amtrak, and SEPTA ▪ Thundersnow was recorded
21.0 inches	December 25-26, 1909	▪ Named the Christmas Day Snowstorm ▪ In sections of the City, snowdrifts were 4-5 feet high
19.4 inches	April 3-4, 1915	▪ Occurred over Easter weekend ▪ Over 19 inches fell in under 12 hours ▪ Broke the snowfall record for April – old record was set back in 1841 ▪ No storm has come close to matching the April record

18.9 inches	February 12-14, 1899	▪ Named the Blizzard of ‘99 ▪ Formed in tandem with one of the greatest outbreaks of Artic air on record ▪ The 18.9 inches fell in addition to the 12 inches already on the ground from an earlier storm ▪ The snow depth exacerbated the cold, high temperatures did not exceed beyond 10°F February 11-13
18.7 inches	February 16-17, 2003	▪ Snow emergency declared ▪ 2 fatalities ▪ Several roof and porch collapses ▪ PHL closed on the 17th ▪ Greyhound suspended services on the 17th ▪ SEPTA ran on weekend service ▪ Snow removal cost approximately $8 million
16.7 inches	January 22-24, 1935	▪ No information available.
15.8 inches	February 9-10, 2010	▪ 19.5 inches recorded at Rockledge, 17.0 inches at Pine Valley, 15.8 inches at PHL, 13.9 inches at Green Lane ▪ 37mph peak wind gusts at PHL ▪ State of Emergency declared by Governor ▪ PECO declared a snow emergency – 9th greatest power outage in PECO history; 17,000 customers lost power in Philadelphia ▪ Two fatalities occurred in Philadelphia ▪ Philadelphia schools were closed from February 10-11th ▪ PHL closed on February 10th and reopened the afternoon of the 11th ▪ SEPTA regional rail and bus service suspended services from February 10-11th ▪ Trash pick-ups delayed

4.3.13.3 *Future Occurrences*

Winter storms will continue to occur in Philadelphia. Based off monthly climate normals[335] from 1981 to 2010 (the most recent analysis period conducted by the National Weather Service), the City potentially will experience snowfalls in the amounts and months shown in the table and graph below.



4.3.13.4 *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. The elderly are the most susceptible to winter storms due to their increased risk of injury and death from falls, overexertion during snow removal,

---

[335] Normals are averages calculated from the latest three-decade averages of climatological variables.

and/or hypothermia. 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 business 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.[336] The Flooding 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 buildings 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. The Infrastructure Failure hazard profile in this document contains additional information on building collapses.

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.

There is a network of approximately 2,575 miles of city and state roads within Philadelphia. PennDOT, the Streets Department and the Philadelphia Department of Parks and Recreation share the responsibility for maintaining roadways during winter storms. Of the 360 miles of state roads, PennDOT maintains 50 miles of limited access state highways, including I-95 and I-76. The remaining 310 miles are state roads that the state contracts with the City for snow and ice removal. This amounts to a total of 2,525 miles of city and state roads that the City maintains. The Department of Parks and Recreation removes snow and ice from 35 miles of Park roads, including roadways that bisect Fairmount Park including Lincoln Drive, Kelly Drive and Martin Luther King (MLK) Drive. Snow and ice removal on the remaining 2,490 miles of city streets is the responsibility of the Philadelphia Streets Department.[337] For a point of reference, the

---

[336] “Ice Jam”. NOAA Glossary. Retrieved May 4, 2016.

[337] Philadelphia Streets Department Snow and Ice Operations Plan. Retrieved 21 February 2012.

most recent storm (Storm Jonas) in January 2016 cost the city over $6.2 million dollars by Streets Department costs alone.

Using the average total costs incurred from winter storms in 2016, 1996, and 1994, the total costs for a significant winter storm event would average $12,051,161.[338] By looking at the typical breakdown in costs, planners calculated the range of costs for a significant winter storm event by type of cost.

Significant Winter Storm Expense Breakdown by City Agency in 2016 USD

Year	Average Cost
Managing Directors Office	$ 4,244.72
Revenue Department	$ 7,566.43
Commerce Department - Division of Aviation	$ 2,088,193.05
Fairmount Park Commission	$ 170,802.15
Fire Department	$ 48,404.61
Office of Fleet Management	$ 477,029.72
Department of Human Services	$ 112,182.35
311	$ 8,483.02
Philadelphia Housing Authority	$ 712,986.75
Department of Licenses and Inspections	$ 29,186.51
Philadelphia Parking Authority	$ 472,213.08
Police Department	$ 311,221.75
Philadelphia Prisons	$ 76,208.02
Department of Health	$ 31,697.59
Department of Public Property	$ 135,481.31
Department of Recreation	$ 84,516.54
Streets Department	$ 8,293,756.87
Philadelphia Water Department	$ 1,299,187.49
School District of Philadelphia (SDP)	$ 1,032,339.82
Total	$ 12,051,161.05

Using the worst case scenario for a winter storm, in this case a combination of the winter storms occuring in 1994 and 1996, planners can estimate the impact severe winter storms have on city structures. Severe winter storm conditions could cause an average of 72.5 structures to collapse, 97 percent of which are residential.[339] Using

---

[338] Information for costs from the submission for reimbursement costs for the winter storms in 1994, 1996, 2010, and 2016. All costs adjusted for inflation.

[339] Structural collapse data retrieved from damage assessment surveys for the 1994 and 1996 winter storms used for individual assistance filings.

these same years, planners can estimate that 445.5 residents would need to evacaute from their homes during a severe winter storm, with 287.5 residents needing sheltering.

4.4 Risk Assessment

4.4.1 Documentation and Sources

The risk assessment process used for Philadelphia's *2017 Hazard Mitigation Plan is consistent with the process and steps presented in the Federal Emergency Management Agency (FEMA) 386-2, State and Local Mitigation Planning How-to-Guide, Understanding Your Risks – Identifying Hazards and Estimating Losses*, and complies with *Pennsylvania's All-Hazard Mitigation Planning Standard Operating Guide*.

4.4.2 Risk Analyses for Profiled Hazards

Following PEMA's *All-Hazard Mitigation Planning Standard Operating Guide*, the summary of each hazard's probability, impact, spatial extent, warning time, and duration is weighted to establish an overall degree of risk for the City of Philadelphia. Weights are as follows:

- Probability: 30%
- Impact: 30%
- Spatial Extent: 20%
- Warning Time: 10%
- Duration: 10%

Planners and stakeholders can use these risk factors to rank and prioritize hazards and mitigation actions. Risk factors were developed following the development of hazard profiles in order to ensure ample information was provided in shaping the degree of risk. Each degree of risk is assigned a numerical value from one to four, with one being the lowest and four the highest degree of risk.

4.4.2.1 Risk Factor by Hazard

The table below is a summary of the probability, impact, spatial extent, warning time, and duration of those hazards included in this Hazard Mitigation Plan.

For more information on each factor indexed, see the respective section below. For more information on each hazard, see each respective hazard profile included in the Hazard Profiles section of this plan.

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Overall Risk
Active Shooter	2	3.3	2	4	1	2.5
Infrastructure Failure	2	1.9	2	4	1	1.6
Drought	2	1.3	4	1	4	2.3
Earthquake	2	2.3	4	4	1	2.6
Extreme Cold	4	3.0	4	1	3	3.3
Extreme Heat	4	3.0	4	1	3	3.3
Flooding	4	3.3	4	2	4	3.6
Hazardous Material Train Derailment	2	3.7	2	4	4	2.9
Improvised Explosive Device	1	3.0	2	4	1	2.1
Tropical Storm/Hurricane	3	2.3	4	1	3	2.8
Urban Conflagration	1	2.7	2	4	3	2.2
Winter Storm	4	2.7	4	1	3	3.2
Windstorm/Tornado	4	3.0	4	2	1	3.2

4.4.2.2 Probability of Hazards

The probability of occurrence is an estimate of how often a hazard event occurs. A review of historic events assists with this determination. In the 2012 Hazard Mitigation plan, planners used an alphanumeric classification system. In the past, an ‘A’ classification indicated that the hazard has a likelihood of affecting Philadelphia every 1-5 years; a ‘B’ classification, every 5-10 years; and a ‘C’ classification every 10 years or more.

To comply with PEMA’s Risk Factor approach, planners altered these categories for the 2017 Plan in order to conduct an assessment that is both more useful to the City and complies with standardized methods across the state. There are four levels of probability for the purpose of this assessment:

1. Unlikely: Less than 1.0 percent annual probability

2. Possible: Between one percent and 49.9 percent annual probability
3. Likely: Between 50.0 percent and 89.9 percent annual probability
4. Highly Likely: Greater than 90 percent annual probability

The table below depicts this ranking and the primary vulnerability factor(s) behind each classification.

Probability of Occurrence for Hazards in Philadelphia

Hazard	Probability	Vulnerability
Active Shooter	2	Most of the gun crime in the City is largely criminal rather than active shooter
		There have been few instances of incidents that qualify as a potential or founded active shooter
Infrastructure Failure	3	There have been no instances of a bridge collapse in Philadelphia in the past
		A large number of bridges in the area have been declared structurally deficient, increasing the risk of structural collapse
		There have been no instances of a dam collapse in Philadelphia in the past
		There have been instances of building collapses in the past
Drought	2	One Presidential and five Gubernatorial Declarations have been issued as a result of the drought emergencies
		Since 1980 there have been 9 drought watches, 12 drought warnings and 6 drought emergencies
Earthquake	2	Hundreds of earthquakes have occurred in or around Philadelphia; however there has only been one 4.0 magnitude earthquake since 1737
Extreme Cold	4	Occur annually
		Since, there have been 207 days where the daily average temperature was below 32
Extreme Heat	4	Occur annually
		On average, the temperature reaches 90°F between 25 and 30 days annually in Philadelphia
Flooding	4	Can result in any month of the year
		There have been 81 flooding events between 1996 and 2015
		Between 1955 and 2011, Philadelphia experienced 15 Presidential Disaster/Emergency Declarations, and/or Gubernatorial Declarations related to flooding
Hazardous Materials Train Derailment	2	Philadelphia has experienced several incidents and close calls involving hazardous materials carrying train cars in the past

Improvised Explosive Device	1	Philadelphia has not experienced a coordinated improvised handheld or vehicular based explosive device attack
Tropical Cyclone, Hurricane	3	From 1861-2015 31 tropical cyclones have had centers of circulation past through or within 65 statute miles of Philadelphia
		Based on historical data between 1944 and 1999, there is approximately an 18 percent chance of experiencing a tropical storm or hurricane event between June and November of any given year[340]
Urban Conflagration	1	There have been four instances of an urban conflagration since 1850
		Increasing housing density and aging infrastructure contributes to an increased risk of urban conflagration
Winter Storm	4	Philadelphia averages 22.3 inches of snowfall annually
		Seasonal totals range from just a trace during the 1972/1973 season to 78.7 inches during the 2009/2010 season[341]
		Between 1955 and 2015, Philadelphia acquired 6 Presidential Disaster / Emergency Declarations, and 6 Gubernatorial Declarations related to winter storms
Windstorm, Tornado	4	Windstorms are consider high probably, as they occur annually
		Between 1995 and 2015, there were 130 events in Philadelphia with wind speeds greater than 35 mph[342]
		Tornadoes are less frequent
		Since reliable record keeping began in 1950, 8 tornadoes have touched down in Philadelphia, all being classified an F2 or weaker

---

[340] Chris Landsea. “What is my chance of being struck by a tropical storm or hurricane?”. AOML NOAA. Retrieved March 17, 2016.

[341] Uccellini Koci. “A Snowfall Impact Scale Derived from Northeast Storm Snowfall Distributions”.

[342] NCDC Storm Events Database: High Wind, Strong Wind for Philadelphia. Retrieved March 17, 2016.

4.4.2.3 Potential Impact of Hazards

The impact of each hazard in Philadelphia is broken down into three categories: impact on the population, impact on the infrastructure, and the impact on the economy. Each impact ranking is based on the documented historic losses and projected losses detailed in the hazard profiles. Those hazards listed below have been determined to be of higher risk to the City of Philadelphia.

The 2012 Hazard Mitigation Plan used alphanumeric categories to illustrate the level of impact for each category, with "C" being a low probability of impact, "B" being a medium probability of impact, and "A" being a high probability of impact. To comply with PEMA's Risk Factor approach, these categories have been altered for the 2017 Plan in order to conduct a more accurate assessment. There are four levels of probability for the purpose of this assessment:

1. Minor: Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.
2. Limited: Minor injuries only. More than 10 percent of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.
3. Critical: Multiple deaths/injuries possible. More than 25 percent of properties in affected area damaged or destroyed. Complete shutdown for critical facilities for more than one week.
4. Catastrophic: High number of deaths/injuries possible. More than 50 percent of properties in the affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.

The table on the following pages illustrates this ranking and the main determination factor(s) behind each classification.

Impact to Philadelphia: Population, Infrastructure, and Economy

Hazard of Concern	Impact Category	Average Overall Impact	Vulnerability
Active Shooter	Population: 4	3.3	Numerous fatalities/injuries, dependent on the extent of the attack
	Infrastructure: 1		Minimal, if any, damage to surrounding structures
	Economy: 2		Temporary loss of business in the immediate area
Infrastructure Failure: Bridge Collapse	Population: 4	2.7	Numerous fatalities/injuries both on and surrounding the structure
	Infrastructure: 4		Extensive damage to the bridge itself, as well as any surrounding structures or roadways
	Economy: 3		Repair costs to bridge and surrounding area Loss of business
Infrastructure Failure: Dam Collapse	Population: 1	1.3	Few injuries and deaths occur, mostly within vehicles driving through flooded roads Mold contaminates homes and buildings
	Infrastructure: 4		Extensive damage to dam, moderate damage to surrounding homes and businesses
	Economy: 2		Repair costs for dam Loss of business due to localized flooding
Infrastructure Failure: Building Collapse	Population: 2	1.7	Several fatalities and injuries both in and around the immediate vicinity of the structure
	Infrastructure: 2		Damage or total loss of the building, with damage to surrounding structures
	Economy: 1		Temporary loss of business to the immediate area
Drought	Population: 1	1.3	Health issues related to use restrictions and lack of hygiene
	Infrastructure: 1		Does not affect infrastructure such as highways, bridges and buildings
	Economy: 1		Losses towards water-reliant businesses Loss of crops
Earthquake	Population: 2	2.3	Minimal fatalities/injuries
	Infrastructure: 3		Limited structural damage would be sustained, but would be worst in older buildings of Philadelphia
	Economy: 2		Economic loss would be in the millions due to repair costs and loss of business
Extreme Cold	Population: 3	3	Fatalities caused by extreme temperatures ranks the highest in the United States, with 140 deaths on average the past ten years

	Infrastructure: 2		Roads and bridges can erode or develop potholes due to freeze/thaw cycle and brining/salting operations Gas and water mains can burst due to cold Fire hazard increases
	Economy: 2		Higher electric and gas bills Repairs to roads and infrastructure
Extreme Heat	Population: 3	3	Fatalities caused by extreme temperatures ranks the highest in the United States, with 140 deaths on average the past ten years
	Infrastructure: 2		Brownouts and blackouts can occur during extreme heat Roads and bridges can buckle due to expansion in heat Fire hazard increases
	Economy: 2		Higher electric bills Repairs to roads and infrastructure
Flooding	Population: 2	3.3	Few injuries and deaths occur, mostly within vehicles driving through flooded roads Mold contaminates homes and buildings
	Infrastructure: 2		Disruption in transportation services from closed roads and rail lines Damaged buildings and homes in floodplains
	Economy: 4		Direct Economic Loss from a 100-Year Flood Event could be in the multi-millions
Hazardous Train Derailment	Population: 3	3.7	Several fatalities/injuries, depending on the location of the derailment and chemical on board Widespread psychological effects long-term
	Infrastructure: 4		Damage to the immediate area, with secondary effects damage (such as environmental damage and fire) dependent on the location and chemical involved
	Economy: 4		Infrastructure damage and cost of repair Surrounding structural and environmental damage and cost of repair Loss of business, goods, and commodities regionally, depending on the duration, location, and extent of damages
Improvised Explosive Device	Population: 4	3	Extensive fatalities/injuries, depending on the location of the attack Widespread psychological effects long-term
	Infrastructure: 4		Extensive damage to the immediate area, depending on the size and chemical used for the device
	Economy: 3		Structural repair to the affected area Loss of business

Tropical Cyclone, Hurricane	Population: 2	2.3	Minimal fatalities/injuries
	Infrastructure: 3		Similar to flooding and windstorm
	Economy: 3		Direct economic loss from a 100-year hurricane event would be nearly $100 million
Urban Conflagration	Population: 2	2.7	Limited fatalities, several injuries related to smoke inhalation and burns
	Infrastructure: 4		Extensive damage to structures in the area
	Economy: 3		Repair costs to structures Loss of business
Winter Storm	Population: 3	2.7	Accidents due to wintery conditions may occur Transportation for emergency medical services is hindered
	Infrastructure: 2		May collapse roofs Flooding/flash flooding can occur following rapid snowmelt or resulting from ice blockage on waterways
	Economy: 3		Cost accrued from snow and ice removal, salting roads, repairing roads from the freeze/thaw process, and the loss of business
Windstorm, Tornado	Population: 2	3	Minimal fatalities/injuries
	Infrastructure: 4		Damage can be sustained to building, especially high-rises Powerlines can go down, knocking out power for several days
	Economy: 4		Direct consequences to the local economy resulting from windstorms related to both physical damages and interrupted services could be in the multi-billions

4.4.2.4 Extent, Warning Time, and Duration of Hazards

This section investigates three aspects of the hazards detailed in this document:

- Spatial Extent
- Warning Time
- Duration

Spatial extent refers to the size of an area that could be affected by a hazard. This measurement examines whether affects are localized or widespread. Following PEMA's guidance, there are four index levels used to describe spatial extent in this assessment:

1. Negligible: less than 1 percent of the city affected
2. Small: between 1 and 10.9 percent of the city affected
3. Moderate: between 11 and 25 of the city affected
4. Large: greater than 25 percent of the city affected

Warning time refers to whether there is lead time prior to a hazard that would provide time for warning measures to be issued or put in place. Following PEMA's guidance, there are four index levels used to describe warning time in this assessment:

1. More than 24 hours
2. 12 to 24 hours
3. 6 to 12 hours
4. Less than 6 hours

Duration refers to how long a hazard lasts. Following PEMA's guidance, there are four index levels used to describe duration in this assessment:

1. Less than 6 hours
2. Between 6 and 24 hours
3. Between 24 hours and one week
4. Greater than one week

Probability of Occurrence for Hazards in Philadelphia			
Hazard	**Spatial Extent**	**Warning Time**	**Duration**
Active Shooter	2	4	1
Infrastructure Failure	2	4	1
Drought	4	1	4
Earthquake	4	4	1
Extreme Cold	4	1	3
Extreme Heat	4	1	3
Flooding	4	2	4
Hazardous Materials Train Derailment	2	4	4
Improvised Explosive Device	2	4	1
Tropical Cyclone, Hurricane	4	1	3
Urban Conflagration	2	4	3
Winter Storm	4	1	3
Windstorm, Tornado	4	2	1

*4.1.1. **Description of Methodology for Risk Factor Assessment***

The risk factor assessment took into account numerous different data sources to formulate the overall risk. Historical instances utilized as the basis for the probability of a hazard's occurrence were taken from sources such as:

- 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

*4.4.1. **Hazard Vulnerability Summary***

The hazard vulnerability summarizes the potential effects of hazards on the City of Philadelphia, represented by measures such as population at risk, percent damages, and dollar loss estimation. This information provides an additional basis for the creation and prioritization of mitigation strategies.

Data used to conduct vulnerability assessments came from a variety of sources. The assessment identifies critical facilities using Pennsylvania Department of Health data, local Philadelphia Fire and Police information, and Office of Emergency Management mapping data.

Planners calculated loss estimates from the most recent assessment data from the Philadelphia Office of Property Assessment (OPA). To model residential parcels, the OPA used several years of sales data and data related to the physical characteristics of the parcels to estimate value using a comparable sales approach.[343] Damaged home calculations and estimated economic loss data is supplemented with county tract-level calculations created using HAZUS when available.

---

[343] For a complete overview of the value determining process, visit www.phila.gov/assessments.

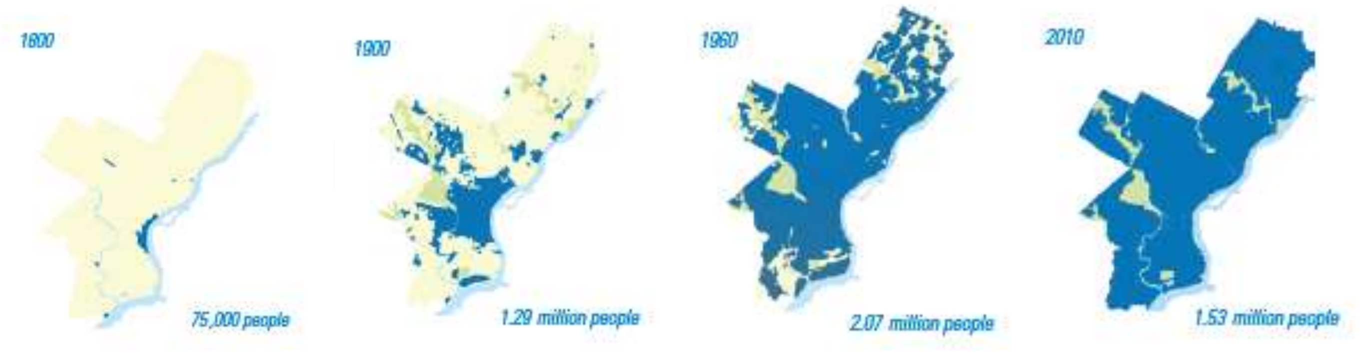
4.4.2. ***Future Land Uses and Development Trends***

Philadelphia has experienced both the boom of population growth and the bust of population decline. Philadelphia's population peaked by the early 1950's. As in many cities of the Northeast, a decades-long period of de-industrialization resulted in closed factories, population loss, vacant land, and urban decay. Following this decline, Philadelphia experienced a slow growth through reinvestment and economic diversification. This growth stabilized and reversed the declining population, and for the first time in 50 years in 2010, the City experienced a population gain of 0.6 percent, according to the U.S. Census Bureau.

In 2010, the Philadelphia City Planning Commission (PCPC) developed an aspirational population forecast for 2035 taking into account historic trends, recent trends, and current conditions. The PCPC forecast for 2035 utilizes a range of forecasts based on different assumptions, including the extrapolation of long-term and short-term trends as well as the consideration of the impacts of future conditions and interventions on births, deaths, and migration.

These separate forecasts were then averaged to reflect a likely future outcome within a range of possible outcomes. The combination of five different forecasts yield an average forecast of approximately 1.63 million Philadelphia residents by 2035. This suggests a population increase of 100,000 people over 25 years, a significant increase not experienced since before 1950. The table on the following page shows the maps of population trends both in the past and up to the year 2035.

Philadelphia's Population Growth
Images from Philadelphia City Planning Commission



Summary of Five Population Forecast Models				
Population Forecast Model and Assumptions	**2010 Base Population (millions)**	**2035 Forecast Population (millions)**	**2010-2035 Change**	**Notes**
Decennial Census Trend, Composite *Averages high, medium, and low interpretations of decennial Census trends, 1980-2010*	1.53	1.45	-80,000	Ranges from high of 1.88m to low of 1.26m
DVRPC Forecast Adjusted to 2010 Base *Same annual changes to 2035 as Delaware Valley Regional Planning Commission "Connections" Plan*	1.53	1.53	0	Slight decrease through 2015, followed by slight increase
City Share of Region, Composite *Averages high, medium, and low interpretations of trends in city's share of 12-county region, 1970-2010*	1.53	1.65	120,000	Ranges from high of 1.83m to low of 1.48m
Annual Estimates Census Trend *Extension to 2035 of 2000-2010 changes reported by Census Annual Estimates Program*	1.53	1.66	130,000	Reflects annual growth rate of approximately 0.3 percent

High Demand/ High Capacity *Substantial increase in retention and immigration of domestic and foreign residents*	1.53	1.85	320,000	Reflects City's capacity to accommodate growth from combined effects of city-friendly trends and policies in immigration, the economy, and the environment
Average	1.53	1.63	100,000	

5 Capability Assessment

5.1 Philadelphia 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, as well as highlight the positive mitigation measures already underway in Philadelphia.

5.2 Conducting the Capability Assessment

In order to inventory Philadelphia's capabilities, a Capability Assessment Survey was distributed to the members of the Hazard Mitigation Planning Committee. 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 the Self-Assessment Capability Survey Annex.

5.3 Capability Assessment Findings

The findings of the capability assessment are summarized in this plan to provide insight into Philadelphia's capacity to implement hazard mitigation actions. All information is based upon the responses provided by the Hazard Mitigation Planning Committee and City agencies.

5.3.1 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.[344] 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 loss reduction. 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.

---

[344] PCPC, Philadelphia 2035. Retrieved 5 November 2015.

Planning and Regulatory Capability Inventory						
	Status				Updates	
Planning /Regulatory Tool	In Place	Updating	Under Development	Not Applicable	Year Last Updated	Changes or additions since 2012
Hazard Mitigation Plan	X	X			2017	▪ Inclusion of human caused threats ▪ Inclusion of a localized annex ▪ General updates
Emergency Operations Plan	X				2015	▪ General updates
Hazard Based Emergency Plans	X	X	X		Varies	
Function-based Emergency Plans	X	X	X		Varies	
Evacuation Plan	X	X			2016	▪ Neighborhood level route identification ▪ Hazard-specific approach
Continuity of Operations Plan	X				2015	▪ Orders of succession & delegation of authority ▪ Contact information ▪ Funding information ▪ General updates
National Flood Insurance Program	X					
National Flood Insurance Program: Community Rating System			X		TBD	▪ The City of Philadelphia underwent a Community Assistance Visit by FEMA in 2016. More details below. ▪ The City is in preliminary stages of application for participation in the Community Rating System

Floodplain Regulations	X				Varies	
Floodplain Management Plan	X				Varies	
Zoning Codes	X				2015	▪ Philadelphia Property Maintenance Code (Subcode “PM”) was repealed and replaced by Bill No. 120647, approved January 20, 2014 and effective July 1, 2015. ▪ Philadelphia Property Maintenance Code (Subcode “PM”) was further amended, and its substantive provisions replaced in their entirety, by Bill No. 140856, approved December 19, 2014 and effective July 1, 2015. ▪ Title 14: Zoning and Planning was repealed and replaced by the provisions of Bill No. 110845, approved December 22, 2011 and effective August 22, 2012.
Subdivision Regulations	X				2016	▪ Subdivision design standards regarding visitability updated in 2013.
Comprehensive Land Use Plan	X	X			Varies	▪ Since the 2012 Hazard Mitigation Plan, the City Planning Commission has completed 13 of 18 *Philadelphia2035* district plans. ▪ As of October 2016, there were an additional two more plans underway, with three more scheduled for Spring 2016, and the final three scheduled for 2017 and 2018.
Open Space Management Plan	X				Varies	▪ Open space planning completed on a planning district by planning district basis.
Stormwater Management Plan	X				2014	▪ Planned for and installed new stormwater management tools citywide. ▪ Updates the monitoring and assessment of surface waters, groundwater, rainfall, and green infrastructure performance.

Watershed Management Plan	X				2014	▪ Updates the monitoring and assessment of surface waters, groundwater, rainfall, CSO discharges, sewer flows, and green infrastructure performance.
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
Economic Development Framework	X					
Historic Preservation Plan			X		2016	▪ Historical site assessments conducted in early 2016 ▪ Mitigation actions developed for both the City and property owners
Building Codes	X				2010	▪ City adoption of new codes

5.3.1.1 Emergency Management

Emergency management is a comprehensive, integrated program of mitigation, preparedness, response, and recovery for emergencies of any kind. In Philadelphia the responsibility of ensuring the City's preparedness and resiliency falls under the Office of Emergency Management (OEM). OEM coordinates the combined efforts of 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's mission is to focus people, plans, and programs to promote a prepared and resilient Philadelphia.

OEM endeavors to create a more prepared and resilient Philadelphia through a variety of programs that include planning, operational coordination, and external engagement, and performs numerous analyses to identify potential areas for improvement. One of the ways these areas are identified is through multi-agency exercises and training. The Office of Emergency Management conducted numerous exercises and trainings since 2012, including a Mass Casualty/ Mass Decontamination Exercise series throughout the spring and summer of 2015, coordinating efforts across City departments to further develop and socialize plans. Other training and exercise events include the Public Alerting Conference, ICS trainings, and Radiological Dispersion Device (RDD) Workshop, among many others.

Exercises and training also assists in response readiness. The Office of Emergency Management responds to both planned events and unplanned incidents to assist in coordination of resources and services. OEM averages four responses per month and 49 per year.

OEM has also grown in 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 has also undergone several physical changes. In December 2012, OEM opened its newly renovated Emergency Operations Center to better accommodate liaisons and staff with more efficient layouts, updated electronics, and v-shaped work stations for face to face collaboration. The Office of Emergency Management also established and inventoried a departmental warehouse that provides equipment for events and incidents of various sizes and types. Equipment ranges from generators to durable medical equipment.

5.3.1.2 Hazard Mitigation Plan

A hazard mitigation plan 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. 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 2017 Hazard Mitigation Plan is the newest iteration of the plan.

> *A hazard mitigation plan represents a community's plan for how it intends to reduce the impact of hazards on people and the built environment.*

5.3.1.3 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 a coordinated and effective response to any disaster that may affect lives and property in Philadelphia. Philadelphia's EOP is reviewed biennially by the Pennsylvania Emergency Management Agency.

5.3.1.4 Hazard-Specific Planning

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-specific plans are used in the 2017 Hazard Mitigation Plan 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 Hazard Mitigation Plan. Individual hazard-specific plans reference the Hazard Mitigation Plan for additional hazard and vulnerability information.

5.3.1.5 Function-based Planning

Philadelphia MDO-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 routinely reviewed and revised. Current plans include, but are not limited to, those listed in the Function-based Plans table below. Function-based plans are used in the 2017 Hazard Mitigation Plan to help identify response and recovery capabilities and gaps for future mitigation actions.

5.3.1.6 Evacuation Plan

The City of Philadelphia has never had cause to evacuate the 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 community will support individuals who do not have access to their own transportation. OEM started revising evacuation planning in early 2016. The updated plan focuses on a neighborhood level planning approach, with emphasis on localized hazards in areas with known issues, such as flooding. The update is set to be completed later in 2017.

5.3.1.7 Continuity of Operations Plan

Continuity of Operations Planning 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. The most recent iteration of the plan was in 2015, and is updated regularly.

5.3.1.8 Zoning Codes

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 Commission is charged with enforcing 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.

5.3.1.9 Subdivision Regulations

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.

5.3.1.10 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 to future governmental decision making. Typically a comprehensive plan contains 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. The Philadelphia 2035: The Comprehensive Plan is managed by the PCPC, but dozens of other organizations and individuals assisted with the development of the plan. Philadelphia2035 is one component of a broader initiative known as the “Integrated Planning and Zoning Process.” The process is designed to align Philadelphia’s zoning code changes with comprehensive and strategic planning, all of which is informed by a formalized public education and outreach organization, the Citizens Planning Institute.

Since the 2012 Hazard Mitigation Plan, Philadelphia2035 has completed 10 of 18 district plans. As of November 2015, there were an additional two more plans underway, with three more scheduled for Spring 2016, and the final three slotted to take place in the near future.[345] Each of these district plans produces a proposed land use plan for the district, among several other important components. These land-use plans serve as the basis for zoning map revisions, an important activity of the Zoning Code reform work. The 2017 Hazard Mitigation Plan integrates existing and future land use as laid out by Philadelphia2035 district plans.

5.3.1.11 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. In addition to Philadelphia2035, the Mayor’s Office of Sustainability in partnership with PCPC, has been actively targeting the creation of park and recreation amenities within 10 minutes of 75 percent of Philadelphia residents through 500 new acres of public open space by 2015.[346] Further, under Philadelphia’s Combined Sewer Overflow Long Term Control Plan titled *Green City, Clean Waters,* the Philadelphia Water Department has installed more than 581 greened acres, well ahead of their goal

---

[345] Philadelphia2035. District Plan Schedule. Retrieved 5 November 2015.

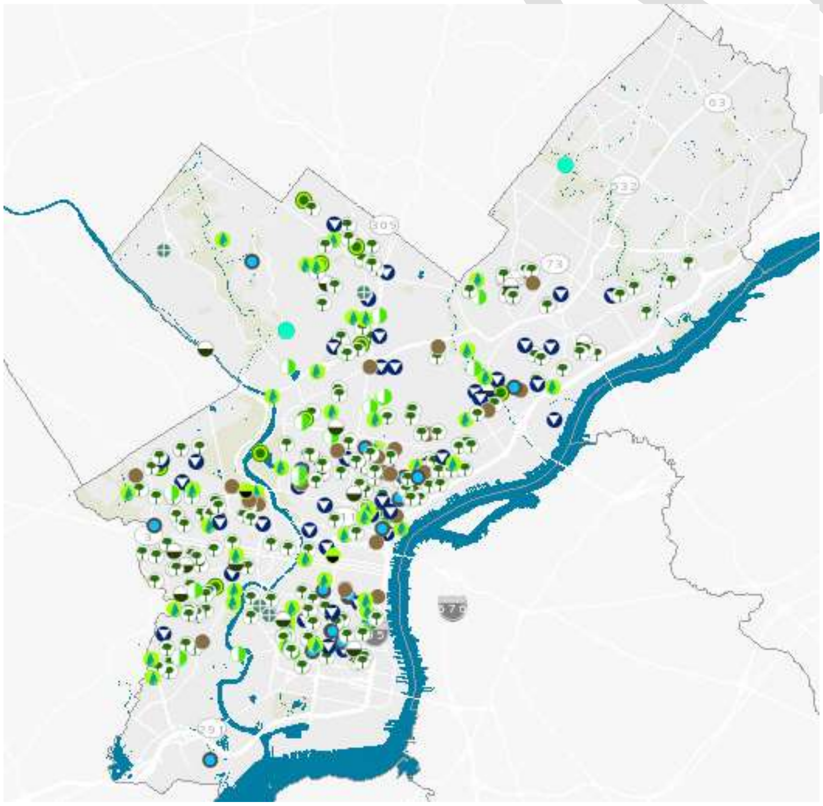
[346] Target 9: Provide Park And Recreation Resources Within 10 Minutes Of 75 Percent Of Residents. Philadelphia Greenworks. Retrieved November 30, 2015.

to install 450 new greened acres by the close of 2015.[347] Beyond 2015, the City is exploring more options to create more open space through partnerships with the Philadelphia Land Bank. The City works on a number of fronts to improve the city's open space network, including the Philadelphia Water Department's stormwater management plan and the Philadelphia School District's Campus Park Program.

5.3.1.12 Stormwater Management Plan

A stormwater management plan is designed to address flooding associated with stormwater runoff. Philadelphia Water Department actively updates the City's Stormwater Management plan, with the latest version approved on July 1, 2015. In addition to the plan, PWD wrote a corresponding manual to help home owners, contractors, and citizens in general better understand how to efficiently comply with Stormwater regulations.

Philadelphia also is taking great strides in stormwater management through green infrastructure. As of June 1, 2011 the Philadelphia Water Department's "Green City, Clean Waters", stormwater management plan, was approved by the EPA and PADEP. The purpose of the plan is to modify the stormwater infrastructure in Philadelphia to



The Philadelphia Water Department has completed or is in the process of designing:

- *485 Stormwater Tree Trenches*
- *73 Stormwater Planters*
- *49 Stormwater Bump-outs*
- *96 Rain Gardens*
- *12 Stormwater Basins*
- *141 Infiltration/Storage Trenches*
- *31 Porous Paving Projects*
- *28 Swales*
- *2 Stormwater Wetlands*
- *33 Downspout Planters (not shown in map)*
- *15 Other Projects*

---

[347] Greenworks Progress Report 2015. Mayor's Office of Sustainability. Retrieved December 15, 2015.

reduce the amount of contaminated water that enters rivers and streams. Since the plan's introduction and enactment, Philadelphia Water Department and private developers have added over 1,100 green stormwater tools to Philadelphia's landscape, such as planters, porous pavement, and stormwater wetlands.

The plan is expected to reduce the amount of sewer overflow entering city waterways by 5 to 8 billion gallons per year as construction continues. This is an 80 to 90 percent reduction in flow. The plan includes several green infrastructure projects to attain water quality goals and also to mitigate climate change impacts while stimulating economic development. Future projects include incorporating porous asphalt, bioswales[348], rooftop gardens, street repaving, roadside plantings, and thousands of new trees.

5.3.1.13 Watershed Management Plan

The 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, Clear Waters" with waterways restoration, waterways assessment, and the incorporation of green stormwater infrastructure.

5.3.1.14 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. The plan is updated annually.

---

[348] Bioswales are storm water runoff conveyance systems that provide an alternative to storm sewers. They absorb low flows or carry runoff from heavy rains to storm sewer inlets or directly to surface waters. A road side ditch with vegetation can serve as a bioswale.

5.3.1.15 Economic Development Framework

The Greater Philadelphia Economic Development Framework 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 Betsy Ross House is one of several historically important sites located in a flood plain in Philadelphia.

5.3.1.16 Historic Preservation Plan

A historic preservation plan is intended to preserve historic structures or districts within a community and is managed by the Philadelphia Historic Commission. The Pennsylvania Historical and Museum Commission, in partnership with the Philadelphia Office of Emergency Management, U.S. Army Corps of Engineers, private firms, and the Philadelphia Historic Commission is currently conducting a two-phase project that is leading to the development of recommended mitigation actions for inclusion in both the Historic Preservation Plan and Philadelphia's Hazard Mitigation Plan.[349]

5.3.1.17 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.

---

[349] Image: "Betsy-Ross-House" by Wolle8ball - Own work. Licensed under CC BY 3.0 via Wikimedia Commons. Retrieved February 8, 2016.

5.3.2 Administrative and Technical Capabilities

Philadelphia’s ability to plan and implement mitigation programs ties 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. The Administrative and Technical Capability table below provides a summary of the administrative and technical capability of Philadelphia.

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	
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	

Local agencies that can provide technical assistance for mitigation activities include, but are not limited to:

- Office of Emergency Management
- Philadelphia Fire Department
- Philadelphia Office of Sustainability
- Philadelphia Land Bank
- Philadelphia Historic Commission
- Philadelphia Police Department
- Philadelphia Water Department
- Philadelphia Department of Public Health
- Philadelphia Gas Works
- Philadelphia Streets Department

- Philadelphia Licenses and Inspections
- Philadelphia Parks and Recreation
- Philadelphia City Planning Commission
- Philadelphia International Airport
- Office of Innovation and Technology
- Delaware River Port Authority
- Veolia Energy

State agencies agency that can provide technical assistance for mitigation activities include, but are not limited to:

- Pennsylvania Department of Community and Economic Development
- Pennsylvania Department of Conservation and Natural Resources
- Pennsylvania Department of Environmental Protection
- Pennsylvania Department of Labor and Industry (Building Codes)
- Pennsylvania Department of Transportation
- Pennsylvania Emergency Management Agency
- Southeast Pennsylvania Transportation Authority

Federal agencies which can provide technical assistance for mitigation activities include, but are not limited to:

- Army Corp of Engineers
- Department of Housing and Urban Development
- Department of Agriculture
- Department of Transportation
- Economic Development Administration
- Environmental Protection Agency
- Federal Emergency Management Agency
- Small Business Administration

5.3.3 ***Fiscal Capabilities***

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.

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

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

Federal programs that may provide financial support for mitigation activities include, but are not limited to:

- Community Development Block Grants (CDBG)
- Disaster Housing Program
- Emergency Conservation Program
- Emergency Watershed Protection Program
- Hazard Mitigation Grant Program (HMGP)
- Flood Mitigation Assistance Program (FMA)
- Non-insured Crop Disaster Assistance Program
- Pre-Disaster Mitigation Program (PDM)
- Repetitive Flood Claims Program (RFC)

- Section 108 Loan Guarantee Programs
- Severe Repetitive Loss Grant Program (SRL)
- Weatherization Assistance Program

5.3.4 Education and Outreach Capabilities

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:[350]

Wally the Shelter in Place Turtle attends outreach events with the Office of Emergency Management and other city stakeholders year-round.

- Office of Emergency Management
- Philadelphia Police Department
- Philadelphia Fire Department
- Philadelphia Water Department
- Mayor's Office of Sustainability
- Philadelphia City Planning Commission

In addition to these efforts, Philadelphia participates in several programs and organizations that support mitigation-related education and outreach activities such as:

- 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

---

[350] Image: Office of Emergency Management. Retrieved March 7, 2016.

5.3.5 ***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. This insurance 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:

- *4,216 policies in force*
- *1,893 in high risk for flooding areas*
- *590 in moderate to low risk areas*

Philadelphia is an active participant in the NFIP. As of May 31, 2015 there are 4,216 insurance policies in force within Philadelphia[351], increased from 3,907 policies at the time of the 2012 Hazard Mitigation Plan. Of the 4,216 insurance polices, 1,893 are in the high-risk areas for flooding and 590 are in the moderate to low-risk areas.[352]

The U.S. Congress mandates that federally regulated or insured lenders require flood insurance on properties that are located 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. Philadelphia City Planning Commission (PCPC) is the City's lead coordinating agency for NFIP, and is responsible for updating the floodplain management ordinances for the City. PCPC reviews project permits, including those in a flood plain, 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,

---

[351] Region III Fact Sheet. FEMA. February 01, 2016. Retrieved February 8, 2016.

[352] Community Information System. FEMA. Retrieved 14 August 2015.

including a basement.[353] A full list of floodplain regulations and ordinances can be found in the Philadelphia Floodplain Ordinance Annex.

Flood maps for the City of Philadelphia were last updated in early 2014, with the map updates taking effect on November 18, 2015. During the 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 around 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 support is provided through the Flood Risk Management Task Force, comprised of several city agencies in the city, including PCPC, PWD, and OEM.

5.3.5.1 Community Rating System

During the writing of the 2017 Hazard Mitigation Plan, the City of Philadelphia began the process for participation in the Community Rating System (CRS) program. In compliance with FEMA’s requirement of a Community Assistance Visit (CAV), both a five year obligatory action as well as a prerequisite for participating in the Community Rating System, Philadelphia underwent a CAV in early 2016. A Community Assistance Visit (CAV) reviews and assesses an area’s floodplain management program, including permitting and enforcement processes, mitigation actions, and floodplain management ordinances.[354]

---

[353] Permit Guide. City of Philadelphia. Retrieved November 23, 2015.

[354] National Flood Insurance Program (NFIP): Guidance for Conducting Community Assistance Contacts and Community Assistance Visits. April 2011. Retrieved December 15, 2015.

6 Mitigation Strategy

The Mitigation Strategy describes how Philadelphia will reduce or eliminate potential losses from natural hazards identified in Section 4: Risk Assessment. The strategy focuses on existing and potential mitigation actions aimed to mitigate the effects of a natural hazard event on Philadelphia's population, economy, and infrastructure.

6.1 Mitigation Planning Strategy

The FEMA publication: *Developing the Mitigation Plan: Identifying Mitigation Actions and Implementing Strategies* provided the general mitigation planning approach used to develop this plan.[355] The document includes four steps used to support mitigation planning for this HMP.

- **Step 1: Develop mitigation goals and objectives**. Mitigation goals and objectives were developed using the hazard profiles, vulnerability assessments, and risk assessment.

- **Step 2: Identify and prioritize mitigation actions**. The risk assessment, the mitigation goals and objectives, existing policies, and input from the planning committee all helped identify mitigation actions. The potential mitigation actions were qualitatively evaluated using the PASTEEL method. Actions were then prioritized into three categories: highest priority, high priority, and moderate priority.

- **Step 3: Prepare an implementation strategy**. Highest and high priority actions are recommended for first consideration for implementation. However, based on community-specific needs, cost estimation, and available funding, some moderate priority mitigation actions may also be addressed before some of the highest or high priority actions.

- **Step 4: Document the mitigation planning process**. The mitigation planning process is documented throughout this plan.

---

[355] Federal Emergency Management Agency (FEMA). Developing the Mitigation Plan: Identifying Mitigation Actions and Implementing Strategies (FEMA 386-3). Retrieved 9 February 2012.

6.1.1 ***FEMA Requirements Addressed in this Section***

The Hazard Mitigation Planning Committee developed the mitigation strategy consistent with the process and steps presented in FEMA's How-To-Guide: *Developing the Mitigation Plan.* This section satisfies the following requirements:

- **Requirement 201.6(c) (3) (i):** [The hazard mitigation strategy ***shall*** include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.
- **Requirement 201.6(c)(3)(ii):** [The mitigation strategy ***shall*** include] a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program (NFIP), and continued compliance with NFIP requirements, as appropriate.
- **Requirement: 201.6(c) (3) (iii):** [The mitigation strategy section ***shall*** include] an action plan describing how the actions identified in section (c) (3) (ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization ***shall*** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

6.2 Mitigation Goals and Objectives

The first step in developing a hazard mitigation strategy is to establish goals and objectives that aim to reduce or eliminate Philadelphia's long term vulnerability to natural hazards. Mitigation goals are general guidelines explaining what Philadelphia wants to achieve in terms of hazard prevention. Objectives are specific, measurable strategies or implementation steps used to achieve the identified goals.

The goals and objectives identified in the table below provide the necessary framework to develop a mitigation strategy. Philadelphia will re-evaluate its hazard mitigation goals and objectives each plan maintenance cycle to ensure they continue to represent Philadelphia's hazard mitigation priorities.

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 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 which could impact mitigation and recovery efforts.
Objective 5.5	Identify and fill equipment and staging location gaps which 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.

6.3 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 (LPR)**: These actions include government authorities, policies or codes that influence the way land and buildings are developed and built.
2. **Structure and Infrastructure Projects (SIP)**: 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 (NRP)**: These actions aim to minimize damage and losses, preserve, or restore the functions of natural systems.
4. **Education and Awareness Programs (EAP)**: These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them.

In addition to these four categories, planners included two additional categories to address mitigating casualties and property losses.

5. **Human-Caused Hazard Casualty Reduction (HCHCR)**: These actions aim to reduce injuries and loss of life resulting from human caused hazards by increasing local protection and detection capabilities.

6. **Preparedness**: Actions that typically are not considered mitigation techniques but reduce the impacts of a hazard event on people and property. These actions are often taken prior to, during, or in response to an emergency or disaster.

The following table summarizes Philadelphia’s mitigation actions by hazard, mitigation action category, and goal/objective addressed.

Summary of Mitigation Actions			
Mitigation Actions by Hazard			
Category	**Existing**	**Potential**	**Total**
Active Shooter	19	11	30
Drought	8	13	21
Earthquake	0	1	1
Extreme Cold	2	1	3
Extreme heat	4	5	9
Flood	27	41	68
Hazardous materials train derailment	9	11	20
Improvised explosive device	0	8	8
Infrastructure failure	3	6	9
Hurricane, Tropical Storm	11	16	27
Urban conflagration	0	2	2
Windstorm, Tornado	2	0	2
Winter Storm	4	19	23
Multi-Hazard	64	88	152
Mitigation Actions by Category*			
Category	**Existing**	**Potential**	**Total**
Local planning and regulations	24	63	87
Property protection	4	8	12
Education and awareness programs	14	17	31
Natural systems protection	18	9	27
Structure and infrastructure projects	25	63	88
Human Caused Casualty Reduction	2	14	16
Mitigation Actions by Goal/Objective Addressed*			
Category	**Existing**	**Potential**	**Total**
Goal 1: Sustain and enhance public safety, health, and security capabilities.			
1.1	4	1	5
1.2	19	14	33
1.3	14	17	31
1.4	6	1	7
1.5	18	5	23
1.6	6	7	13
Goal 2: Protect property.			
2.1	8	34	42
2.2	4	16	20
2.3	0	5	5
2.4	5	16	21
2.5	1	12	13

2.6	2	2	4
Goal 3: Protect the natural environment.			
3.1	4	4	8
3.2	1	0	1
3.3	9	2	11
3.4	0	3	3
3.5	3	4	7
3.6	12	0	12
Goal 4: Promote a sustainable economy.			
4.1	4	10	14
4.2	4	5	9
4.3	4	6	10
4.4	4	5	9
Goal 5: Sustain and strengthen all hazards preparedness.			
5.1	5	18	23
5.2	17	16	33
5.3	3	11	14
5.4	0	28	28
Goal 6: Protect historical and cultural assets.			
6.1	3	1	4
Goal 7: Sustain and enhance communications and network security capabilities.			
7.1	5	2	7
7.2	1	1	2
Goal 8: Protect critical infrastructure.			
8.1	21	28	49
8.2	3	8	11
8.3	5	10	15
8.4	2	12	14
8.5	0	1	1

*Many mitigation actions address more than one goal and/or objective or category

6.4 Mitigation Action Plan

This section presents mitigation actions for Philadelphia to reduce potential exposure and losses identified as concerns in Section 4: Risk Assessment in this hazard mitigation plan. The planning committee reviewed the Risk Assessment to identify and develop these mitigation actions.

6.4.1 Existing Mitigation Actions

Existing mitigation actions are Philadelphia's programs, plans, projects, and policies currently underway that mitigate natural hazards. By assessing what Philadelphia is currently doing to mitigate natural hazards, the planning committee was able to determine how Philadelphia might expand or improve upon these programs. The *Existing Mitigation Actions* table lists the existing mitigation acts identified by the planning committee. Actions included in both the 2012 and 2017 plan contain an updated status if there are any changes in the action's progress or challenges.

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
1	Multi-Hazard	Pre-identify emergency sheltering locations for different types of disaster.	OEM	Ongoing		Staff Time	Grants	HSGP	Local planning and regulations	1.2, 4.2, 5.2	OEM conducts training and exercises on an ongoing basis
2	Multi-Hazard	Develop a list prioritizing City buildings that require redundant power sources.	OEM	Ongoing	Currently ongoing as funding becomes available	Staff Time	Grants	HSGP	Local planning and regulations	2.1, 2.4, 8.3	OEM is assessing City facility power needs through June 2016.
3	Multi-Hazard	Continue EOC training and exercises.	OEM	Ongoing		Staff Time	Grants	HSGP	Preparedness	1.3	OEM continues to conduct trainings on an ongoing basis for staff and stakeholders.
4	Multi-Hazard	Conduct outreach and coordinate personnel to keep the Philadelphia homeless population safe during extreme cold and extreme heat events.	OSH	Ongoing		Staff Time	Agency Operating Budget		Education and awareness programs	1.2	Ongoing, now conducted under DBH and Project Home
5	Flood	Maintain enrollment in NFIP by implementing floodplain management initiatives, reducing the City's flood risk, and allowing residents to receive discounted flood insurance	PCPC	Ongoing		Staff Time	Agency Operating Budget		Local planning and regulations	2.2	Currently going through the Community Rating System that will possibly increase the discount of flood insurance. Working with FEMA to provide training for inspectors and City Staff.

No.	**Hazard**	**Mitigation Action and Description**	**Lead Agency/ Agencies**	**Completion Status**	**Ongoing/ Updating Cycle**	**Estimated Project Cost**	**Possible Funding Source(s)**	**Specific Grant Funding Sources**	**FEMA Category**	**Goals and Objectives**	**Update Since 2012**
6	Flood	Revise current floodplain ordinances to comply with the latest national standards	PCPC	Ongoing		Staff Time	Agency Operating Budget		Local planning and regulations	2.2	Updated in 2012 and then reviewed by FEMA in 2015 to be found in compliance.
7	Flood	Require new facilities located in flood zones to be raised above the base flood elevation by 18 inches	PCPC	Ongoing		Staff Time	Agency Operating Budget		Property Protection	2.2	Regulations were amended from 12" to 18" and now in zoning code.
8	Flood	Develop and distribute fliers for mold abatement.	PDPH	Complete		Staff Time	Agency Operating Budget		Education and awareness programs	5.1, 5.2	Completed.
9	Flood	Prepare equipment and resources necessary to respond to flooding.	STREETS	Pre-event		Staff Time	Agency Operating Budget		Preparedness	1.2, 2.1	Ongoing
10	Winter Storm	Increase training of staff involved in Winter Operations.	STREETS	5 years		Staff Time	Agency Operating Budget		Preparedness	1.3	Ongoing
11	Multi-Hazard	Maintain mutual aid agreements with New Jersey Emergency Management Agency and the Southeastern Pennsylvania Regional Task Force	OEM	Complete		Staff time	Grants	HSGP	Local planning and regulations	1.4, 1.5, 1.5, 1.5	
12	Multi-Hazard	Maintain and update Mass Fatality Plan	OEM	Complete		Staff time	Grants	HSGP	Local planning and regulations	1.4	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
13	Multi-Hazard	Maintain and update Mass Casualty Plan	OEM	Complete		Staff time	Grants	HSGP	Local planning and regulations	1.4	
14	Multi-Hazard	Maintain roam secure alert network as a government notification system	OEM	Complete		Staff time	Grants	HSGP	Preparedness	5.3	
15	Hazardous Materials Train Derailment	Maintain and update the Hazardous Materials Response Plan.	OEM, PFD	Complete		Staff time	Grants	HSGP	Local planning and regulations	1.4, 2.1, 3.2, 4.1	
16	Hazardous Materials Train Derailment	Maintain Hazmat Rail Annex	OEM, PFD	Complete		Staff time	Grants	HSGP	Local planning and regulations	6.1, 1.3, 1.6,	
17	Active Shooter, IED	Maintain suspicious activity reporting protocol	DVIC, PPD	Complete		Staff time	Grants	HSGP	Local planning and regulations	6.1, 1.3, 1.6,	
18	Active Shooter, IED	Maintain city facility security criteria	OEM, RISK, DPP	Ongoing		Staff time	Grants	HSGP	Local planning and regulations	8.4	
19	Multi-Hazard	Maintain and update asset classification and assessment program.	OEM	Ongoing		Staff time	Grants	HSGP	Local planning and regulations	1.7	
20	Active Shooter, IED	Maintain trauma kits supplies.	OEM	Ongoing		Staff time	Grants	HSGP	Preparedness	1.7	
21	Active Shooter, IED	Maintain tactical tourniquet supplies and distribution.	PPD	Complete		Staff time	Grants	HSGP	Preparedness	1.7	
22	Active Shooter	Offer RAMS training for PFD-EMS	PPD, PFD-EMS	Ongoing		Staff time	Grants	HSGP	Preparedness	1.3	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
23	Active Shooter	Mac-Tac training program for patrol officers	PPD	Ongoing		Staff time	Grants	HSGP	Preparedness	1.5	
24	Active Shooter	Purchase Glock-T17 force on force pistols	PPD	Complete		Staff time	Grants	HSGP	Preparedness	1.5	
25	Infrastructure Failure	Conduct bridge inspections.	STREETS-HIGHWAY, PENNDOT	Ongoing		Staff time	Agency Operating Budget		Structure and infrastructure projects	1.6	
26	Infrastructure Failure	Train bridge inspectors	STREETS-HIGHWAY, PENNDOT	Ongoing		Staff time	Agency Operating Budget		Structure and infrastructure projects	1.3	
27	Extreme Heat	Include information on projected changes in climate and increases in high heat days in health bulletins and outreach materials.	PDPH	Ongoing		Staff time			Education and awareness programs	5.3, 5.2	
28	Extreme Heat	Monitor new tree watering contracts to ensure the trees have sufficient time to take root and establish themselves under warmer temperatures.	PPR	Ongoing		Staff time	Capital budget		Natural systems protection	3.1, 3.5	
29	Multi-Hazard	Utilize City Works Trees to track real-time response and management of downed trees and vegetation prior to, during, and following events.	PPR	Ongoing		Staff time	Capital budget		Natural systems protection	2.5	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
30	Multi-Hazard	Host mass casualty/ decontamination workshop	OEM, PFD	Complete		Staff time	Grants	HSGP	Preparedness	1.3	
31	Multi-Hazard	Host mass casualty/ table top exercise	OEM, PFD	Complete		Staff time	Grants	HSGP	Preparedness	1.3	
32	Multi-Hazard	Host mass casualty/ decontamination functional exercise	OEM, PFD	Complete		Staff time	Grants	HSGP	Preparedness	1.3	
33	Multi-Hazard	Formalize pre-event calls between OEM and other departments to coordinate response and support during extreme weather events	OEM	Completed		Staff time	Grants	HSGP	Local planning and regulations	5.2, 7.1, 7.2	
34	Multi-Hazard	Regularly mapping locations of vulnerable populations and using the information to target the location of community outreach to at-risk neighborhoods	OEM	Ongoing	Annually or as new data becomes available	Staff time	Grants	HSGP	Local planning and regulations	1.1, 5.1, 5.2	
35	Multi-Hazard	Partner with Community Groups such as local community organizations, including civic, business, town watch, faith-based, senior, special needs and tenant	OEM	Ongoing		$5,000	Grants	HSGP	Education and awareness programs	1.2, 4.3, 4.4, 5.2	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
		associations to promote emergency preparedness and mitigation efforts.									
36	Multi-Hazard	Provide public outreach throughout Philadelphia with READYhome and READYbusiness by presenting and tabling at community and private sector events.	OEM	Ongoing	Outreach ongoing, with an average of 5 face to face outreach activities happening a month	$5,000	Grants	HSGP	Education and awareness programs	1.2, 4.3, 4.4, 5.2	READYHome, READYCommunity, and READYBusiness replaced the existing personal preparedness programs in 2016.
37	Extreme Heat, Extreme Cold	Target community outreach to at-risk individuals.	PDPH	Ongoing	Annually	$5,000	Grants		Education and awareness programs	1.2	Climate Change and Health adaptation strategy in progress.
38	Multi-Hazard	Execute weekly equipment testing & exercises.	OEM	Ongoing	Equipment maintenance completed as needed	$5,000	Grants	HSGP	Preparedness	2.1	Ongoing
39	Multi-Hazard	Develop and issue community-based bulletins, describing health risk and actions to minimize morbidity and mortality. Bulletins translated into 17 languages.	PDPH	Ongoing	Per seasonal issue	$5,000	Grants	HHS	Education and awareness programs	5.2, 5.3	Limited implementation due to competing priorities and lack of funding.
40	Extreme Heat, Extreme Cold	Develop health bulletins for seasonally appropriate risks.	PDPH	Complete	Per seasonal issue	$5,000	Grants	HHS	Education and awareness programs	5.2	Completed.

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
41	Multi-Hazard	Increasing Health Alert Network Recipients.	PDPH	Ongoing	Annually	$5,000	Grants	HHS	Education and awareness programs	5.2, 1.5	Ongoing
42	Multi-Hazard	Provide redundant power in emergency operations (Portable 8K generator).	OEM	Ongoing	Update Equipment Inventory (5 years)	$8,000	Grants	HSGP	Structure and infrastructure projects	8.3	Purchases are ongoing as equipment updates are needed.
43	Multi-Hazard	Maintain mobile command vehicle.	OEM	Ongoing	Update Equipment Inventory (3 years)	$15,000	Grants	HSGP	Preparedness	8.3	Ongoing
44	Tropical Cyclone	Prioritize Emergency Shelters locations by applicable factor (e.g. projected demand).	OEM	Completed		$15,000	Grants	HSGP	Local planning and regulations	1.2, 4.2, 5.2	Completed.
45	Multi-Hazard	Purchase satellite communication (Secondary Communications).	OEM	Completed	Update as necessary	$20,000	Grants	HSGP	Preparedness	1.1	OEM completed the purchase of secondary communications since 2012 and updates the equipment cache as needed to maintain functionality.
46	Multi-Hazard	Enhance the capability and reach of the reverse 9-1-1 telephone notification system.	STREETS	Completed		$25,000	Grants		Education and awareness programs	1.5	Completed in 2014 with the purchase of Everbridge
47	Multi-Hazard	Conduct community outreach for General Professional Preparedness.	PDPH	Ongoing	Annually	$25,000	Grants	HHS	Education and awareness programs	5.2	Competing priorities and lack of funding delayed implementation.

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
48	Multi-Hazard	Distribute and educate public on Ready Philadelphia guides for general preparedness and business continuity information.	OEM	Ongoing		$40,000	Grants	HSGP	Education and awareness programs	1.2, 4.3, 4.4, 5.2	Ongoing
49	Multi-Hazard	Pilot study the growth of Southern plant species with sustainable planting practices in preparation for increasing temperatures over the next century.	PPR	Ongoing		$ 50,000.00	Capital budget		Natural systems protection	3.1, 3.5	
50	Multi-Hazard	Inspect trees within 100 ft. of walkways and roadways for signs of the emerald ash borer and treat affected trees every three years.	PPR	Ongoing		$80,000	Capital budget, Grants	National Park Service grants, DCNR grants	Natural systems protection	3.1, 3.5	
51	Multi-Hazard	Purchase event/site specific remote video cameras for better situational awareness.	OEM	Completed		$100,000	Grants	HSGP	Preparedness	1.5, 4.2	Completed.
52	Multi-Hazard	Strengthen the traffic signals beyond the national standards in reference to wind tolerance.	STREETS	10 years		$100,000	Grants		Preparedness	1.2	As intersections are upgraded, wind tolerant traffic signals are used. It is anticipated for completion in the next 20 years.

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
53	Multi-Hazard	Development of COOP Planning for PDPH internally to keep Health Dept. running after disaster to prevent secondary infections/illness.	PDPH	Ongoing	Annually	$100,000	Grants	HHS	Local planning and regulations	2.4, 4.1	COOP plan in place, sustainment of operations during severe pandemic limited.
54	Winter Storm	Upgrade Snow HQ technology including and use of the City's police/traffic camera system.	STREETS	Completed		$200,000	Grants		Preparedness	1.5	Completed in 2015.
55	Multi-Hazard	Maintain portable EOC in a Box.	OEM	Ongoing	Update inventory every 3 years	$250,000	Grants	HSGP	Preparedness	1.1	OEM maintains equipment and updates stock as needed.
56	Multi-Hazard	Increase subscription to the Everbridge ReadyPhiladelphia system	OEM	Ongoing		$250,000	Grants	HSGP	Education and awareness programs	1.2, 4.3, 4.4, 5.2	ReadyPhiladelphia replaced the ReadyNotifyPA system in 2015.
57	Windstorm, Tornado	Install traffic signal devices which adhere to national standards for wind tolerance.	STREETS	Ongoing		$250,000	Agency Operating Budget		Structure and infrastructure projects	2.1	Ongoing. As intersections are upgraded, wind tolerant traffic signals are used. It is anticipated for completion in the next 20 years.
58	Drought, Flood, Dam Failure	Perform structural repairs to Valley Green Road and Spring Lane to improve safety of	PWD	Ongoing		$400,000	Capital Budget		Prevention, Structure and infrastructure projects, & Natural	3.6, 3.3, 8.1	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
		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.							systems protection		
59	Hurricane/ Tropical Storm, Floods	Complete stream and creek restoration projects to aid in eliminating historic flooding hazards along Valley Green Road and Spring Lane.	PWD	Ongoing		$400,000	PWD Operations/ Capital Budget/ Grant Funding		Natural systems protection	3.6, 3.3, 8.1	
60	Flood	Redesign roadways and bridges to lesson occurrence/impact of flooding.	STREETS	10 years		$500,000	Grants		Property Protection	1.2, 2.4, 2.6	Upkeep of roadways is ongoing, with bridge inspections occurring for scour and structural deficiencies.
61	Multi-Hazard	Upgrade City Emergency Operations Center.	OEM	Completed		$1,000,000	Grants	HSGP	Preparedness	1.5, 1.2, 4.1	Completed in 2012
62	Multi-Hazard	Utilize ReadyNotifyPA, an advanced warning system which provides emergency text and email alerts.	OEM	Ongoing	System used as needed	$1,000,000	Grants	HSGP	Education and awareness programs	1.1, 1.5, 1.2, 5.2	ReadyPhiladelphia replaced the ReadyNotifyPA system in 2015.

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
63	Multi-Hazard	Purchase a communications system capable of notifying and communicate critical emergency information and actions to be taken by airport employees and the surrounding communities to reduce the impacts prior to, during, or in response to an emergency or disaster.	PHL	Completed		$1,000,000	Grants, Capital Program and/or Operating Budget		Preparedness	1.5	Completed in July 2014 through the purchase of Everbridge under the Operating Budget
64	Drought, Flood, Dam Failure	Perform Cobbs Creek Stream Rehabilitation Reaches 1 to 3 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	Ongoing		$1,000,000	Capital Budget		Prevention, Structure and infrastructure projects, & Natural systems protection	3.6, 3.3, 8.1	
65	Hurricane/ Tropical	Complete stream and creek restoration projects	PWD	Ongoing		$1,000,000	PWD Operations/ Capital		Natural systems protection	3.6, 3.3, 8.1	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
	Storm, Floods	to aid in eliminating historic flooding hazards along Cobbs Creek Reaches 1 to 3.					Budget/ Grant Funding				
66	Multi-Hazard	Maintain portable generators for key traffic intersections.	STREETS	Ongoing		$1,000,000	Agency Operating Budget		Property Protection	2.1	Ongoing, some higher volume traffic intersections have back-up batteries installed
67	Winter Storm	Upgrade equipment and vehicles used in storm operations.	STREETS	10 years		$2,000,000	Grants		Preparedness	1.2, 2.4	Ongoing
68	Drought, Flood, Dam Failure	Perform Cobbs Creek Stream Channel Rehabilitation Reaches 6 to 8 in Phase 2 of the project 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	Ongoing		$2,300,000	Capital Budget		Prevention, Structure and infrastructure projects, & Natural systems protection	3.6, 3.3, 8.1	
69	Hurricane/ Tropical Storm, Floods	Complete stream and creek restoration projects to aid in eliminating	PWD	Ongoing		$2,300,000	PWD Operations/ Capital Budget/		Natural systems protection	3.6, 3.3, 8.1	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
		historic flooding hazards Cobbs Creek Stream Channel Reaches 6 to 8 in Phase 2.					Grant Funding				
70	Multi-Hazard	Enhance fatality management by obtaining body bag stockpile, morgue and forensic expansion and collection.	PDPH	Ongoing		$ 5,000,000.00	Grants	HHS	Preparedness	5.5	Limited implementation due to competing priorities and lack of funding.
71	Multi-Hazard	Hire more doctors and nurses for health centers and outreach.	PDPH	Ongoing		$ 5,000,000.00	Grants	HHS	Preparedness	5.2, 1.2	Limited implementation due to competing priorities and lack of funding.
72	Winter Storm	Upgrade equipment and vehicles for Brine usage in storm operations.	STREETS	10 years		$6,000,000	Grants		Preparedness	1.2, 2.4	Ongoing
73	Hurricane/ Tropical Storm, Floods	Phase V of Northern Liberties infrastructure projects, which affects Northern Liberties and surrounding neighborhoods water infrastructure capabilities.	PWD	Ongoing		$8,200,000	PWD Operations/ Capital Budget/ Grant Funding		Structure and infrastructure projects	5.6, 8.1	
74	Hurricane/ Tropical Storm, Floods	Phase VI of Northern Liberties infrastructure projects, which	PWD	Ongoing		$10,500,000	PWD Operations/ Capital Budget/		Structure and infrastructure projects	5.6, 8.1	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
		affects Northern Liberties and surrounding neighborhoods water infrastructure capabilities.					Grant Funding				
75	Drought, Flood, Dam Failure	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	Ongoing		$11,500,000	Capital Budget		Prevention, Structure and infrastructure projects, & Natural systems protection	3.6, 3.3, 8.1	
76	Hurricane/ Tropical Storm, Floods	Complete stream and creek restoration projects to aid in eliminating historic flooding hazards along Tacony Creek.	PWD	Ongoing		$11,500,000	PWD Operations/ Capital Budget/ Grant Funding		Natural systems protection	3.6, 8.1	
77	Multi-Hazard	Expand community immunizations capacity.	PDPH	Ongoing		$ 20,000,000.00	Grants	HHS	Human Caused Casualty Reduction	1.2,	Limited implementation due to competing priorities and lack of funding.

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
78	Multi-Hazard	Expand scope of practice and facility capacity for City Health Centers.	PDPH	Ongoing		$100,000,000	Grants	HHS	Preparedness	5.2, 1.2	Limited implementation due to competing priorities and lack of funding.
79	Multi-Hazard	Expand lab capacity to rapidly identify and subtype organisms.	PDPH	Ongoing		$10 million	Grants	HHS	Human Caused Casualty Reduction	5.1	Ongoing, but limited implementation due to funding restrictions.
80	Windstorm, Tornado	Ensure adequate material and equipment is available to repair and replace street lights and traffic poles & signs.	STREETS	Ongoing		$10,000-$100,0000	Agency Operating Budget, Grants		Property Protection	1.2	Ongoing
81	Drought, Flood, Dam Failure	Perform structural repairs to dams and/ or removal of fishway structure at Fairmont 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	Ongoing		$100,000 - $250,000	Capital Budget		Prevention, Structure and infrastructure projects, & Natural systems protection	3.6, 8.1	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
82	Hurricane/ Tropical Storm, Floods	Complete smaller sewer and green infrastructure projects whose impact is localized to discreet areas. Over one hundred are currently in design stages.	PWD	Ongoing		$100,000-$4,000,000 per project	PWD Operations/ Capital Budget/ Grant Funding		Structure and infrastructure projects	5.6, 8.1	
83	Hurricane/ Tropical Storm, Floods	Ongoing identification of larger infrastructure projects whose impact effects large areas of the city through PWD studies.	PWD	Ongoing		$100,000-$40,000,000 per project	PWD Operations/ Capital Budget/ Grant Funding		Structure and infrastructure projects	5.6, 8.1	
84	Drought, Flood, Dam Failure	Perform structural repairs to dams and/ or removal of Flat Rock 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	Ongoing		$12,000,000 - $20,000,000	Capital Budget		Prevention, Structure and infrastructure projects, & Natural systems protection	3.6, 8.1	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
85	Drought, Flood, Dam Failure	Perform structural repairs to dams and/ or removal of Mount 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	Ongoing		$3,000,000 - $5,000,000	Capital Budget		Prevention, Structure and infrastructure projects, & Natural systems protection	3.6, 8.1	
86	Hurricane/ Tropical Storm, Floods	Identify additional stream and creek restoration projects to aid in eliminating historic flooding hazards through area studies.	PWD	Ongoing		$400,000- $12,000,000 per project	PWD Operations/ Capital Budget/ Grant Funding		Natural systems protection	1.6, 3.1, 3.3, 5.1	
87	Multi-Hazard	Purchase redundant alert notification system for extreme weather to notify City owned facilities (NOAA Radio).	OEM	Completed		$5,000 (each radio)	Grants	HSGP	Preparedness	8.3	Completed since 2012
88	Drought, Flood, Dam Failure	Perform structural repairs to dams and/ or removal of Fairmont Dam to improve safety of structure or surrounding areas,	PWD	Ongoing		$6,000,000 - $10,000,000	Capital Budget		Prevention, Structure and infrastructure projects, & Natural systems protection	3.6, 8.1	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
		eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.									
89	Hurricane/ Tropical Storm, Floods	Moore St. drainage from Christopher Columbus to River infrastructure project to improve capabilities in the area.	PWD	Ongoing		$7,000,000 - $10,000,000	PWD Operations/ Capital Budget/ Grant Funding		Structure and infrastructure projects	5.6, 8.1	
90	Multi-Hazard	Implement Ready Region, a program aimed at educating the public on preparedness.	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	Ready Region programs ceased.
91	Multi-Hazard	Continue Emergency Rest Center Train the Trainer which includes Ready Philadelphia curriculum which promotes mitigation strategies for individuals and families.	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	Action components are consolidated into READYHome, READYBusiness, and READYCommunity programs.
92	Multi-Hazard	Distribute Emergency Rest Center supply kits containing	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	Supply kits distributed by American Red Cross.

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
		emergency supplies in the event of evacuation.									
93	Multi-Hazard	Mitigation Training Coordination: Regional Volunteer Management Coordinators may share resources and mitigation training opportunities.	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	Program components are consolidated into READYHome, READYBusiness, and READYCommunity programs.
94	Multi-Hazard	Pre-identify and target potential ERCs which are located along Philadelphia evacuation routes, and offer preparedness and mitigation training, and discuss business continuity.	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	Program components are consolidated into READYHome, READYBusiness, and READYCommunity programs.
95	Flood	Incorporate Flood Safety Training into Community Emergency Response Team Curriculum: Adapt CERT curriculum to educate team members on strategies that will mitigate the impact of flooding on the community.	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	CERT program ceased. READYCommunity encompasses training opportunities based off local hazards.

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
96	Multi-Hazard	Incorporate Flood Safety Training into Community Emergency Response Team Curriculum: Adapt CERT curriculum to educate team members on strategies that will mitigate the impact of flooding on the community.	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	CERT program ceased. READYCommunity encompasses training opportunities based off local hazards.
97	Multi-Hazard	Conduct mitigation training for all Regional Volunteer Management Coordinators so they may share resources and mitigation training opportunities.	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	Regional Volunteer Management Coordinator Program no longer in place.
98	Multi-Hazard	Partner with the CERT program once it is online in Philadelphia and continue to partner with other local community organizations, including civic, business, town watch, faith-based, senior, special needs and tenant	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	CERT program ceased. READYCommunity coordinates with local community organizations to promote emergency preparedness and mitigation strategies.

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
		associations to promote emergency preparedness and mitigation strategies.									
99	Multi-Hazard	Incorporate Business Continuity into ERC train the trainer: Provide training and a strategy for ERC's to assure continuity of services.	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	Program ceased. READYBusiness encompasses training and education for business continuity planning.
100	Multi-Hazard	Partner the CERT program, ERC Program, and VOAD partner agencies with local community organizations including civic, faith-based, and tenant associations, to promote mitigation strategies.	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	CERT program ceased. Meet quarterly with VOAD partners to maintain preparedness, ensure situational awareness, identify resource capabilities, and build stakeholder relationships pre-disaster.
101	Multi-Hazard	Pilot Corporate CERT: CERT teams based in businesses with supplemental training focused on business continuity and workplace mitigation strategies such as protecting utility services, redundant	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	CERT program ceased.

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
		communication, and continuity of business services.									
102	Multi-Hazard	CERT Community Mapping: Community teams may pre-identify critical infrastructure and offer mitigation strategies including business continuity and Ready Philadelphia information.	OEM	Action Removed		Action Removed	Grants	HSGP	Action Removed	Action Removed	CERT program ceased.
103	Flood	Upgrade drainage capacity on Streets Department maintained drains.	STREETS	Action Removed		Action Removed	Action Removed		Action Removed	Action Removed	Drainage upgrades have been found to be less helpful than anticipated in 2012. Different storm water management solutions are being explored instead.
104	Multi-Hazard	Regional MOU’s	Multiple Agencies	Ongoing		N/A	Grants		Local planning and regulations	8.3, 4.2	
105	Hurricane/ Tropical Storm, Floods	Eastwick drainage and flooding prevention infrastructure design.	PWD	Ongoing		TBD	PWD Operations/ Capital Budget/ Grant Funding		Structure and infrastructure projects	2.6, 5.6, 8.1	
106	Active Shooter	Offer active shooter training program for patrol officer	PPD	Ongoing			Grants	HSGP	Preparedness	1.3	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
107	Active Shooter	Purchase force on force face protectors	PPD	Complete			Grants	HSGP	Preparedness	1.5	
108	Active Shooter	Purchase force on force throat protectors	PPD	Complete			Grants	HSGP	Preparedness	1.5	
109	Active Shooter	Purchase force on force converting bolts for AR-15	PPD	Complete			Grants	HSGP	Preparedness	1.5	
110	Active Shooter	Purchase 9mm force on force marking rounds	PPD	Complete			Grants	HSGP	Preparedness	1.5	
111	Hazardous Materials Train Derailment	Conduct hydraulic modeling.	PWD	Ongoing			PWD General Fund		Natural systems protection	5.1,	
112	Hazardous Materials Train Derailment	Implement and install an intake contamination detection system.	PWD	Ongoing			PWD General Fund		Structure and infrastructure projects	3.3	
113	Hazardous Materials Train Derailment	Maintain and utilize early warning system	PWD	Ongoing			EPA grant, industry user funding, PWD general fund		Preparedness	7.1	
114	Infrastructure Failure	Maintain safe roadways and bridges through roadway milling and paving capital projects.	STREETS-HIGHWAY	Ongoing			Special gas tax		Structure and infrastructure projects	8.1	
115	Multi-Hazard	Maintain and update electricity disruption plan	OEM	Ongoing			Grants	HSGP	Local planning and regulations	2.1	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
116	Hazardous Materials Train Derailment	Maintain Tier II Reporting and GIS program	OEM, PFD	Ongoing			Grants	HSGP	Local planning and regulations	1.6	
117	Active Shooter	PPD Public Areas - Bullet Proof Glazing.	DPP, PPD	Complete			General fund, Police fund, Capital Improvement Fund		Structure and infrastructure projects	8.1	
118	Active Shooter	PPD Public Areas - Wall reinforcement.	DPP, PPD	Complete			General fund, Police fund, Capital Improvement Fund		Structure and infrastructure projects	8.1	
119	Active Shooter	Install secured area keypad mag locks.	DPP, PPD	Ongoing			General fund, Police fund, Capital Improvement Fund		Structure and infrastructure projects	8.2	
120	Multi-Hazard	Maintain and update Human Services Recovery Plan.	OEM, PFD	Ongoing			Grants	HSGP	Local planning and regulations	2.1, 2.2, 4.1	
121	Multi-Hazard	Maintain and update Mass Care and Shelter Plan	OEM	Ongoing			Grants	HSGP	Local planning and regulations	1.4	
122	Active Shooter	Install CCTV cameras.	DPP, PPD	Ongoing			General fund, Police fund, Capital Improvement Fund		Structure and infrastructure projects	8.2	
123	Active Shooter	Install access control keycard system.	DPP, PPD	Ongoing			General fund, Police fund, Capital Improvement Fund		Structure and infrastructure projects	8.2	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
124	Hazardous Materials Train Derailment	Upkeep PFD Hazmat training and equipment	PFD	Ongoing			General fund		Preparedness	1.3	
125	Hazardous Materials Train Derailment	Upkeep PFD HMAU training and equipment	PFD	Ongoing			General fund		Preparedness	1.3	
126	Multi-Hazard	Establish and maintain SECOM Network	OEM	Ongoing			Grants	HSGP	Preparedness	7.1	
127	Multi-Hazard	Establish and maintain an Emergency Operations Plan	OEM	Ongoing			Grants	HSGP	Local planning and regulations	6.1, 7.1, ,	
128	Multi-Hazard	Establish and maintain an Emergency Operations Center Procedures	OEM	Ongoing			Grants	HSGP	Local planning and regulations	7.1	
129	Hazardous Materials Train Derailment	Upkeep the CSX Secure Now system	OEM	Ongoing			Grants	HSGP	Local planning and regulations	1.4, 8.4, 1.6,	
130	Multi-Hazard	Upkeep PFD Special Operations Command training and equipment	PFD	Ongoing			General fund		Preparedness	1.3	
131	Multi-Hazard	Establish, maintain, and train a Homeland Security Unit	PPD	Ongoing			General fund		Preparedness	1.3, 1.5	
132	Active Shooter	Establish, maintain, and train a	PPD	Ongoing			General fund		Preparedness	1.5	

No.	Hazard	Mitigation Action and Description	Lead Agency/ Agencies	Completion Status	Ongoing/ Updating Cycle	Estimated Project Cost	Possible Funding Source(s)	Specific Grant Funding Sources	FEMA Category	Goals and Objectives	Update Since 2012
		Philadelphia Police MIRT									
133	Active Shooter, IED	Establish, maintain, and train a Philadelphia Police SWAT	PPD	Ongoing			General fund		Preparedness	1.5	
134	IED	Establish, maintain, and train a Philadelphia Bomb Disposal Unit	PPD	Ongoing			General fund		Preparedness	1.5	

6.4.2 ***Potential Mitigation Actions***

Potential mitigation actions are programs, plans, projects or policies Philadelphia may implement to help reduce or eliminate the long-term risk to human life, property and the environment from natural hazards. The HMP's planning committee identified, analyzed and prioritized all potential actions. Prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns may ultimately prevent some identified mitigation actions from implementation. The *Potential Mitigation Actions* table details the potential mitigation acts identified by the Planning Committee.

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
1	Multi-Hazard	Operationalize IPAWS for city use	OEM, PEMA, FEMA	Staff time	Agency operating budget, Grants	HSGP	Local Planning and Regulations	5.3		
2	Multi-Hazard	Revise city-wide evacuation planning	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	5.1		
3	Multi-Hazard	Conduct logistics center planning	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	5.5		
4	Multi-Hazard	Revise Mass Care and shelter plan	OEM	Staff time	Grants	HSGP	Local Planning and Regulations			
5	Multi-Hazard	Develop surge staffing for expanded shelters	OEM	Staff time	Grants	HSGP	Local Planning and Regulations			
6	Multi-Hazard	Identify logistics staging sites	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	5.5		
7	Multi-Hazard	Pre-identify POD locations	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	5.5		
8	Multi-Hazard	Conduct logistics operations functional exercises	OEM	Staff time	Grants	HSGP	Preparedness	1.3		
9	Hazardous Material Train Derailment	Conduct preparedness workshops within crude rail transport corridors	OEM	Staff time	Grants	HSGP	Preparedness	5.1, 2.1, 5.3		
10	Active Shooter, IED	Expand SPOT training for all PPD personnel	PPD	Staff time	Grants	HSGP	Preparedness	1.3		
11	Active Shooter, IED	Train key staff and security on	PPD, OEM	Staff time	Grants	HSGP	Preparedness	1.3		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		recognizing suspicious vehicles								
12	IED, Hazardous Materials Train Derailment	Conduct outreach with CIKR assets to assess blast resistance and HVAC shutdown procedures	PPD, OEM	Staff time	Agency operating budget, Grants	HSGP	Education and Awareness Programs	5.1, 8.4, 2.1		
13	Multi-Hazard	Establish emergency contracts for 500kW/1mW generators	OEM	Staff time	Grants	HSGP	Structure and Infrastructure Programs	4.1, 2.4		
14	Multi-Hazard	Enhance THIRA process to identify resource gaps	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	5.1, 8.4		
15	Earthquake	Evaluate various seismic building design enhancements using HAZUS-MH to identify enhancements that reduce losses generated by earthquakes.	OEM	Staff Time	Grants	HSGP	Local Planning and Regulations	2.2, 2.4, 5.4	x	2012 HMP stated the timeframe as 2 years. Due to lack of funding and expertise, the assessment was delayed.
16	Flooding	Evaluate various building enhancements using HAZUS-MH to identify opportunities to reduce flooding.	OEM	Staff Time	Grants	HSGP	Local Planning and Regulations	2.2, 2.4, 5.4	x	2012 HMP stated the timeframe as 2 years. Due to lack of funding and expertise, the assessment was delayed.
17	Hurricane, Tropical Storm	Hazards U.S. Multi-Hazard (HAZUS-MH) Modeling:	OEM	Staff Time	Grants	HSGP	Local Planning and Regulations	2.2, 2.4	x	2012 HMP stated the timeframe as 2 years. Due to lack

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		Determine losses generated by tropical cyclones and engineering effectiveness and cost-benefit of various mitigation actions.								of funding and expertise, the assessment was delayed.
18	Multi-Hazard	Conduct or update natural hazard vulnerability assessments for critical facilities throughout the Philadelphia.	OEM	Staff Time	Grants	HSGP	Local Planning and Regulations	2.1	x	Ongoing annual action moving forward.
19	Multi-Hazard	Determine losses generated by various natural disasters and engineering effectiveness and cost-benefit of various mitigation measures using HAZUS-MH or other computer modeling software. Evaluate various building enhancements using prototypical Philadelphia building types.	OEM	Staff Time	Grants	PDM, HMGP, HSGP	Local Planning and Regulations	2.3, 5.1	x	Due to lack of funding, expertise, data, and staff time, the action was delayed since its inclusion in the 2012 HMP.
20	Multi-Hazard	COOP Site enhancement, including electrical systems	OEM	Staff time	Grants	HSGP, PDM, HMGP	Property Protection	2.1, 8.3, 2.2, 2.4, 4.1,		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		enhancement, systems synchronizing, and the installation of quick connects for generators.								
21	Multi-Hazard	Creation of a specific asset inventory across Philadelphia City agencies which catalogues resources.	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	4.2		
22	Multi-Hazard	Formalize the process of resource tracking, receiving, and distribution for large emergencies or events.	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	4.2		
23	Multi-Hazard	Create a mobile feeding and commodity distribution plan.	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	1.2		
24	Multi-Hazard	Formalize resource requesting plan for pre-event resource requests that may impact a widespread area to streamline resource distribution.	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	4.2		
25	Multi-Hazard	Train Health and Human Service staff and partners in continuity of	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	1.3, 4.3, 4.4, 5.2		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		operations plan and mitigation measures.								
26	Flooding	Conduct a flood risk analysis - compile/map all areas at PHL at greatest risk of flooding during 100-yr and 500-yr flood events	PHL	Staff time	Grants		Local Planning and Regulations	2.1		
27	Flooding	Update the Airport Flood Emergency Response Plan (AFERP) with Operations, Engineering, and Planning	PHL-DOA	Staff time	Agency operating budget		Local Planning and Regulations	2.1		
28	Multi-Hazard	Meet quarterly with VOAD partners to maintain preparedness, ensure situational awareness, identify resource capabilities, and build stakeholder relationships pre-disaster.	OEM	Staff time	Agency operating budget		Education and Awareness Programs	5.2, 5.3		
29	Multi-Hazard	Partner with community leaders and stakeholders for the development of materials for READYCommunity to increase community	OEM	Staff time	Agency operating budget		Education and Awareness Programs	5.2, 5.3		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		preparedness and mitigation.								
30	Multi-Hazard	Provide technical assistance to communities in the development of community emergency plans.	OEM	Staff time	Agency operating budget		Education and Awareness Programs,	5.2, 5.3		
31	Multi-Hazard	Maintaining relationships with universities and colleges within Philadelphia to support emergency planning, training, and exercises between the City and higher educational facilities.	OEM	Staff time	Agency operating budget		Education and Awareness Programs	5.2, 5.3		
32	Multi-Hazard	Update City of Philadelphia Building Codes.	PCPC, L&I	Staff time	Agency operating budget		Local Planning and Regulations	2.1, 2.4, 5.4		
33	Multi-Hazard	Update City of Philadelphia zoning maps.	L&I	Staff time	Agency operating budget		Local Planning and Regulations	5.1		Pending state involvement and support
34	Multi-Hazard	Include public facilities in capital planning.	PCPC, DPP	Staff time	Agency operating budget		Local Planning and Regulations	2.3		
35	Multi-Hazard	Create a brownfield reuse and mitigation plan and procedure.	Multiple agencies	Staff time	Agency operating budget		Local Planning and Regulations	3.1		
36	Multi-Hazard	Utilize district planning as a method to communicate about risks as	PCPC, OEM	Staff time	Agency operating budget		Property Protection, Local Planning and Regulations	5.2, 5.3		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		Philadelphia2035 moves forward.								
37	Multi-Hazard	Create zoning and development awareness programs to inform planning processes that may be impacted by hazardous material train derailments.	Multiple agencies	Staff time	Agency operating budget, Grants	HSGP	Property Protection, Local Planning and Regulations	2.1, 2.2, 2.3, 4.3, 5.1,		
38	Multi-Hazard	Coordinate with construction community for large scale emergency responses.	L&I, PCPC, OEM	Staff time	Agency operating budget, Grants	HSGP	Local Planning and Regulations	1.3		
39	Multi-Hazard	Establish public outreach programs in L&I.	L&I	Staff time	Agency operating budget		Education and Awareness Programs	5.2, 5.2		
40	Flooding	Update inundation mapping.	L&I, PCPC, OEM	Staff time	Agency operating budget, Grants	PDM, HSGP	Local Planning and Regulations	5.1		
41	Flooding	Creation of a tactical guide for flood pre-event actions and response activities	OEM/ Multiple Agencies	Staff time	Grants	HSGP	Local Planning and Regulations	2.3, 2.6		
42	Multi-Hazard	Develop educational and promotional video series to educate and increase public awareness of City hazards and response plans.	OEM	Staff time	Grants	HSGP	Education and Awareness Programs	5.2, 5.3, 5.2		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
43	Flood	Determine low-lying substation vulnerabilities and outline options for adaptation and mitigation; coordinate with DOE on their vulnerable infrastructure studies	OEM	Staff time	Grants	DOE, HSGP, USACE	Local Planning and Regulations	2.1, 2.4, 4.1		
44	Multi-Hazard	Preparing, adopting, implementing, and updating a comprehensive long-term recovery plan to direct how and where state or federal disaster recovery funds are used to rebuild resilient communities	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	5.2, 5.3		
45	Multi-Hazard	Identify dead and falling trees along pathways and roads for removal.	PPR	Staff time	Capital budget		Natural Systems Protection, Structure and Infrastructure Projects	2.5		
46	Multi-Hazard	Establish a policy based on need and funding availability for a regular pruning cycle for city trees.	PPR	Staff time	Capital budget, Grants	NPS, DCNR	Local Planning and Regulations	2.5		
47	Multi-Hazard	Establish open end contracts with construction	PPR	Staff time	Capital budget		Natural Systems Protection,	2.5		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		companies for emergency vegetation management.					Local Planning and Regulations			
48	Multi-Hazard	Support resiliency of the City's private sector though information sharing, partnership building, training and education on preparedness, COOP, mitigation principles and Philadelphia's HMP.	OEM, Multiple agencies	Staff time			Education and Awareness Programs	4.1		
49	Flood	Support regulations to improve resiliency of buildings in areas facing increased risk of flood with the Flood Risk Management Task Force	PCPC	Staff time	Agency operating budget		Local Planning and Regulations	2.1, 2.2		
50	Multi-Hazard	Create a guide on steps that commercial and residential property owners can take to make their existing buildings more resilient to climate change	OOS	Staff time	Agency operating budget		Education and Awareness Programs	3.5		
51	Flood	Examine and evaluate the strategy of using rolling easements to	OOS	Staff time	Agency operating budget		Local Planning and Regulations	3.5		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		assist in adapting to the potential consequences of sea level rise.								
52	Multi-Hazard	Acknowledging and addressing climate change issues, concerns, and impacts in Philadelphia2035 district plans.	PCPC	Staff time	Agency operating budget		Local Planning and Regulations	3.5		
53	Flood	Evaluate properties buyout feasibility for structures that are damaged or at high risk of damage from sea level rise or storm events both reactively over time as properties are damaged, or proactively for properties that are at a high risk for flooding.	Multiple Agencies	Staff time	Agency operating budget, Grants	National Association of Home Builders (NAHB), PDM, FMA,	Local Planning and Regulations	2.6		
54	Extreme heat	Continuously update and improve zoning maps and codes to encourage uses, buildings, and site improvements that reduce exterior and interior heat island effects.	PCPC	Staff time	Agency operating budget, Grants	National Association of Home Builders (NAHB), PDM, FMA,	Local Planning and Regulations	2.1, 2.2		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
55	Hazardous Material Train Derailment	Develop planning and zoning recommendations for hazardous material transportation throughout the City.	Multiple agencies	Staff time	Agency operating budget		Local Planning and Regulations	2.2		
56	Multi-Hazard	Promote sustainable, mitigation-driven redevelopment for City-acquired properties.	PCPC	Staff time	Agency operating budget, Grants	National Association of Realtors (NAR), National Association of Home Builders (NAHB), AIA Upjohn Research Initiative	Local Planning and Regulations	2.2, 3.1		
57	Multi-Hazard	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	Staff time, $10,000	Grants	HSGP	Local Planning and Regulations	5.1	x	Due to lack of funding and staff time, the action was delayed since its inclusion in the 2012 HMP.

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
58	Multi-Hazard	Promote post disaster mitigation strategies throughout SEPA region, targeting communities that are most vulnerable. VOAD partner agencies may implement mitigation strategies.	OEM	Staff Time/ $15,000	Grants	HSGP	Education and Awareness Programs	1.2, 2.44.2. 5.15.2,	x	Continuing through READYCommunity initiatives, SEPA regional work groups,
59	Multi-Hazard	Support resiliency of the City's private sector though information sharing, partnership building, training and education on preparedness, COOP, mitigation principles and Philadelphia's HMP.	OEM	Staff Time/ $20,000	Grants	HSGP	Education and Awareness Programs	4.1, 4.2, 4.3, 4.4	x	OEM continues to hold stakeholder trainings and tabletop exercise.
60	Multi-Hazard	Update and expand READY programs for those with functional needs.	OEM	Staff Time/ $50,000	Grants	HSGP	Education and Awareness Programs	1.2, 4.3, 4.4, 5.2	x	Expanding outreach materials and presentations to be more inclusive.
1	Multi-Hazard	Optimize use of HAZUS-MH software for Philadelphia's unique urban environment. The software update will allow Philadelphia to generate more accurate loss	OEM	$ 5,000.00	Grants	HMGP, PDM	Local Planning and Regulations	2.2, 2.4		Due to lack of funding, data, and expertise, the action was delayed since its inclusion in the 2012 HMP.

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		estimates for various hazards.								
62	Flood	Improve/enhance flood vulnerability data. Enhance planning by using surveys to more accurately define flood vulnerability.	PCPC	$ 10,000.00	Grants		Property Protection, Preparedness	2.2	x	In CAV process with FEMA where Flood Prone areas and properties were inspected.
63	Multi-Hazard	Coordinate and provide public outreach on mitigation strategies the public can take to reduce or eliminate the impact of hazards on their services and infrastructure. Opportunities to educate the public include conferences, OEMs website, social media, and presentations.	OEM	$ 15,000.00	Grants	HSGP	Education and Awareness Programs	1.2, 4.3, 4.4, 5.2	x	Since 2012, public outreach coordination through OEM's website, social media, and public presentation is ongoing. Efforts have expanded into READYCommunity outreach strategies.
64	Multi-Hazard	Equip drawbridges with back-up generators	STREETS	$ 15,000.00	Grants		Structure and Infrastructure Projects	2.1	x	
65	Multi-Hazard	Purchase two VMS signs for deployment prior to and during emergencies and events to promote public safety and awareness.	OEM	$ 17,500.00	Grants	HSGP	Preparedness	1.5		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
66	Winter Storm	Install GPS on all storm operations vehicles.	STREETS	$ 20,000.00	Grants		Preparedness	1.2	x	Still a priority, but additional costs need to be considered as part of the project, including maintenance costs, staffing needed, and upgrades required to support the GPS equipment.
67	Multi-Hazard	Implement program to track and study areas impacted by natural disasters using the RIC data and GIS technology.	OEM	$ 25,000.00	Grants	HSGP	Local Planning and Regulations	1.2, 2.1, 5.15.2,	x	Ongoing since 2012.
68	Flood	Establish a smart detour plan for flooding of Wissahickon Creek, Schuylkill River and Cobbs Creek.	STREETS	$ 25,000.00	Grants		Preparedness	1.2	x	A study must be conducted prior to the smart detour is put in place. The project is still a priority, and is subject to funding.
69	Multi-Hazard	Train L&I in damage assessment policies and procedures.	L&I	$ 42,000.00	HSGP		Local Planning and Regulations	1.3		
70	Multi-Hazard	Develop guides for all-hazards preparedness, hazard specific information, business continuity information, as well as guides for	OEM	$ 50,000.00	Grants	HSGP	Education and Awareness Programs	1.2, 4.3, 4.4, 5.2	x	Ongoing

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		specific vulnerable populations. Brochures will be offered in up to seven languages, large print, Braille and auto CDs.								
71	Multi-Hazard	Establish an open-end contract to purchase or rent material/equipment for unforeseen events.	STREETS	$ 50,000.00	Grants		Local Planning and Regulations	1.2, 2.1	x	
72	Multi-Hazard	Install battery back-up traffic signal controllers (75,000 each) 10% of signals in City.	STREETS	$ 50,000.00	Grants		Structure and Infrastructure Projects	2.1	x	Battery back-up installation has started and is ongoing
73	Multi-Hazard	Purchase portable trailer lights for each Streets Department facility or yard.	STREETS	$ 50,000.00	Grants		Structure and Infrastructure Projects	2.1	x	Portable light trailers have been purchased for three yards. Additional purchases needed to complete project.
74	Multi-Hazard	Conduct additional medical countermeasure exercises	PDPH, OEM	$ 50,000.00	Grants	HSGP	Preparedness	1.3		
75	Multi-Hazard	Enhance the EOC in a Box.	OEM	$ 60,000.00	Grants	HSGP	Preparedness	8.3	x	Mobile EOC and EOC in a box continues to be enhanced, updated, and replaces as needed.

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
76	Active Shooter, IED	Procure and install CCTV cameras for the Triplex and Tunnel	DPP	$ 70,000.00	Agency operating budget, Grants	HSGP	Human-Caused Hazard Casualty Reduction	8.4, 2.1		
77	Infrastructure Failure	Procure a hi-rail bucket truck	STREETS	$ 80,000.00	Agency operating budget		Preparedness	5.1, 8.4		
78	Hazardous Material Train Derailment	Procure additional unites of level B PPE for surge operators	PFD, PPD, OEM	$ 90,000.00	Grants	HSGP	Human-Caused Hazard Casualty Reduction	1.6		
79	Hurricane/ Tropical Storm, Floods	Elevate electrical and HVAC equipment at Waterworks.	PWD	$ 100,000.00	Grants		Structure and Infrastructure Projects	8.1, 5.4		
80	Flood	Buy equipment to upgrade capability to survey flood prone bridges and roads.	STREETS	$ 100,000.00	Grants		Preparedness	2.4, 2.2	x	
81	Flood	Construct ground water interceptors to capture water seeping from rock outcrops to prevent constant ice accumulation on Lincoln and Kelly Drives.	STREETS/ PPR	$ 100,000.00	Grants		Structure and Infrastructure Projects, Natural Systems Protection	2.4, 2.2	x	Lincoln Drive has a plan in place for the project in the event funding becomes available. Kelly Drive is partially funded, but requires additional funding for implementation.
82	Infrastructure Failure	Procure traffic detour modelling software	STREETS, OEM	$ 100,000.00	Grants	USDOT, HSGP	Local Planning and Regulations	5.1, 2.1		
83	Multi-Hazard	Procure pedestrian modelling software	OEM	$ 100,000.00	Grants	HSGP	Local Planning and Regulations	5.1, 8.4		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
84	Multi-Hazard	Conduct mass casualty exercises	PFD, PPD, OEM	$ 100,000.00	Grants	HSGP	Preparedness	1.3		
85	Multi-Hazard	Expand cache of body bags	PDPH-MEO, OEM	$ 100,000.00	Grants	HSGP	Preparedness	5.5		
86	Hazardous Material Train Derailment	Integrate plume modeling into OEM/ EOC/ RIC GIS systems	OEM	$ 100,000.00	Grants	HSGP	Local Planning and Regulations	1.1, 1.2, 1.4, 1.6, 2.1, 8.4		
87	Flood	Construct ground water interceptors to capture water seeping from rock outcrops to prevent constant ice accumulation on Lincoln and Kelly Drives.	STREETS/ PPR	$ 100,000.00	Grants		Natural Systems Protection, Structure and Infrastructure Projects	2.4, 2.2	x	Lincoln Drive has a plan in place for the project in the event funding becomes available. Kelly Drive is partially funded, but requires additional funding for implementation.
88	Active Shooter	Deploy trauma kits to all SDP schools	OEM	$ 120,000.00	Grants	HSGP	Human-Caused Hazard Casualty Reduction	8.4, 2.1		
89	IED	Conduct large-scale hot zone IED operation training	PPD-BDU, PFD	$ 120,000.00	Grants	HSGP	Preparedness	1.3		
90	Active Shooter, IED	Deploy trauma kits to all commercial CIKR assets	OEM	$ 120,000.00	Grants	HSGP	Human-Caused Hazard Casualty Reduction	5.1, 2.1		
91	Multi-Hazard	Expand cot and DME/G caches	OEM	$ 120,000.00	Grants	HSGP	Preparedness	1.2		
92	Active Shooter	Implement an armed Triplex security force		$ 150,000.00	Agency operating budget, Grants	HSGP	Human-Caused Hazard	8.4, 2.1		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
							Casualty Reduction			
93	Hazardous Material Train Derailment	Conduct crude by rail functional exercises and use outcomes to identify opportunities to strengthen plans and training.	OEM, PFD	$ 150,000.00	Grants	HSGP	Local Planning and Regulations	1.3, 1.6		
94	Hazardous Material Train Derailment	Conduct ongoing mass decontamination exercises	PFD, OEM	$ 150,000.00	Grants	HSGP	Preparedness	1.3, 1.6		
95	Active Shooter	Procure and issue tourniquets to all PFD members	PPD, PFD, OEM	$ 160,000.00	Grants	HSGP	Preparedness	1.3		
96	Active Shooter	Procure and install Triplex magnetometers		$ 170,000.00	Agency operating budget, Grants	HSGP	Human-Caused Hazard Casualty Reduction	8.4, 2.1		
97	Winter Storm	Upgrade pickup trucks for plowing and salting when purchased.	PWD/ OFM	$ 200,000.00	Grants		Structure and Infrastructure Projects	5.5		
98	Active Shooter	Expand MACTAC training	PPD, PFD, OEM	$ 200,000.00	Grants		Human-Caused Hazard Casualty Reduction	1.3		
99	Hazardous Material Train Derailment	Procure additional light and air unit for hazardous material response purposes	PFD	$ 200,000.00	Agency operating budget, Grants	HSGP	Human-Caused Hazard Casualty Reduction	1.6		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
100	Infrastructure Failure	Procure three more high reach bucket trucks	STREETS	$ 240,000.00	Agency operating budget		Human-Caused Hazard Casualty Reduction	5.1, 8.4, 2.1		
101	Multi-Hazard	Purchase additional secondary communication systems (i.e. radios).	OEM	$ 250,000.00	Grants	HSGP	Preparedness	8.3	x	Additional secondary communication devices have been purchased since 2012 and continue to be replaced as needed.
102	Multi-Hazard	Purchase additional portable redundant power sources.	OEM	$ 250,000.00	Grants	HSGP	Preparedness	8.3	x	Redundant power sources are continuing to be purchased and replaced as needed.
103	Hazardous Material Train Derailment	Procure two additional foam tenders	PFD	$ 250,000.00	Agency operating budget, Grants	HSGP	Human-Caused Hazard Casualty Reduction	1.6		
104	Multi-Hazard	Procure two refrigerated semi-tractor trailers	PDPH-MEO, PPD, FLEET	$ 250,000.00	Grants	HSGP	Preparedness	5.5		
105	Flood	Enlarge culverts of the Poquessing Creek tributaries to protect roadway and residences.	STREETS	$ 300,000.00	Capital Budget		Structure and Infrastructure Projects	1.2	x	
106	Multi-Hazard	Purchase Cyclomedia software to assist in the identification of	PPR	$ 400,000.00	Capital budget		Natural Systems Protection, Structure and	2.5		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		high priority areas for the removal of dead and falling trees.					Infrastructure Projects			
107	Hazardous Material Train Derailment	Intake booming materials	PWD	$ 500,000.00	Agency operating budget, Grants	EPA	Preparedness	2.1, 1.6		
108	IED	Conduct a follow-on functional 3-day IED exercise	PPD-BDU, OEM	$ 750,000.00	Grants	HSGP	Preparedness	1.3, 1.5, 1.5, 1.5		
109	Multi-Hazard	G1/G2/FLV3 emergency and non-emergency generator engine rehabilitation and electrical upgrades	PHL-DOA	$ 950,000.00	Capital Budget		Property Protection	2.1		
110	Flooding	Install electrical substation upgrades/flood control at A-East	PHL-DOA	$ 1,000,000.00	Capital Budget		Property Protection	2.1		
111	Flooding	Upgrade/repair stormwater infrastructure near terminal complex.	PHL-DOA	$ 1,000,000.00	Capital Budget		Structure and Infrastructure Projects Project Implementation	2.1		
112	Improvised Explosive Device	Improve and upgrade Southwest Water Pollution Control Plant security system Gate Controls and purchase additional cameras to prevent theft of chemicals, contamination of	PWD	$ 1,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	8.2		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		treated drinking water, and damage to critical infrastructure.								
113	Improvised Explosive Device	Improve and upgrade Belmont Water Treatment Plant truck turn around to prevent theft of chemicals, contamination of treated drinking water, and damage to critical infrastructure.	PWD	$ 1,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	8.2		
114	Improvised Explosive Device	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	$ 1,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	8.2		
115	IED	Procure wastewater system HME sensors	PWD, OEM	$ 1,000,000.00	Grants	HSGP, EPA	Structure and Infrastructure Programs	5.1, 1.5		
116	IED	Procure ZBV backscatter unit	PPD-BDU, OEM	$ 1,000,000.00	Grants	HSGP	Human-Caused Hazard Casualty Reduction	1.5		
117	Hurricane/ Tropical Storm, Wind	Install backup generators at West Oak Lane to ensure	PWD	$ 1,500,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	4.1, 5.4, 8.1		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
	Storms/ Tornado, Winter Storms	operations during power outages.								
118	IED	Increase standoff distance at City Hall Apron	DPP, PPD, OEM	$ 1,500,000.00	Grants	HSGP	Human-Caused Hazard Casualty Reduction	8.4, 2.1		
119	Flooding	Flood Prevention for Electrical Substations in Terminal A-East: installing a new 15 HP, 1200 GPM to increase the storm water pumping capacity, furnishing and installing of flood prevention planks at the substation entrances, furnishing and installing the four new oil-filled switches to allow substations to be isolated electrically and replacement of existing fire alarm and fire protection system with a new pre-action sprinkler system	PHL-DOA	$ 1,900,000.00	Capital Budget		Property Protection	2.1		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
120	Improvised Explosive Device	Improve and upgrade Northeast Water Pollution Control Plant through lighting replacement to prevent theft of chemicals, contamination of treated drinking water, and damage to critical infrastructure.	PWD	$ 2,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	8.2		
121	Active Shooter, IED	Implement underground inter-operational communications development	PPD-BDU, OEM	$ 2,000,000.00	Grants	HSGP, USDOT	Preparedness	7.1		
122	Multi-Hazard	Expand the EOC to accommodate 90 liaisons	OEM	$ 2,000,000.00	Grants	HSGP	Preparedness	6.1, 7.1		
123	Improvised Explosive Device	Improve and upgrade Northeast Water Pollution Control Plant Balfour Street Entrance to prevent theft of chemicals, contamination of treated drinking water, and damage to critical infrastructure.	PWD	$ 2,200,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	8.2		
124	Hurricane/ Tropical	Elevate electrical and HVAC equipment at Queen	PWD	$ 2,300,000.00	Capital Budget/ Grant Funding		Preparedness, Structure and	8.1, 5.4		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
	Storm, Floods	Lane Raw Water Intake switch gear and generator.					Infrastructure Projects			
125	Hurricane/ Tropical Storm, Wind Storms/ Tornado, Winter Storms	Install backup generators and switchgear at Queen Lane Raw Pump Station to ensure operations during power outages.	PWD	$ 2,300,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	4.1, 5.4, 8.1		
126	Hurricane/ Tropical Storm, Floods	Upgrade P-796 at the Navy Yard Design to handle increased flows from wet weather events.	PWD	$ 2,500,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 5.6, 8.1		
127	Hurricane/ Tropical Storm, Floods	Elevate electrical and HVAC equipment at rehabilitation of Baxter Emergency Intake Building Equipment.	PWD	$ 2,800,000.00	Capital Budget/ Grant Funding		Preparedness, Structure and Infrastructure Projects	8.1, 5.4		
128	Drought, Winter Storm	Rehabilitate Baxter Emergency Intake Building Equipment to ensure reliable source during droughts and winter storms.	PWD	$ 2,800,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		
129	Flood, Winter Storm, Drought	Rehabilitate Baxter Emergency Intake building equipment to make the structure more resilient in order to handle intake during	PWD	$ 2,800,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		extreme weather events.								
130	Improvised Explosive Device	Improve and upgrade 29th Street Complex Storage Units and revised traffic flow to prevent theft of chemicals, contamination of treated drinking water, and damage to critical infrastructure.	PWD	$ 3,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	8.2		
131	Hurricane/ Tropical Storm, Floods	Upgrade Mingo Creek Pumping Station to handle increased flows from wet weather events.	PWD	$ 4,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 5.6, 8.1		
132	Multi-Hazard	Implement an Asset Management System (under development)	PHL-DOA	$ 4,000,000.00	Capital, Operating		Local Planning and Regulations	2.1		
133	Improvised Explosive Device	Improve and upgrade Baxter Water Treatment Plant security capabilities to prevent theft of chemicals, contamination of treated drinking water, and damage to critical infrastructure.	PWD	$ 5,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	8.2		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
134	Hurricane/ Tropical Storm, Wind Storms/ Tornado, Winter Storms	Install standby generator at Belmont Raw Water Pumping Station to ensure operations during power outages.	PWD	$ 6,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	4.1, 5.4, 8.1		
135	Flood, Winter Storm, Drought	Upgrade West Oak Lane to make the station more resilient in order to deliver water during extreme weather events.	PWD	$ 6,500,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		
136	Drought, Winter Storm	Replace Baxter Raw Water Basin Intake to ensure reliable source during droughts and winter storms.	PWD	$ 8,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		
137	Improvised Explosive Device	Improve and upgrade water security system to prevent theft of chemicals, contamination of treated drinking water, and damage to critical infrastructure.	PWD	$ 15,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	8.2		
138	Drought, Winter Storm	Relocate Queen Lane Raw Water Intake to ensure reliable source during droughts and winter storms.	PWD	$ 15,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
139	Drought, Winter Storm	Relocate Belmont Raw Water Pump Station Intake to ensure reliable source during droughts and winter storms.	PWD	$ 15,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		
140	Flood, Winter Storm, Drought	Rehabilitate Belmont Raw Water Pump Station and Intake to make the station more resilient in order to deliver water during extreme weather events.	PWD	$ 15,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		
141	Flood, Winter Storm, Drought	Rehabilitate Queen Lane Raw Water Pumping Station to make the station more resilient in order to deliver water during extreme weather events.	PWD	$ 35,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		
142	Drought, Extreme Heat, Urban Conflagration	Build additional finished water storage and rehab. Current finished water storage at East Park to ensure that water can be supplied during extreme weather events or other	PWD	$ 40,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.3		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		system-disrupting events.								
143	Drought, Extreme Heat, Urban Conflagration	Build additional finished water storage and rehab current finished water storage at Baxter Clearwell Basins to ensure that water can be supplied during extreme weather events or other system-disrupting events.	PWD	$ 40,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		
144	Flood, Winter Storm, Drought	Upgrade Lardner's Point Pumping Station to make the station more resilient in order to deliver water during extreme weather events.	PWD	$ 55,000,000.00	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		
145	Extreme Heat, Drought	Construction of additional chemical dosing boosters and flushers throughout the city to maintain water quality.	PWD	$1,500,000-$5,300,000	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	3.3, 5.4		
146	Hurricane/ Tropical Storm, Wind Storms/ Tornado, Winter Storms	Install back up generators at Lardner's Point Pumping Stations to ensure operations during power outages.	PWD	$1,5000,000 - $6,000,000	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	4.1, 5.4, 8.1		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
147	Hurricane/ Tropical Storm, Floods	Elevate electrical and HVAC equipment at Lardner's Point Pumping Station.	PWD	$10,000,000 - $15,000,000	Capital Budget/ Grant Funding		Preparedness, Structure and Infrastructure Projects	8.1, 5.4		
148	Multi-Hazard	Expand the study of Southern plant species by 30 acres using sustainable planting practices in preparation for increasing temperatures over the next century.	PPR	$10,000/acre	Capital budget, Grants	NPS, DCNR	Natural Systems Protection	3.1, 3.5		
149	Hurricane/ Tropical Storm, Floods	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	$2,000,000 - $100,000,000 per project	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.3		
150	Hazardous Material Train Derailment	Upgrade or replace the contaminant warning system to maintain optimal function.	PWD	$20,000- $50,000	Operating Funds/ Grant Funding		Education and Awareness Programs	8.4, 3.3, 7.2		
151	Multi-Hazard	Purchase eight (8) additional chippers to assist in limb maintenance, reducing debris, and downed vegetation	Streets/PPR	$20,000/unit	Capital Budget		Natural Systems Protection, Structure and Infrastructure Projects	2.5		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		prior to and following storms to reduce damages to properties, road way closures, and debris.								
152	Hurricane/ Tropical Storm, Floods	Upgrade of various wastewater and stormwater pump stations to handle increased flows from wet weather events.	PWD	$400,000 - $4,000,000 per project	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 5.6, 8.1		
153	Hurricane/ Tropical Storm, Floods	Addition of effluent and outfall pumping station to a water pollution control plant to pump treated water to the river during extreme wet weather events and high tide.	PWD	$45,000,000 per project	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.6, 8.1		
154	Hurricane/ Tropical Storm, Floods	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	$45,000,000 per project	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	8.3, 8.1		
155	Multi-Hazard	Build additional water mains to provide better	PWD	$5,000,000 - $10,000,000 per project	Capital Budget/ Grant Funding		Structure and Infrastructure Projects	5.4, 8.1		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		system redundancy and resiliency.								
156	Extreme Heat, Extreme Cold	Provide air quality alerts to the public.	PDPH	$500/ alert	Grants	HHS	Education and Awareness Programs	5.2, 5.3, 5.2		
157	Multi-Hazard	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	$700 per tree removed			Natural Systems Protection, Structure and Infrastructure Projects	2.5		
158	Hurricane/ Tropical Storm, Floods	Acquire properties that are prone to historic repetitive losses or damage from flooding.	PWD/ Public Property	(Market value of properties)	Operating Funds/ Grant Funding		Preparedness	8.1		
159	Infrastructure Failure	Procure additional breaching saws	PFD-SOC	Action Removed			Action Removed			Not mitigation action
160	Flooding	Develop a software platform to share flooding event information across departments in real-time as well as historically.	Multiple Agencies	N/A	Agency Budget		Local Planning and Regulations	2.2		
161	Active Shooter	Conduct active shooter training for city staff	PPD, OEM	NA	Staff time		Preparedness	1.3		
162	IED	Conduct fire station station-based IED hot zone training	PPD-BDU, PFD	NA	Staff time		Preparedness	1.3		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
163	Infrastructure Failure	Increase bridge inspection training	STREETS	NA	PennDOT		Human-Caused Hazard Casualty Reduction, Structure and Infrastructure Projects	1.3		
164	Infrastructure Failure	Renew/ review emergency crane contracts	STREETS, PROCUREMENT	NA	Agency operating budget		Local Planning and Regulations	2.4		
165	Multi-Hazard	Operationalize IPAWS for city use	OEM, PEMA, FEMA	NA	Staff time		Local Planning and Regulations	5.3		
166	Multi-Hazard	Revise city-wide evacuation planning	OEM	NA	Staff time		Local Planning and Regulations	5.1		
167	Multi-Hazard	Conduct logistics center planning	OEM	NA	Staff time		Local Planning and Regulations	5.5		
168	Multi-Hazard	Revise Mass Care and shelter plan	OEM	NA	Staff time		Local Planning and Regulations			
169	Multi-Hazard	Develop surge staffing for expanded shelters	OEM	NA	Staff time		Local Planning and Regulations			
170	Multi-Hazard	Identify logistics staging sites	OEM	NA	Staff time		Local Planning and Regulations	5.5		
171	Multi-Hazard	Pre-identify POD locations	OEM	NA	Staff time		Local Planning and Regulations	5.5		
172	Multi-Hazard	Conduct logistics operations functional exercises	OEM	NA	Staff time		Preparedness	1.3		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
173	Hazardous Material Train Derailment	Conduct preparedness workshops within crude rail transport corridors	OEM	NA	Staff time		Preparedness	5.1, 2.1, 5.3		
174	Active Shooter, IED	Expand SPOT training for all PPD personnel	PPD	NA	Staff time		Preparedness	1.3		
175	Active Shooter, IED	Train key staff and security on recognizing suspicious vehicles	PPD, OEM	NA	Staff time		Preparedness	1.3		
176	IED, Hazardous Materials Train Derailment	Conduct outreach with CIKR assets to assess blast resistance and HVAC shutdown procedures	PPD, OEM	NA	Staff time		Education and Awareness Programs	5.1, 8.4, 2.1		
177	Multi-Hazard	Establish emergency contracts for 500kW/1mW generators	OEM	NA	Staff time		Structure and Infrastructure Programs	4.1, 2.4		
178	Multi-Hazard	Enhance THIRA process to identify resource gaps	OEM	NA	Staff time		Local Planning and Regulations	5.1, 8.4		
179	Earthquake	Evaluate various seismic building design enhancements using HAZUS-MH to identify enhancements that reduce losses generated by earthquakes.	OEM	Staff Time	Grants	HSGP	Local Planning and Regulations	2.2, 2.4, 5.4	x	2012 HMP stated the timeframe as 2 years. Due to lack of funding and expertise, the assessment was delayed.

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
180	Flooding	Evaluate various building enhancements using HAZUS-MH to identify opportunities to reduce flooding.	OEM	Staff Time	Grants	HSGP	Local Planning and Regulations	2.2, 2.4, 5.4	x	2012 HMP stated the timeframe as 2 years. Due to lack of funding and expertise, the assessment was delayed.
181	Hurricane, Tropical Storm	Hazards U.S. Multi-Hazard (HAZUS-MH) Modeling: Determine losses generated by tropical cyclones and engineering effectiveness and cost-benefit of various mitigation actions.	OEM	Staff Time	Grants	HSGP	Local Planning and Regulations	2.2, 2.4	x	2012 HMP stated the timeframe as 2 years. Due to lack of funding and expertise, the assessment was delayed.
182	Multi-Hazard	Conduct or update natural hazard vulnerability assessments for critical facilities throughout the Philadelphia.	OEM	Staff Time	Grants	HSGP	Local Planning and Regulations	2.1	x	Ongoing annual action moving forward.
183	Multi-Hazard	Determine losses generated by various natural disasters and engineering effectiveness and cost-benefit of various mitigation measures using HAZUS-MH or other computer modeling	OEM	Staff Time	Grants	PDM, HMGP, HSGP	Local Planning and Regulations	2.3, 5.1	x	Due to lack of funding, expertise, data, and staff time, the action was delayed since its inclusion in the 2012 HMP.

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		software. Evaluate various building enhancements using prototypical Philadelphia building types.								
184	Multi-Hazard	COOP Site enhancement, including electrical systems enhancement, systems synchronizing, and the installation of quick connects for generators.	OEM	Staff time	Grants	HSGP, PDM, HMGP	Property Protection	2.1, 8.3, 2.2, 2.4, 4.1,		
185	Multi-Hazard	Creation of a specific asset inventory across Philadelphia City agencies which catalogues resources.	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	4.2		
186	Multi-Hazard	Formalize the process of resource tracking, receiving, and distribution for large emergencies or events.	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	4.2		
187	Multi-Hazard	Create a mobile feeding and commodity distribution plan.	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	1.2		
188	Multi-Hazard	Formalize resource requesting plan for pre-event resource	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	4.2		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		requests that may impact a widespread area to streamline resource distribution.								
189	Multi-Hazard	Train Health and Human Service staff and partners in continuity of operations plan and mitigation measures.	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	1.3, 4.3, 4.4, 5.2		
190	Flooding	Conduct a flood risk analysis - compile/map all areas at PHL at greatest risk of flooding during 100-yr and 500-yr flood events	PHL-DOA	Staff time	Grants		Local Planning and Regulations	2.1		
191	Flooding	Update the Airport Flood Emergency Response Plan (AFERP) with Operations, Engineering, and Planning	PHL-DOA	Staff time	Operating Budget		Local Planning and Regulations	2.1		
192	Multi-Hazard	Meet quarterly with VOAD partners to maintain preparedness, ensure situational awareness, identify resource capabilities, and build stakeholder	OEM	Staff time	Agency operating budget		Education and Awareness Programs	5.2, 5.3		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		relationships pre-disaster.								
193	Multi-Hazard	Partner with community leaders and stakeholders for the development of materials for READYCommunity to increase community preparedness and mitigation.	OEM	Staff time	Agency operating budget		Education and Awareness Programs	5.2, 5.3		
194	Multi-Hazard	Provide technical assistance to communities in the development of community emergency plans.	OEM	Staff time	Agency operating budget		Education and Awareness Programs,	5.2, 5.3		
195	Multi-Hazard	Maintaining relationships with universities and colleges within Philadelphia to support emergency planning, training, and exercises between the City and higher educational facilities.	OEM	Staff time	Agency operating budget		Education and Awareness Programs	5.2, 5.3		
196	Multi-Hazard	Create zoning and development awareness programs to inform planning processes that may be impacted by	Multiple agencies	Staff time	Agency operating budget		Property Protection, Local Planning and Regulations	2.1, 2.2, 2.3, 4.3, 5.1,		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		hazardous material train derailments.								
197	Multi-Hazard	Coordinate with construction community for large scale emergency responses.	L&I/ Multiple agencies	Staff time	Agency operating budget		Local Planning and Regulations	1.3		
198	Multi-Hazard	Establish public outreach programs in L&I.	L&I	Staff time	Agency operating budget		Education and Awareness Programs	5.2, 5.2		
199	Flooding	Update inundation mapping.	L&I, PCPC, OEM	Staff time	Grants, Agency Operating Budgets	PDM, HSGP	Local Planning and Regulations	5.1		
200	Flooding	Creation of a tactical guide for flood pre-event actions and response activities	OEM/ Multiple Agencies	Staff time	Staff time		Local Planning and Regulations	2.3, 2.6		
201	Multi-Hazard	Develop educational and promotional video series to educate and increase public awareness of City hazards and response plans.	OEM	Staff time	Grants	HSGP	Education and Awareness Programs	5.2, 5.3, 5.2		
202	Flood	Determine low-lying substation vulnerabilities and outline options for adaptation and mitigation; coordinate with DOE on their vulnerable infrastructure studies	OEM	Staff time	Grants	DOE, HSGP, USACE	Local Planning and Regulations	2.1, 2.4, 4.1		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
203	IED	Procure urban blast modelling tool	Action Removed							No longer feasible
204	Multi-Hazard	Develop individual hazard management plans for historic structures that take climate change impacts into account; if necessary, consider moving the structure to a safer location	PHMC/ OEM, USACE		Grants	NPS	Local Planning and Regulations	6.1		
205	Flooding	Complete outstanding follow-up items from the most recent Community Assistance Visit.					Local Planning and Regulations	2.2, 2.3, 2.4, 2.5, 3.1		
206	Flooding	Investigate the possibility of consolidating floodplain management licensing and inspection responsibilities into one or two positions.					Local Planning and Regulations	2.1		
207	Multi-Hazard	Assess properties which may benefit from elevation, acquisition, relocation, or retrofitting.					Local Planning and Regulations, Structure and Infrastructure Projects	2.4		
208	Multi-Hazard	Preparing, adopting, implementing, and updating a	OEM	Staff time	Grants	HSGP	Local Planning and Regulations	5.2, 5.3		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		comprehensive long-term recovery plan to direct how and where state or federal disaster recovery funds are used to rebuild resilient communities								
209	Multi-Hazard	Identify dead and falling trees along pathways and roads for removal.	PPR	Staff time	Capital budget		Natural Systems Protection, Structure and Infrastructure Projects	2.5		
210	Multi-Hazard	Establish a policy based on need and funding availability for a regular pruning cycle for city trees.	PPR	Staff time	Capital budget, Grants	NPS, DCNR	Local Planning and Regulations	2.5		
211	Multi-Hazard	Establish open end contracts with construction companies for emergency vegetation management.	PPR	Staff time	Capital budget		Natural Systems Protection, Local Planning and Regulations	2.5		
212	Multi-Hazard	Support resiliency of the City’s private sector though information sharing, partnership building, training and education on preparedness, COOP, mitigation	OEM, Multiple agencies	Staff time			Education and Awareness Programs	4.1		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		principles and Philadelphia's HMP.								
213	Flood	Support regulations to improve resiliency of buildings in areas facing increased risk of flood with the Flood Risk Management Task Force	PCPC	Staff time	Agency operating budget		Local Planning and Regulations	2.1, 2.2		
214	Multi-Hazard	Create a guide on steps that commercial and residential property owners can take to make their existing buildings more resilient to climate change	OOS	Staff time	Agency operating budget		Education and Awareness Programs	3.5		
215	Flood	Examine and evaluate the strategy of using rolling easements to assist in adapting to the potential consequences of sea level rise.	OOS	Staff time	Agency operating budget		Local Planning and Regulations	3.5		
216	Multi-Hazard	Acknowledging and addressing climate change issues, concerns, and impacts in Philadelphia2035 district plans.	PCPC	Staff time	Agency operating budget		Local Planning and Regulations	3.5		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
217	Flood	Evaluate properties buyout feasibility for structures that are damaged or at high risk of damage from sea level rise or storm events both reactively over time as properties are damaged, or proactively for properties that are at a high risk for flooding.	Multiple Agencies	Staff time	Agency operating budget, Grants	National Association of Home Builders (NAHB), PDM, FMA,	Local Planning and Regulations	2.6		
218	Extreme heat	Continuously update and improve zoning maps and codes to encourage uses, buildings, and site improvements that reduce exterior and interior heat island effects.	PCPC	Staff time	Agency operating budget, Grants	National Association of Home Builders (NAHB), PDM, FMA,	Local Planning and Regulations	2.1, 2.2		
219	Hazardous Material Train Derailment	Develop planning and zoning recommendations for hazardous material transportation throughout the City.	Multiple Agencies	Staff time	Agency Budget		Local Planning and Regulations	2.2		
220	Multi-Hazard	Promote sustainable, mitigation-driven redevelopment for City-acquired properties.	PCPC	Staff time	Agency operating budget, Grants	National Association of Realtors (NAR), National Association	Local Planning and Regulations	2.2, 3.1		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
						of Home Builders (NAHB), AIA Upjohn Research Initiative				
221	Multi-Hazard	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	Staff time, $10,000	Grants	HSGP	Local Planning and Regulations	5.1	x	Due to lack of funding and staff time, the action was delayed since its inclusion in the 2012 HMP.
222	Multi-Hazard	Promote post disaster mitigation strategies throughout SEPA region, targeting communities that are most vulnerable. VOAD partner agencies may implement mitigation strategies.	OEM	Staff Time/ $15,000	Grants	HSGP	Education and Awareness Programs	1.2, 2.44.2. 5.15.2,	x	Continuing through READYCommunity initiatives, SEPA regional work groups,
223	Multi-Hazard	Support resiliency of the City's private sector though	OEM	Staff Time/ $20,000	Grants	HSGP	Education and Awareness Programs	4.1, 4.2, 4.3, 4.4	x	OEM continues to hold stakeholder

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		information sharing, partnership building, training and education on preparedness, COOP, mitigation principles and Philadelphia's HMP.								trainings and tabletop exercise.
224	Multi-Hazard	Update and expand READY programs for those with functional needs.	OEM	Staff Time/ $50,000	Grants	HSGP	Education and Awareness Programs	1.2, 4.3, 4.4, 5.2	x	Expanding outreach materials and presentations to be more inclusive.
225	Multi-Hazard	Purchase of an additional 300 KVA generator, as well as compatible cabling, distribution boxes, and transfers.	OEM		Grants	HSGP	Structure and Infrastructure Projects	2.1, 3.4		
226	Multi-Hazard	Create a support trailer for emergency deployment with generator use.	OEM		Grants	HSGP	Structure and Infrastructure Projects	8.3, 3.4		
227	Multi-Hazard	Purchase of eighteen 6.5, 7, 8 kW generators with support power strips and extension cords and cables.	OEM		Grants	HSGP, PDM, HMGP	Structure and Infrastructure Projects	8.3, 3.4		
228	Multi-Hazard	Replace OEM radios, and use current radios as a surge cache for emergency response and events.	OEM		Grants	HSGP	Preparedness	1.5		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
229	Multi-Hazard	Create five mass care and sheltering trailers.	OEM		Grants	HSGP	Preparedness	1.2		
230	Multi-Hazard	Assessment for quick connect prioritization for city facilities.	OEM		Grants	HSGP	Local Planning and Regulations	8.3		
231	Multi-Hazard	Install a 2 MW peak shaving generator for demand response events. Can also be used as backup power in emergencies.	PHL-DOA		Capital Budget		Property Protection	2.1		
232	Multi-Hazard	Obtain vehicles and personnel to assist in the transportation of homeless and vulnerable populations prior to or following an incident	OSH		Agency operating budget		Human-Caused Hazard Casualty Reduction	1.2		
233	Multi-Hazard	Conduct logistics staging sites assessment for City agency use during an emergency.	OEM		Agency operating budget		Local Planning and Regulations	4.1, 5.1		
234	Drought	Develop and implement a communication plan for public outreach for water conservation.	PWD		Grants		Education and Awareness Programs	5.2, 5.3, 5.2		
235	Multi-Hazard	Establish contracts with outside companies to assist	Multiple Agencies		Staff time		Local Planning and Regulations	8.5, 2.5		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		with debris removal following a disaster.								
236	Multi-Hazard	Establish open end contracts with construction companies for emergency bridge and road repairs.	Streets		Staff time		Local Planning and Regulations	8.1		
237	Multi-Hazard	Establish open end contracts with construction companies for emergency building demolition.	L&I		Staff time		Local Planning and Regulations	8.1		
238	Multi-Hazard	Establish open end contracts with construction companies for emergency vegetation management.	PPR		Staff time		Local Planning and Regulations	2.5, 8.1		
239	Winter Storm	Purchase and maintain hyper-local street-level weather stations to assist in salting, flooding, and plowing operations.	Streets		Capital Budget		Structure and Infrastructure Projects	5.5		
240	Flooding	Purchase and maintain drop-gates for known dangerous roads during emergency events, particularly along Cobbs Creek, for Bells Mill Road,	Streets		Capital Budget		Structure and Infrastructure Projects	5.5		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		and on Delaware Ave								
241	Flooding	Clean and maintain streams and canals of debris prior to and following weather events.	PWD		Staff time		Natural Systems Protection	2.5		
242	Flooding	Purchase additional sweepers to assist in debris removal prior to and following flooding events.	Streets		Capital Budget		Structure and Infrastructure Projects	2.5		
243	Flooding	Purchase additional flusher trucks for use during flooding events.	Streets		Capital Budget		Structure and Infrastructure Projects	5.5		
244	Winter Storm	Purchase additional brining trucks for brining operations prior to winter storm events.	Streets		Capital Budget		Structure and Infrastructure Projects	5.5		
245	Winter Storm	Purchase additional salting trucks for brining operations prior to and during winter storm events.	Streets		Capital Budget		Structure and Infrastructure Projects	5.5		
246	Multi-Hazard	Purchase additional chippers to assist in limb maintenance, reducing debris, and downed vegetation prior to and following storms	Streets/PPR		Capital Budget		Structure and Infrastructure Projects	2.5, 5.5		
247	Multi-Hazard	Purchase additional fuel truck for refueling vehicles	Streets		Capital Budget		Structure and Infrastructure Projects	5.5		

No.	Hazard	Mitigation Action and Description	Lead/ Supporting Agency(s)	Estimated Project Cost	Possible Funding Source(s)	Specific Grants	Category	Goals and Objectives	Included in 2012 HMP	Update Since 2012
		during staging and response for emergency events, as well as for refueling generators and un-moveable equipment deployed during emergency events.								
248	Winter Storm	Develop a list of City owned property that can temporarily be used to store emergency debris & snow (by district).	Streets/OEM		Staff time		Local Planning and Regulations	5.5		
249	IED	Implement blast and thermal hardening for high ranked CIKR assets	PPD-BDU, OEM						No longer feasible	
250	Multi-Hazard	Elevate, acquire, relocate, or retrofit those repetitive loss properties that benefit from elevation, acquisition, relocation, or retrofitting.					Structure and Infrastructure Projects	2.4		

6.4.2.1 Prioritization of Hazard Mitigation Actions

The Hazard Mitigation Planning Committee conducted a qualitative evaluation of potential mitigation actions using the PASTEEL (political, administrative, social, technical, economic, environmental and legal) review method. PASTEEL is an evaluation process developed by PEMA that is a systematic method to help identify the benefits and constraints of a particular mitigation action. The table below provides a summary of the PASTEEL criteria.

PASTEEL Summary Table	
Criteria	**Description**
P	**Political criteria**: Does the action have public and political support?
A	**Administrative criteria**: Is there adequate staffing and funding available to implement the action in a timely manner?
S	**Social criteria:** Will the action be acceptable by the community or will it cause any one segment of the population to be treated unfairly?
T	**Technical criteria**: How effective will the action be in avoiding or reducing future losses?
E	**Economic criteria:** What are the costs and benefits of the action and does it contribute to community economic goals?
E	**Environmental criteria:** Will the action provide environmental benefits and will it comply with local, state and federal environmental regulations?
L	**Legal criteria**: Does the community have the authority to implement the proposed measure?

Planners used these criteria rank mitigation projects into highest, high, and moderate priorities.

- **Highest Priority**: A project that meets at least 21 favorable PASTEEL criteria considerations
- **High Priority**: A project that meets at least 18 favorable PASTEEL criteria considerations
- **Moderate Priority**: A project that meets less than 18 favorable PASTEEL criteria considerations

The agency submitting the mitigation action has the ultimate authority to determine a mitigation action’s priority. An agency can weigh one or more criteria within the PASTEEL matrix to produce the most appropriate prioritization level.

Mitigation Action and Description	**PA STEEL Criteria Considerations**																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
Evaluate various seismic building design enhancements using HAZUS-MH to identify enhancements that reduce losses generated by earthquakes.	+	+	+	+	+	+	+	+	N	+	+	+	N	+	+	N	+	N	+	+	+	N	17	0	5	**Moderate Priority**
Evaluate various building enhancements using HAZUS-MH to identify opportunities to reduce flooding.	+	+	+	+	+	+	+	+	N	+	+	+	N	+	+	N	+	N	+	+	+	N	17	0	5	**Moderate Priority**
Hazards U.S. Multi-Hazard (HAZUS-MH) Modeling: Determine losses generated by tropical cyclones and engineering effectiveness and cost-benefit of various mitigation actions.	+	+	+	+	+	+	+	+	N	+	+	+	N	+	+	N	+	N	+	+	+	N	17	0	5	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Coordinate and provide public outreach on mitigation strategies the public can take to reduce or eliminate the impact of hazards on their services and infrastructure. Opportunities to educate the public include conferences, OEMs website, social media, and presentations.	+	+	+	-	+	+	+	+	+	N	+	+	N	N	N	N	N	N	N	+	+	N	12	1	9	**Moderate Priority**
Conduct or update natural hazard vulnerability assessments for critical facilities throughout the Philadelphia.	+	+	+	+	+	+	+	+	N	+	+	+	N	+	+	N	+	N	+	+	+	N	17	0	5	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Optimize use of HAZUS-MH software for Philadelphia's unique urban environment. The software update will allow Philadelphia to generate more accurate loss estimates for various hazards.	+	+	+	+	+	+	+	+	N	+	+	+	N	+	+	N	+	N	+	+	+	N	17	0	5	**Moderate Priority**
Develop guides for all-hazards preparedness, hazard specific information, business continuity information, as well as guides for specific vulnerable populations. Brochures will be offered in up to seven languages, large print, Braille and auto CDs.	+	+	+	-	+	+	+	+	+	N	+	+	N	N	N	N	N	N	N	+	+	N	12	1	9	**Moderate Priority**
Update and expand READY programs for those with functional needs.	+	+	+	-	+	+	+	+	+	N	+	+	N	N	N	N	N	N	N	+	+	N	12	1	9	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Purchase additional secondary communication systems (i.e. radios).	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	+	+	N	+	N	18	0	4	**High Priority**
Purchase additional portable redundant power sources.	+	+	+	+	+	+	+	+	N	+	+	+	N	+	N	N	N	+	N	N	+	N	14	0	8	**Moderate Priority**
Enhance the EOC in a Box.	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	N	N	N	N	N	+	N	14	0	8	**Moderate Priority**
Support resiliency of the City's private sector though information sharing, partnership building, training and education on preparedness, COOP, mitigation principles and Philadelphia's HMP.	+	+	+	+	+	+	+	+	-	+	+	+	+	-	N	N	N	N	N	+	+	N	14	2	6	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Promote post disaster mitigation strategies throughout SEPA region, targeting communities that are most vulnerable. VOAD partner agencies may implement mitigation strategies.	+	+	+	-	+	+	+	+	+	+	+	+	N	N	N	N	N	N	N	+	+	N	13	1	8	**Moderate Priority**
Determine losses generated by various natural disasters and engineering effectiveness and cost-benefit of various mitigation measures using HAZUS-MH or other computer modeling software. Evaluate various building enhancements using prototypical Philadelphia building types.	+	+	+	+	+	+	+	+	N	+	+	+	N	+	+	N	+	N	+	+	+	N	17	0	5	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
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.	+	+	+	-	+	+	+	+	-	+	+	+	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**
Implement program to track and study areas impacted by natural disasters using the RIC data and GIS technology.	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	N	N	N	+	+	+	N	16	0	6	**Moderate Priority**
COOP Site enhancement, including electrical systems enhancement, systems syncing, and the installation of quick connects for generators	+	+	+	-	+	+	+	+	+	+	+	-	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**

Mitigation Action and Description	**PA STEEL Criteria Considerations**																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
Mitigation Action and Description	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
Purchase of an additional 300 KVA generator, as well as compatible cabling, distribution boxes, and transfers	+	+	+	-	+	+	+	+	+	+	+	-	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**
Create a support trailer for emergency deployment with generator use	+	+	+	-	+	+	+	+	+	+	+	-	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**
Purchase of eighteen 6.5, 7, 8 kW generators with support power strips and extension cords and cables	+	+	+	-	+	+	+	+	+	+	+	-	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**
Purchase two VMS signs fro deployment prior to and during emergencies and events to promote public safety and awareness.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**

Mitigation Action and Description	**PA STEEL Criteria Considerations**																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Replace OEM radios, and use current radios as a surge cache for emergency response and events	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Creation of a specific asset inventory across Philadelphia City agencies which catalogues resources.	+	+	+	-	+	+	+	+	-	+	+	+	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**
Formalize the process fo resource tracking, receiving, and distributoin for large emergencies or events.	+	+	+	-	+	+	+	+	-	+	+	+	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**
Create a mobile feeding and commodity distribution plan.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**
Formalize resource requesting plan for pre-event resource requests that may impact a widespread area to streamline resource distribution.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
Create five mass care and sheltering trailers.	N	N	N	N	+	N	+	+	N	N	+	N	N	+	N	N	N	N	N	N	N	N	5	0	17	**Moderate Priority**
Assessment for quick connect prioritization for city facilities.	N	N	N	-	N	N	N	-	+	N	+	-	-	-	N	N	N	N	N	N	+	N	3	5	14	**Moderate Priority**
Train Health and Human Service staff and partners in continuity of operations plan and mitigation measures.	+	N	-	-	N	N	+	N	+	N	+	+	N	-	N	N	N	N	N	N	+	N	6	3	13	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Flood Prevention for Electrical Substations in Terminal A-East:installing a new 15 HP, 1200 GPM to increase the storm water pumping capacity, furnishing and installing of flood prevention planks at the substation entrances, furnishing and installing the four new oil-filled switches to allow substations to be isolated electrically and replacement of existing fire alarm and fire protection system with a new pre-action sprinkler system	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Install electrical substation upgrades/flood control at A-East	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																						Total Favorable	Total Less Favorable	Total Not Applicable	Priority
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
G1/G2/FLV3 emergency and non-emergency generator engine rehabilitation and electrical upgrades	+	+	+	-	+	+	+	+	+	+	+	-	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**
Upgrade/repair stormwater infrastructure near terminal complex.	+	+	+	-	+	+	+	+	+	+	+	-	N	+	N	N	N	N	N	+	+	N	0	0	1	**Moderate Priority**
Implement an Asset Management System (under development)	N	N	N	+	-	N	N	+	+	+	+	+	N	+	N	N	N	N	N	N	+	N	8	1	13	**Moderate Priority**
Conduct a flood risk analysis - compile/map all areas at PHL at greatest risk of flooding during 100-yr and 500-yr flood events	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Update the Airport Flood Emergency Response Plan (AFERP) with Operations, Engineering, and Planning	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
Meet quarterly with VOAD partners to maintain preparedness, ensure situational awareness, identify resource capabilities, and build stakeholder relationships pre-disaster.	+	+	+	+	+	+	+	N	+	N	+	+	N	+	N	N	N	N	N	N	+	N	12	0	10	**Moderate Priority**
Partner with community leaders and stakeholders for the development of materials for READYCommunity to increase community preparedness and mitigation.	+	+	+	+	+	+	+	+	-	+	+	+	+	-	N	N	N	N	N	+	+	N	14	2	6	**Moderate Priority**
Provide technical assistance to communities in the development of community emergency plans.	+	+	+	+	+	+	+	N	+	N	+	+	N	+	N	N	N	N	N	N	+	N	12	0	10	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
Maintaining relationships with universities and colleges within Philadelphia to support emergency planning, training, and exercises between the City and higher educational facilities.	+	+	+	+	+	+	+	N	+	N	+	+	N	+	N	N	N	N	N	N	+	N	12	0	10	**Moderate Priority**
Obtain vehicles and personnel to assist in the transportation of homeless and vulnerable populations prior to or following an incident																						N	0	0	1	**Moderate Priority**
Improve/enhance flood vulnerability data. Enhance planning by using surveys to more accurately define flood vulnerability.	+	+	+	+	+	+	+	+	-	+	+	+	+	-	N	N	N	N	N	+	+	N	14	2	6	**Moderate Priority**
Update City of Philadelphia Building Codes.	-	-	-	+	-	+	+	+	+	+	+	+	N	N	+	N	N	+	+	+	-	N	12	5	5	**Moderate Priority**

Mitigation Action and Description	**PA STEEL Criteria Considerations**																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
Update City of Philadelphia zoning maps.	-	-	+	+	-	-	N	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	16	4	2	**Moderate Priority**
Include public facilities in capital planning.	+	+	+	+	+	N	N	+	+	+	+	+	+	+	+	N	N	N	+	+	+	N	16	0	6	**Moderate Priority**
Create a brownfield reuse and mitigation plan and procedure.	+	+	+	-	-	+	N	+	+	+	+	+	N	-	+	+	+	+	+	+	+	N	16	3	3	**Moderate Priority**
Utilize district planning as a method to communicate about risks as Philadelphia2035 moves forward.	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	N	19	2	1	**High Priority**
Conduct logistics staging sites assessment for City agency use during an emergency.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**
Create zoning and development awareness programs to inform planning processes that may be impacted by hazardous material train derailments.	+	+	-	-	-	+	+	+	+	+	+	+	N	-	N	N	N	+	+	+	+	N	13	4	5	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																						Total Favorable	Total Less Favorable	Total Not Applicable	Priority
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Coordinate with construction community for large scale emergency responses.	+	+	+	+	-	+	N	+	-	N	+	+	N	+	N	N	N	N	+	+	+	N	12	2	8	**Moderate Priority**
Train L&I in damage assessment policies and procedures	+	+	+	+	+	+	N	+	+	N	+	+	+	-	N	N	N	N	+	+	+	N	14	1	7	**Moderate Priority**
Establish public outreach programs in L&I.	+	+	-	-	-	+	N	+	+	+	+	+	N	-	N	N	N	N	+	+	+	N	11	4	7	**Moderate Priority**
Update inundation mapping.	+	+	+	+	+	+	+	+	+	+	+	+	N	+	+	+	+	+	+	+	+	N	20	0	2	**High Priority**
Provide air quality alerts to the public.	+	+	+	+	-	+	+	+	+	+	+	+	N	+	N	N	N	N	+	+	+	N	15	1	6	**Moderate Priority**
Upgrade or replace the contaminant warning system to maintain optimal function.	N	N	N	-	-	N	N	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	9	4	9	**Moderate Priority**
Elevate electrical and HVAC equipment at Lardner's Point Pumping Station.	+	+	N	N	+	N	N	+	+	N	+	+	N	N	N	N	N	N	N	N	N	N	7	0	15	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
Elevate electrical and HVAC equipment at ehabilitation of Baxter Emergency Intake Building Equipment.	+	+	N	N	+	N	N	+	+	N	+	+	N	N	N	N	N	N	N	N	N	N	7	0	15	**Moderate Priority**
Elevate electrical and HVAC equipment at Queen Lane Raw Water Intake switch gear and generator.	+	+	N	N	+	N	N	+	+	N	+	+	N	N	N	N	N	N	N	N	N	N	7	0	15	**Moderate Priority**
Acquire properties that are prone to historic repetitive losses or damage from flooding.	-	-	+	-	+	-	-	+	+	+	+	+	N	-	+	+	+	+	+	+	+	N	14	6	2	**Moderate Priority**
Elevate electrical and HVAC equipment at Waterworks.	+	+	+	-	-	+	N	+	+	+	+	+	+	-	+	N	N	+	+	+	+	N	15	3	4	**Moderate Priority**
Have standard pickup trucks upgraded for plowing and salting when purchased.	+	+	N	N	-	+	+	+	+	N	+	-	+	N	N	N	N	N	N	N	N	N	8	2	12	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Construction of additional chemical dosing boosters and flushers throughout the city to maintain water quality.	+	+	+	+	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	15	3	4	**Moderate Priority**
Upgrade of various wastewater and stormwater pump stations to handle increased flows from wet weather events.	+	+	+	+	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	15	3	4	**Moderate Priority**
Upgrade P-796 at the Navy Yard Design to handle increased flows from wet weather events.	+	+	+	+	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	15	3	4	**Moderate Priority**
Upgrade Mingo Creek Pumping Station to handle increased flows from wet weather events.	+	+	+	+	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	15	3	4	**Moderate Priority**

Mitigation Action and Description	**PA STEEL Criteria Considerations**																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Addition of effluent and outfall pumping station to a water pollution control plant to pump treated water to the river during extreme wet weather events and high tide.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
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.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
Mitigation Action and Description	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
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.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Relocate Queen Lane Raw Water Intake to ensure reliable source during droughts and winter storms.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Relocate Belmont Raw Water Pump Station Intake to ensure reliable source during droughts and winter storms.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Replace Baxter Raw Water Basin Intake to ensure reliable source during droughts and winter storms.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**

PA STEEL Criteria Considerations

+ Favorable **-** Less favorable **N** Not Applicable

Mitigation Action and Description	**P** Political		**A** Administrative			**S** Social		**T** Technical			**E** Economic				**E** Environmental					**L** Legal			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Rehabilitate Baxter Emergency Intake Building Equipment to ensure reliable source during droughts and winter storms.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Build additional finished water storage and rehab. Current finished water storage at East Park to ensure that water can be supplied during extreme weather events or other system-disrupting events.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Build additional finished water storage and rehab current finished water storage at Baxter Clearwell Basins to ensure that water can be supplied during extreme weather events or other system-disrupting events.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**

Mitigation Action and Description	**PA STEEL Criteria Considerations**																						**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Rehabilitate Queen Lane Raw Water Pumping Station to make the station more resilient in order to deliver water during extreme weather events.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Rehabilitate Belmont Raw Water Pump Station and Intake to make the station more resilient in order to deliver water during extreme weather events.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Upgrade Lardner's Point Pumping Station to make the station more resilient in order to deliver water during extreme weather events.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																						Total Favorable	Total Less Favorable	Total Not Applicable	Priority
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Upgrade West Oak Lane to make the station more resilient in order to deliver water during extreme weather events.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Rehabilitate Baxter Emergency Intake building equipment to make the structure more resilient in order to handle intake during extreme weather events.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Install back up generators at Lardner's Point Pumping Stations to ensure operations during power outages.	+	+	+	-	+	+	+	+	+	+	+	-	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Install back up generators and switchgear at Queen Lane Raw Pump Station to ensure operations during power outages.	+	+	+	-	+	+	+	+	+	+	+	-	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**
Install back up generators at West Oak Lane to ensure operations during power outages.	+	+	+	-	+	+	+	+	+	+	+	-	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**
Install standby generator at Belmont Raw Water Pumping Station to ensure operations during power outages.	+	+	+	-	+	+	+	+	+	+	+	-	N	+	N	N	N	N	N	+	+	N	13	2	7	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Build additional water mains to provide better system redundancy and resiliency.	+	+	+	-	-	+	+	+	+	+	+	-	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Establish contracts with outside companies to assist with debris removal following a disaster.	+	+	+	+	-	+	+	+	-	+	+	+	N	+	+	N	N	+	+	+	+	N	16	2	4	**Moderate Priority**
Establish open end contracts with construction companies for emergency bridge and road repairs.	+	+	+	+	-	+	+	+	-	+	+	+	N	+	+	N	N	+	+	+	+	N	16	2	4	**Moderate Priority**
Establish open end contracts with construction companies for emergency building demolision.	+	+	+	+	-	+	+	+	-	+	+	+	N	+	+	N	N	+	+	+	+	N	16	2	4	**Moderate Priority**

Mitigation Action and Description	**PA STEEL Criteria Considerations**																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Establish open end contracts with construction companies for emergency vegetation management.	+	+	+	+	-	+	+	+	-	+	+	+	N	+	+	N	N	+	+	+	+	N	16	2	4	**Moderate Priority**
Purchase and maintain hyper-local street-level weather stations to assist in salting, flooding, and plowing operations.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Purchase and maintain drop-gates for known dangerous roads during emergency events, particularly along Cobbs Creek, for Bells Mill Road, and on Delaware Ave	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Clean and maintain streams and canals of debris prior to and following weather events.	+	+	-	+	-	+	+	+	-	+	+	+	+	+	+	N	N	+	+	+	+	N	16	3	3	**Moderate Priority**

Mitigation Action and Description	**PA STEEL Criteria Considerations**																						**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Purchase additional sweepers to assist in debris removal prior to and following flooding events.	+	+	+	-	-	+	N	+	+	+	+	+	N	-	N	N	N	N	+	+	+	N	12	3	7	**Moderate Priority**
Purchase additional flusher trucks for use during flooding events.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Purchase additional brining trucks for brining operations prior to winter storm events.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Purchase additional salting trucks for brining operations prior to and during winter storm events.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Purchase additional chipers to assist in limb maintenance, reducing debris, and downed vegetation prior to and following storms	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**

Mitigation Action and Description	**PA STEEL Criteria Considerations**																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
Mitigation Action and Description	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
Purchase additional fuel truck for refueling vehicles during staging and response for emergency events, as well as for refueling generators and un-moveable equipment deployed during emergency events.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Develop a list of City owned property that can temporarily be used to store emergency debris & snow (by district).	+	-	N	N	+	-	+	+	+	N	+	+	+	N	+	N	N	N	N	-	+	N	10	3	9	**Moderate Priority**
Creation of a tactical guide for flood pre-event actions and response activities	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**
Enlarge culverts of the Poquessing Creek tributaries to protect roadway and residences.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																						Total Favorable	Total Less Favorable	Total Not Applicable	Priority
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Buy equipment to upgrade capability to survey flood prone bridges and roads.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Construct ground water interceptors to capture water seeping from rock outcrops to prevent constant ice accumulation on Lincoln and Kelly Drives.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Establish a smart detour plan for flooding of Wissahickon Creek, Schuylkill River and Cobbs Creek.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Install GPS on all storm operations vehicles.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Establish an open-end contract to purchase or rent material/equipment for unforeseen events.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Install battery back-up traffic signal controllers (75,000 each) 10% of signals in City.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Purchase portable trailer lights for each Streets Department facility or yard.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Equip drawbridges with back-up generators	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Procure a hi-rail bucket truck	+	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	+	N	19	2	1	**High Priority**
Increase bridge inspection training	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	N	20	1	1	**High Priority**
Procure three more high reach bucket trucks	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																						Total Favorable	Total Less Favorable	Total Not Applicable	Priority
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Renew/ review emergency crane contracts	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	N	20	1	1	**High Priority**
Operationalize IPAWS for city use	-	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	-	N	17	4	1	**Moderate Priority**
Revise city-wide evacuation planning	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**
Procure traffic detour modelling software	+	+	-	+	-	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	N	18	3	1	**High Priority**
Procure pedestrian modelling software	+	+	-	+	-	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	N	18	3	1	**High Priority**
Conduct logistics center planning	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**
Revise Mass Care and shelter plan	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**
Develop surge staffing for expanded shelters	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	19	2	1	**High Priority**
Identify logistics staging sites	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	19	2	1	**High Priority**
Pre-identify POD locations	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																						Total Favorable	Total Less Favorable	Total Not Applicable	Priority
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Procure two refrigerated semi-tractor trailers	+	-	+	-	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	N	17	4	1	**Moderate Priority**
Conduct logistics operations functional exercises	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	N	20	1	1	**High Priority**
Conduct preparedness workshops within crude rail transport corridors	+	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	+	N	19	2	1	**High Priority**
Expand SPOT training for all PPD personnel	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**
Expand cot and DME/G caches	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	20	1	1	**High Priority**
Establish emergency contracts for 500kW/1mW generators	+	+	-	-	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	N	17	4	1	**Moderate Priority**
Expand the EOC to accommodate 90 liaisons	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	21	0	1	**Highest Priority**
Enhance THIRA process to identify resource gaps	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	20	1	1	**High Priority**
Conduct additional medical countermeasure exercises	+	+	-	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	N	18	3	1	**High Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
Conduct mass casualty exercises	+	+	-	-	+	+	+	+	-	+	+	+	+	-	+	+	+	+	+	+	+	N	17	4	1	**Moderate Priority**
Develop educational and promotional video series to educate and increase public awareness of City hazards and response plans.	+	+	+	+	+	+	+	+	N	N	+	+	N	-	N	N	N	N	+	+	+	N	13	1	8	**Moderate Priority**
Determine low-lying substation vulnerabilities and outline options for adaptation and mitigation; coordinate with DOE on their vulnerable infrastructure studies	+	+	+	+	+	+	N	+	-	+	+	+	+	-	N	N	N	N	+	+	+	N	14	2	6	**Moderate Priority**

Mitigation Action and Description	**PA STEEL Criteria Considerations**																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Preparing, adopting, implementing, and updating a comprehensive long-term recovery plan to direct how and where state or federal disaster recovery funds are used to rebuild resilient communities	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	N	20	1	1	**High Priority**
Develop individual hazard management plans for historic structures that take climate change impacts into account; if necessary, consider moving the structure to a safer location	+	+	+	-	-	+	N	+	+	+	+	-	N	-	N	N	N	N	+	+	+	N	11	4	7	**Moderate Priority**
Identify dead and falling trees along pathways and roads for removal.	+	+	+	-	-	+	+	+	-	+	+	+	+	-	+	+	+	+	+	+	+	N	17	4	1	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Purchase Cyclomedia software to assist in the identification of high priority areas for the removal of dead and falling trees.	+	+	-	-	-	+	+	+	+	+	+	-	N	-	+	+	N	+	+	+	+	N	14	5	3	**Moderate Priority**
Establish a policy based on need and funding availability for a regular pruning cycle for city trees.	+	+	+	+	+	+	+	+	+	+	+	+	N	+	+	N	N	+	+	+	+	N	18	0	4	**High Priority**
Decrease the backlog of 2,000+ tree maintenance and removal projects to reduce unpruned and dead trees falling on power lines during storm events.	+	+	-	-	-	+	+	+	-	+	+	+	+	-	+	+	+	+	+	+	+	N	16	5	1	**Moderate Priority**
Purchase eight (8) additional chippers to assist in limb maintenance, reducing debris, and downed vegetation prior to and following storms	+	+	+	-	-	+	+	+	+	+	+	+	N	-	+	N	N	+	+	+	+	N	15	3	4	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Construct ground water interceptors to capture water seeping from rock outcrops to prevent constant ice accumulation on Lincoln and Kelly Drives.	+	+	+	-	-	+	+	+	-	+	+	+	N	-	+	N	N	+	+	+	+	N	14	4	4	**Moderate Priority**
Expand the study of Southern plant species by 30 acres using sustainable planting practices in preparation for increasing temperatures over the next century.	+	+	+	-	-	+	+	+	+	+	+	+	+	-	+	+	N	+	+	+	+	N	17	3	2	**Moderate Priority**
Establish open end contracts with construction companies for emergency vegetation management.	+	+	-	-	+	+	+	+	+	+	+	+	+	+	N	N	+	+	+	+	+	N	17	2	3	**Moderate Priority**
Complete outstanding follow-up items from the most recent Community Assistance Visit.	+	-	+	+	+	-	-	+	+	+	+	-	N	-	+	N	N	N	+	+	+	N	12	5	5	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																									
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge	**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
Investigate the possibility of consolidating floodplain management licensing and inspection responsibilities into one or two positions.	+	+	-	+	+	+	N	N	+	N	+	+	N	N	N	N	N	N	+	+	+	N	11	1	10	**Moderate Priority**
Assess properties which may benefit from elevation, acquisition, relocation, or retrofitting.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0	22	**Moderate Priority**
Elevate, acquire, relocate, or retrofit those repetitive loss properties that benefit from such actions.	+	+	+	-	-	-	N	+	+	+	+	-	+	-	+	N	N	N	+	+	+	N	12	5	5	**Moderate Priority**

Mitigation Action and Description	PA STEEL Criteria Considerations																						Total Favorable	Total Less Favorable	Total Not Applicable	Priority
	+ Favorable **-** Less favorable **N** Not Applicable																									
	P		**A**			**S**		**T**			**E**				**E**					**L**						
	Political		Administrative			Social		Technical			Economic				Environmental					Legal						
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Support resiliency of the City's private sector though information sharing, partnership building, training and education on preparedness, COOP, mitigation principles and Philadelphia's HMP.	+	+	+	+	+	+	+	+	-	+	+	+	+	N	N	N	N	N	N	+	+	N	14	1	7	**Moderate Priority**
Support regulations to improve resiliency of buildings in areas facing increased risk of flood with the Flood Risk Management Task Force	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	+	+	+	+	+	21	0	1	**Highest Priority**
Create a guide on steps that commercial and residential property owners can take to make their existing buildings more resilient to climate change	+	+	+	+	+	+	+	+	-	+	+	+	+	+	N	N	+	+	+	+	+	+	19	1	2	**High Priority**
Examine and evaluate the strategy of using rolling easements to assist in adapting to the potential consequences of sea level rise.	+	+	-	-	+	+	+	+	-	+	+	-	N	-	+	N	+	+	+	+	+	+	15	5	2	**Moderate Priority**
Acknowledging and addressing climate change issues, concerns, and impacts in Philadelphia2035 district plans.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	22	0	0	**Highest Priority**

PA STEEL Criteria Considerations

+ Favorable **-** Less favorable **N** Not Applicable

Mitigation Action and Description	**P** Political		**A** Administrative			**S** Social		**T** Technical			**E** Economic				**E** Environmental					**L** Legal			**Total Favorable**	**Total Less Favorable**	**Total Not Applicable**	**Priority**
	Political Support	Public Support	Staffing	Funding Allocation	Maintenance/ Operations	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land / Water	Effect on Endangered Species	Effect on HAZMAT / Waste Site	Consistent w/ Community Environmental Goals	Consistent w/ Federal Laws	State Authority	Existing Local Authority	Potential Legal Challenge				
Evaluate properties buyout feasibility for structures that are damaged or at high risk of damage from sea level rise or storm events both reactively over time as properties are damaged, or proactively for properties that are at a high risk for flooding.	-	+	-	-	+	+	-	+	+	+	+	-	+	-	+	N	N	+	+	+	+	-	13	7	2	**Moderate Priority**
Continuously update and improve zoning maps and codes to encourage uses, buildings, and site improvements that reduce exterior and interior heat island effects.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	+	+	+	+	21	0	1	**Highest Priority**
Develop planning and zoning recommendations for hazardous material transportation throughout the City.	+	+	+	-	+	+	+	+	-	+	+	+	+	-	+	N	+	+	+	+	+	-	17	4	1	**Moderate Priority**
Develop a software platform to share flooding event information across departments in real-time as well as historically.	+	+	+	-	+	+	+	-	+	+	+	-	+	-	+	N	N	+	+	+	+	+	16	4	2	**Moderate Priority**
Promote sustainable, mitigation-driven redevelopment for City-acquired properties.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	22	0	0	**Highest Priority**

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 on 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, Evaluation and Updating the Plan

The planning committee intends to remain intact as the organization responsible for monitoring, evaluating and updating Philadelphia's HMP. OEM will continue to act as the coordinating agency for the planning committee. The next hazard for inclusion is utility interruption. This human-caused hazard's full analysis will be completed in the year following approval of the 2017 Hazard Mitigation Plan and amended onto the Plan following drafting and approval by the City of Philadelphia, PEMA, and FEMA.

Additionally, the Pennsylvania Historical and Museum Commission is concluding conducting historical mitigation assessments for Philadelphia as part of a larger mitigation assessment project. The mitigation action recommendations and historical mitigation information will be appended to the 2017 Hazard Mitigation Plan following the conclusion of the project and pending City, PEMA, and FEMA approval.

Each participating planning committee member will monitor and evaluate the effectiveness of their agency's projects, programs and policies. The Planning Committee will also look at any changes in City resources that may influence the plan implementation or mitigation action feasibility. The Planning Committee will evaluate the content of the 2017 HMP using the following criteria:

- Are the mitigation actions effective?
- Are those actions listed under future mitigation actions still feasible?
- Are projects changing priority based on the shifting physical, economic, or political landscape of the City?
- Are there any changes in land development that affect mitigation priorities?
- Are the goals, objectives, and mitigation actions relevant given changes in Philadelphia?
- Are the goals, objectives and mitigation actions relevant given any changes to state or federal regulations or policy?
- Is there new data that affects the Risk Assessment portion of the plan?

- Is there new data that affects the Capability Assessment portion of the plan?
- Is there new data that affects the prioritization of mitigation actions?

In addition to ongoing high-level review, OEM will continue to update the Philadelphia HMP plan every five years, as required by FEMA.

7.3 Incorporation into Other Planning Mechanisms

With OEM oversight, each planning committee member's department or office is responsible for implementing its 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 obtaining funds from outside sources to implement the mitigation actions. OEM will continue to monitor potential funding sources to support projects listed in the mitigation plan, but City departments/offices are ultimately responsible for applications and reporting procedures for grants.

7.4 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 provide feedback on the HMP. Individuals will have an opportunity to submit comments through e-mail as well as through the survey. OEM will compile all comments and present them to the Planning Committee during meetings or during targeted outreach, depending on the nature and subject of the comments. The planning committee will consider these comments for incorporation in future plan amendments and updates. OEM will continue to attend public meetings with partner agencies to promote awareness and solicit useful feedback on the mitigation plan.

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 will be submitted to the Pennsylvania State Hazard Mitigation Officer for submission to FEMA. Philadelphia will proceed with formal adoption proceedings when FEMA provides conditional approval 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.

9 Annex: Hazard Mitigation Plan Kick-off Meeting

Hazard Mitigation Plan Kick-Off Meeting

Thursday, November 12, 2015
1:00 PM, Emergency Operations Center, Fire Administration Building

Agenda Item	***Time Allotted***	***Note/Actions***
1. Introductions	*2 minutes*	☐
2. Hazard Mitigation Kick-Off Presentation ☐ *Hazard Mitigation in the Office of Emergency Management* ☐ *Introduction to Hazard Mitigation Planning* ☐ *Updating Process and Timeline* ☐ *Plan Components, Inclusions, and Expansions*	*20 minutes*	☐

3. PEMA and FEMA Hazard Mitigation Discussion	*10 minutes*	☐
4. Working Group Discussions (see reverse for group assignment)	*10 minutes*	☐
5. Questions and discussion	*5 minutes*	☐
6. Action items/next steps	*3 minutes*	☐

Philadelphia
OEM

Hazard Mitigation Kick-Off Meeting
November 12, 2015, 1:00 PM

Name	Agency	Phone	E-Mail
DeAsa Tyler	Fleet Management	686·1698	Dessie.tyler@phila.gov
CHRIS GRIM	PEMA EASTERN AREA	610·962-3003	Chgrim@pa.gov.
Robert Frazee	PA DEP.	484.250.5776	RFRAZEE@PA.GOV.
Emily Alloy	OEM	215.683.3264	emily.alloy@phila.gov
Susan Patterson	PWD	215-685-4974	Susan.patterson@phila.gov
Alison Aminto	PWD	267 563 1354	alison.aminto@phila.gov
Kelly Anderson	PWD	215 685 6245	Kelly.anderson@phila.gov
Kristen Snuck	PWD	267 901 6076	kristen.snuck@phila.gov
Betsie Drust	PADEP	484 250 5162	bdrust@pa.gov
JOHN PFELLER	PPR	215.406-0734	JOHN.PFELLER@PHILA.GOV
Jeremy Young	PHMC	717-787-0771	jereyoung@pa.gov

Philadelphia OEM

Hazard Mitigation Kick-Off Meeting
November 12, 2015, 1:00 PM

Name	Agency	Phone	E-Mail
Chris Palmer	Parks + Rec	215-683 0221	christopher.palmer@phila.gov
Cory Kegerise	PHMC	215-219-3924	cKegerise@pa.gov
Jaime Moreno	PHMC	717 705 6960	jaimemoreno55@hotmail.com
Esther Needham	MCP Student	7178169419	eneedham@design.upenn.edu
Steven Alles	PDPH	215 685 6402	steven.alles@phila.gov
Alison Kearns	FEMA	215-931-5541	alison.kearns@fema.dhs.gov
Matt McCullough	FEMA	(215) 931-5587	matthew.mccullough@fema.dhs.gov
Christine Caggiano	FEMA / Resilience Action Partners	215 446 5193	ccaggiano@mbakerintl.com
stefan Lorenz	streets	215-686-5498	stefan.lorenz@phila.gov
JOHN HAAK	CITY PLANNING	215 683 4653	john.haak@phila.gov
RALPH DIPIETRO	LFI	215 686-2510	RALPH.DIPIETRO@PHILA.GOV

Philadelphia OEM

Hazard Mitigation Kick-Off Meeting
November 12, 2015, 1:00 PM

Name	Agency	Phone	E-Mail
MICHAEL FINK	L&I	215-683-4683	michael.fink@phila.gov
Sarah Wu	MOS	215-686-3649	sarah.wu@phila.gov
TOM HUGHES	PEMA	717-651-2726	thughes@pa.gov
Ernie Szabo	PEMA	717 651 2159	erszabo@pa.gov
Jaime Moreno	RHMC	717 705 6960	jaimemoreno35@hotmail.com

10 Annex: Past Drought Declarations

The following table captures those instances of drought between 1980 and 2015.

<table>
<tr><th colspan="4">Summary of Declared Drought Status from 1980-2015</th></tr>
<tr><th colspan="2">Drought Phase</th><th colspan="2">Date</th></tr>
<tr><td colspan="2" rowspan="9">Drought Watch</td><td colspan="2">August 2011 – September 2011</td></tr>
<tr><td colspan="2">October 2007 – January 2008</td></tr>
<tr><td colspan="2">April 2006 – June 2006</td></tr>
<tr><td colspan="2">November 2001 – December 2001</td></tr>
<tr><td colspan="2">September 1999 – February 2000</td></tr>
<tr><td colspan="2">March 1999 – June 1999</td></tr>
<tr><td colspan="2">December 1998</td></tr>
<tr><td colspan="2">September 1992 – January 1993</td></tr>
<tr><td colspan="2">July 1988 – December 1988</td></tr>
<tr><td colspan="2" rowspan="11">Drought Warning</td><td colspan="2">September 2010 – November 2010</td></tr>
<tr><td colspan="2">November 2002 – December 2002</td></tr>
<tr><td colspan="2">December 2001 – February 2002</td></tr>
<tr><td colspan="2">June 1999 – July 1999</td></tr>
<tr><td colspan="2">October 1997 – January 1998</td></tr>
<tr><td colspan="2">November 1995 – December 1995</td></tr>
<tr><td colspan="2">September 1995</td></tr>
<tr><td colspan="2">September 1991 – September 1992</td></tr>
<tr><td colspan="2">March 1989 – May 1989</td></tr>
<tr><td colspan="2">January 1985 – April 1985</td></tr>
<tr><td colspan="2">November 1982 – March 1983</td></tr>
<tr><td colspan="2" rowspan="6">Drought Emergency</td><td colspan="2">September 2002 – November 2002</td></tr>
<tr><td colspan="2">February 2002 – June 2002</td></tr>
<tr><td colspan="2">July 1999 – September 1999</td></tr>
<tr><td colspan="2">September 1995 – November 1995</td></tr>
<tr><td colspan="2">April 1985 – December 1985</td></tr>
<tr><td colspan="2">November 1980 – April 1982</td></tr>
<tr><td rowspan="2">Totals</td><td>Total Drought Watches</td><td>Total Drought Warnings</td><td>Total Drought Emergencies</td></tr>
<tr><td>9</td><td>12</td><td>6</td></tr>
</table>

11 Annex: Past Occurrences of Earthquakes in or around Southeast Pennsylvania

The table on the following pages uses the USGS data to identify those earthquakes with epicenters in or around Southeast Pennsylvania.

Catalog of Earthquakes with Epicenters in or around Southeast Pennsylvania [1] [356]
(Philadelphia epicenters indicated in bold)

Date	Location	Magnitude	Intensity
5/27/2011	**Philadelphia, PA**	**1.7**	**I**
7/27/1999	Warwick, PA	N/A	N/A
5/31/1999	Columbus, NJ	2.3	N/A
10/27/1998	Centerville, DE	1.5	II
3/25/1998	Salem, NJ	1.9	N/A
3/19/1998	Wilmington, DE	1.7	I-II
3/15/1998	Wilmington, DE	1.8	III
4/16/1997	Talleyville, DE	1.6	III-IV
3/11/1997	Pineville, PA	1.6	N/A
1/29/1997	Wilmington, DE	1.4	II
10/17/1996	Nottingham, PA	2.2	N/A
7/5/1996	Glen Mills, PA	2.6	N/A
6/23/1996	Wilmington, DE	1.7	I-II
6/14/1996	Wilmington, DE	2.1	II-III
12/20/1995	Wilmington, DE	1.4	I-II
10/17/1995	Wilmington, DE	2	II
4/23/1994	Wilmington, DE	2	I-II
2/11/1994	Wilmington, DE	1.9	I
11/8/1993	Wilmington, DE	1.7	I-II
2/26/1993	Haddonfield, NJ	2.5	IV
5/15/1992	Milford, PA	1.6	N/A
9/29/1991	Magnolia, NJ	2.2	N/A
10/23/1990	Salem, NJ	2.9	V
3/30/1990	Downingtown, PA	1.8	N/A
2/2/1989	Perkasie, PA	N/A	N/A
12/6/1987	Columbus, NJ	2.1	N/A
9/15/1986	Roebling, NJ	1.9	N/A

---

[356] Earthquake: Custom Region (North: 41.215, South: 39.065, West: -76.245, East: 73.564). USGS. Retrieved December 7, 2015.

5/2/1986	Wilmington, DE	2.5	N/A
10/20/1985	Wilmington, DE	1.7	III-IV
10/11/1985	Wilmington, DE	1.9	III-IV
10/20/1984	Wilmington, DE	1.7	III-IV
5/10/1984	Hatfield, PA	2.2	N/A
2/15/1984	Wilmington, DE	1.5	I-II
1/20/1984	Wilmington, DE	1.8	I-II
1/19/1984	Wilmington, DE	2.5	IV
12/12/1983	Wilmington, DE	2.4	IV
11/17/1983	Wilmington, DE	2.9	V
5/12/1982	Penndel, PA	2.4	II
4/12/1982	Burlington, NJ	2.8	V
8/30/1980	Medford, NJ	3	N/A
5/2/1980	Abington, PA	2.8	N/A
3/11/1980	Abington, PA	2.8	N/A
3/5/1980	Abington, PA	3.5	IV
3/2/1980	Abington, PA	2.8	N/A
2/10/1977	Wilmington, DE	2.6	VI
3/11/1975	Wilmington, DE	2	VI
4/28/1974	Centerville, DE	3.3	IV
7/10/1973	Newark, DE	3.3	IV
2/28/1973	Penns Grove, NJ	3.8	V-VI
11/29/1972	Wilmington, DE	N/A	III-IV
11/27/1972	Wilmington, DE	2.4	III-IV
11/26/1972	Wilmington, DE	2.4	III-IV
8/14/1972	Wilmington, DE	3.3	IV
2/11/1972	Wilmington, DE	3.2	V
1/23/1972	Wilmington, DE	2.4	IV
1/22/1972	Wilmington, DE	2.4	IV
1/7/1972	Wilmington, DE	2.4	IV
1/3/1972	Wilmington, DE	2.4	IV
1/2/1972	Wilmington, DE	2.4	IV
12/29/1971	Wilmington, DE	3.3	IV
7/14/1971	Wilmington, DE	3.3	IV
12/10/1968	Medford, NJ	3	V
12/27/1961	Croyden Heights, PA	3.3	V
1/8/1944	Bellefonte, DE	3.2	V
11/15/1939	Folsom, NJ	3.8	V
12/3/1937	Deepwater, NJ	2.8	IV-V

1/26/1926	Cinnaminson, NJ	3.5	N/A
1/26/1921	Cinnaminson, NJ	3.3	V
4/29/1900	Gloucester City, NJ	N/A	IV
11/20/1895	Centerville, DE	N/A	IV
9/10/1877	Roebling, NJ	3.2	IV
10/10/1871	Deepwater, NJ	N/A	IV
10/9/1871	Deepwater, NJ	4.1	VII
2/10/1857	Columbus, NJ	3.1	N/A
<1840	**Philadelphia, PA**	**N/A**	**I**
11/23/1777	Darby, PA	N/A	III
3/22/1763	Darby, PA	N/A	III
12/17/1752	Sadsburyville, PA	3.6	IV
12/8/1737	Media, PA	N/A	IV

12 Annex: Flooding Past Occurrences

Flooding: Declared Disaster History 1955-2015 [357] [358]

Date	Type	Action
October 2012	Hurricane Sandy	Gubernatorial and Presidential – Major Disaster for Individual Assistance, Public Assistance and Hazard Mitigation
September 2011	Tropical Storm Lee	Emergency Measures Declaration for Public Assistance and Hazard Mitigation
August 2011	Hurricane Irene	Gubernatorial and Presidential – Major Disaster for Individual Assistance, Public Assistance and Hazard Mitigation
September 2006	Tropical Depression Ernesto	Gubernatorial
June 2006	Proclamation of Emergency - Flooding	Gubernatorial and Presidential – Major Disaster for Individual Assistance, Public Assistance and Hazard Mitigation
September 2005	Proclamation of Emergency - Katrina	Gubernatorial
September 2004	Tropical Depression Ivan	Major Disaster for Individual Assistance
August 2004	Severe Storm & Flooding	Major Disaster for Individual Assistance and Hazard Mitigation
September 2003	Hurricane Isabel/Henri	Gubernatorial and Presidential Declaration – Major Disaster
September 1999	Hurricane Floyd	Gubernatorial and Presidential Declaration – Major Disaster

---

[357] Currently Declared Disasters. PEMA. Retrieved December 3, 2015.

[358] Presidential Disaster Declarations for Pennsylvania. FEMA. Retrieved December 3, 2015.

June 1998	Severe Storms/ Tornadoes	Gubernatorial
January 1996	Flooding	Gubernatorial and Presidential – Major Disaster for Individual Assistance, Public Assistance and Hazard Mitigation
July 1994	Flooding	SBA – Physical Disaster and Economic Injury Disaster Loans
June 1972	Flood (Agnes)	President’s Declaration of Major Disaster – Governor’s Proclamation
September 1971	Flood	Governor’s Proclamation & President’s Declaration of Major Disaster
September 1955	Flood Diane	President’s Declaration of Major Disaster

13 Annex: Capability Assessment Survey

Capability Assessment Survey

Point of Contact Name:	Agency:
Point of Contact Title:	Phone:
E-mail:	

Please provide an approximate measure of your agency's capability to effectively implement hazard mitigation strategies to reduce hazard vulnerabilities. Using the following table, please place an "X" in the box marking the most appropriate degree of capability based on the best available information. Only one response from each participating agency is required.

Area and Description	**Degree of Capability**		
	Limited	**Moderate**	**High**
Planning and Regulatory Based off of planning and regulatory tools and programs currently implemented, what is your agency's estimated or anticipated capability in reducing hazard loss? (Example: Continuity of Operations Plan.)			
Administrative and Technical Based off the staffing of: • Planners (with land use/ land development knowledge) • Engineers or planners (with natural and/or human caused hazards knowledge) • Engineers or professionals trained in building and/or infrastructure construction • Flood plain manager • Land surveyor • Staff familiar with the hazards of the community • Personnel skilled in Geographic Information Systems • Grant writers			
Financial Based off of your agency's access or eligibility to use local financial resources *for hazard mitigation purposes* including the use of state and federal mitigation grant funds. This includes: • Capital Improvement Planning			

• Community Development Block Grants • Special purpose taxes • Utility fees • Water/sewer fees • Storm water fees • Development impact fees • General obligation, revenue, and/or special tax bonds • Partnering arrangements or intergovernmental agreements			
Education and Outreach Based off of the education and outreach programs and methods currently in place that could be used to implement mitigation activities and communicate hazard-related information.			

14 Annex: Snow Disaster Declarations

Between 1955 and 2015, Philadelphia acquired 6 Presidential Disaster / Emergency Declarations, and 6 Gubernatorial Declarations related to winter storms, classified as one or a combination of the following disaster types: severe storms, blizzard, snowstorm, heavy snow and flooding.

Disaster Declarations for Winter Weather

Date	Event	Actions
April, 2010	Severe Winter Storms & Snowstorms	Major Disaster for Public Assistance
February, 2007	Severe Winter Storm	Governor's Proclamation of Disaster Emergency – to utilize all available resources and personnel as is deemed necessary to cope with the magnitude and severity of this emergency situation
February, 2003	Severe Winter Storm	Governor's Proclamation of Disaster Emergency
January, 1996	Flooding	Governor's Proclamation; President's Declaration of Major Disaster
January, 1996	Severe Winter Storms	Major Disaster for Individual Assistance and Public Assistance

January, 1994	Winter Storm/Severe Storm	Governor's Proclamation; President's Declaration of Major Disaster
March, 1993	Blizzard	Governor's Proclamation; President's Declaration of Major Disaster
January, 1978	Heavy Snow	Governor’s Proclamation
January, 1966	Heavy Snow	Governor’s Proclamation
February, 1958	Heavy Snow	Governor’s Proclamation

Results

Agency	Planning and Regulatory	Low (1) to High (3)	Administrative and Technical	Low (1) to High (3)
Philadelphia Department of Health	Moderate	2	Moderate	2
Philadelphia Planning Commission	High	3	High	3
Philadelphia Licensing and Inspections	Limited	1	Moderate	2
Philadelphia Parks and Recreation	Limited	1	Limited	1
Philadelphia Streets	Limited	1	Limited	1
Philadelphia Office of Fleet Management	Moderate	2	Limited	1
Philadelphia Water Department	High	3	High	3
Philadelphia Office of Sustainability	Moderate	2	Moderate	2
		2		2

16 Appendix: HAZUS Earthquake Report

Hazus-MH: Earthquake Event Report

Region Name: Philadelphia

Earthquake Scenario: Arbitrary M 5 Depth 10

Print Date: May 04, 2016

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Pennsylvania

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 142.67 square miles and contains 384 census tracts. There are over 599 thousand households in the region which has a total population of 1,526,006 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 534 thousand buildings in the region with a total building replacement value (excluding contents) of 165,970 (millions of dollars). Approximately 93.00 % of the buildings (and 70.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 7,754 and 1,134 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 534 thousand buildings in the region which have an aggregate total replacement value of 165,970 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 62% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 36 hospitals in the region with a total bed capacity of 9,447 beds. There are 570 schools, 3 fire stations, 28 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 222 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 8,888.00 (millions of dollars). This inventory includes over 469 kilometers of highways, 546 bridges, 124,947 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	546	2,846.20
	Segments	650	3,481.20
	Tunnels	0	0.00
		Subtotal	**6,327.40**
Railways	Bridges	0	0.00
	Facilities	19	50.60
	Segments	616	406.40
	Tunnels	0	0.00
		Subtotal	**457.00**
Light Rail	Bridges	0	0.00
	Facilities	146	388.80
	Segments	211	257.30
	Tunnels	0	0.00
		Subtotal	**646.10**
Bus	Facilities	14	16.60
		Subtotal	**16.60**
Ferry	Facilities	1	1.30
		Subtotal	**1.30**
Port	Facilities	72	143.80
		Subtotal	**143.80**
Airport	Facilities	1	10.70
	Runways	4	151.90
		Subtotal	**162.50**
		Total	**7,754.80**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	1,249.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1,249.50**
Waste Water	Distribution Lines	NA	749.70
	Facilities	4	290.40
	Pipelines	0	0.00
		Subtotal	**1,040.10**
Natural Gas	Distribution Lines	NA	499.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**499.80**
Oil Systems	Facilities	5	0.50
	Pipelines	0	0.00
		Subtotal	**0.50**
Electrical Power	Facilities	7	839.30
		Subtotal	**839.30**
Communication	Facilities	35	3.80
		Subtotal	**3.80**
		Total	**3,633.00**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Arbitrary M 5 Depth 10
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-75.11
Latitude of Epicenter	39.99
Earthquake Magnitude	5.00
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Building Damage

Hazus estimates that about 130,054 buildings will be at least moderately damaged. This is over 24.00 % of the buildings in the region. There are an estimated 9,908 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	104	0.04	88	0.06	105	0.12	44	0.14	13	0.13
Commercial	7,632	2.87	5,738	4.15	8,067	9.11	4,115	13.02	1,264	12.76
Education	342	0.13	243	0.18	361	0.41	184	0.58	56	0.56
Government	183	0.07	126	0.09	201	0.23	109	0.34	34	0.34
Industrial	1,365	0.51	946	0.68	1,503	1.70	836	2.65	258	2.61
Other Residential	24,323	9.15	12,077	8.73	8,624	9.74	3,438	10.87	880	8.89
Religion	1,231	0.46	695	0.50	658	0.74	321	1.02	93	0.94
Single Family	230,510	86.76	118,422	85.61	69,012	77.95	22,567	71.38	7,310	73.77
Total	**265,689**		**138,334**		**88,531**		**31,616**		**9,908**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Wood	198,751	74.81	92456	66.84	35,578	40.19	4,526	14.32	319	3.22
Steel	4,281	1.61	3010	2.18	5,732	6.47	3,322	10.51	1,081	10.91
Concrete	1,025	0.39	744	0.54	1,531	1.73	896	2.83	247	2.49
Precast	316	0.12	177	0.13	384	0.43	327	1.03	78	0.78
RM	3,012	1.13	1095	0.79	1,911	2.16	1,262	3.99	160	1.62
URM	58,084	21.86	40610	29.36	42,943	48.51	21,003	66.43	7,958	80.32
MH	220	0.08	242	0.18	450	0.51	280	0.88	66	0.66
Total	**265,689**		**138,334**		**88,531**		**31,616**		**9,908**	

*Note:

RM	Reinforced Masonry
URM	Unreinforced Masonry
MH	Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 9,447 hospital beds available for use. On the day of the earthquake, the model estimates that only 2,104 hospital beds (22.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 40.00% of the beds will be back in service. By 30 days, 76.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	36	34	0	0
Schools	570	204	0	22
EOCs	0	0	0	0
PoliceStations	28	14	0	0
FireStations	3	2	0	0

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	650	0	0	650	650
	Bridges	546	15	1	533	545
	Tunnels	0	0	0	0	0
Railways	Segments	616	0	0	616	616
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	19	17	0	19	19
Light Rail	Segments	211	0	0	211	211
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	146	107	0	146	146
Bus	Facilities	14	11	0	14	14
Ferry	Facilities	1	1	0	1	1
Port	Facilities	72	54	0	72	72
Airport	Facilities	1	0	0	1	1
	Runways	4	0	0	4	4

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	4	3	0	0	4
Natural Gas	0	0	0	0	0
Oil Systems	5	5	0	0	5
Electrical Power	7	7	0	0	7
Communication	35	33	0	35	35

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	62,474	7106	1776
Waste Water	37,484	5092	1273
Natural Gas	24,989	1461	365
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	599,736	40,416	37,822	32,818	10,134	0
Electric Power		0	0	0	0	0

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 6.35 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 49.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 253,920 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 24,758 households to be displaced due to the earthquake. Of these, 18,860 people (out of a total population of 1,526,006) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

· Severity Level 1:	Injuries will require medical attention but hospitalization is not needed.
· Severity Level 2:	Injuries will require hospitalization but are not considered life-threatening
· Severity Level 3:	Injuries will require hospitalization and can become life threatening if not promptly treated.
· Severity Level 4:	Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	60	14	2	4
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	54	13	2	3
	Other-Residential	1,734	412	59	116
	Single Family	3,934	919	127	248
	Total	**5,782**	**1,359**	**189**	**372**
2 PM	Commercial	3,587	854	115	224
	Commuting	1	1	2	0
	Educational	1,600	395	58	112
	Hotels	0	0	0	0
	Industrial	401	97	13	26
	Other-Residential	423	102	15	28
	Single Family	1,008	243	35	66
	Total	**7,020**	**1,692**	**238**	**455**
5 PM	Commercial	2,494	596	81	156
	Commuting	13	17	29	6
	Educational	263	65	10	19
	Hotels	0	0	0	0
	Industrial	251	61	8	16
	Other-Residential	686	165	24	46
	Single Family	1,584	382	55	103
	Total	**5,291**	**1,285**	**207**	**345**

Economic Loss

The total economic loss estimated for the earthquake is 24,088.19 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 23,377.88 (millions of dollars); 19 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 51 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	85.97	801.03	20.74	62.83	970.57
	Capital-Related	0.00	36.65	668.33	12.46	18.12	735.55
	Rental	211.83	285.03	330.85	8.06	30.64	866.40
	Relocation	736.59	168.76	577.31	40.78	261.35	1,784.78
	Subtotal	**948.41**	**576.41**	**2,377.51**	**82.04**	**372.94**	**4,357.31**
Capital Stock Losses							
	Structural	1,039.79	561.97	1,050.17	166.86	238.93	3,057.72
	Non_Structural	3,669.16	2,879.73	3,024.67	551.89	882.31	11,007.77
	Content	1,423.80	865.25	1,666.93	396.62	517.01	4,869.62
	Inventory	0.00	0.00	26.02	58.87	0.57	85.47
	Subtotal	**6,132.75**	**4,306.96**	**5,767.79**	**1,174.24**	**1,638.83**	**19,020.57**
	Total	**7,081.16**	**4,883.37**	**8,145.30**	**1,256.28**	**2,011.77**	**23,377.88**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	3,481.23	$0.00	0.00
	Bridges	2,846.20	$103.08	3.62
	Tunnels	0.00	$0.00	0.00
	Subtotal	**6327.40**	**103.10**	
Railways	Segments	406.37	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	50.60	$19.20	37.96
	Subtotal	**457.00**	**19.20**	
Light Rail	Segments	257.35	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	388.80	$139.64	35.92
	Subtotal	**646.10**	**139.60**	
Bus	Facilities	16.63	$6.32	38.02
	Subtotal	**16.60**	**6.30**	
Ferry	Facilities	1.33	$0.54	40.89
	Subtotal	**1.30**	**0.50**	
Port	Facilities	143.78	$53.20	37.00
	Subtotal	**143.80**	**53.20**	
Airport	Facilities	10.65	$2.46	23.11
	Runways	151.86	$0.00	0.00
	Subtotal	**162.50**	**2.50**	
	Total	**7754.80**	**324.50**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1,249.50	$31.97	2.56
	Subtotal	**1,249.47**	**$31.97**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	290.40	$77.17	26.57
	Distribution Lines	749.70	$22.92	3.06
	Subtotal	**1,040.06**	**$100.08**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	499.80	$6.57	1.32
	Subtotal	**499.79**	**$6.57**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.50	$0.13	22.95
	Subtotal	**0.55**	**$0.13**	
Electrical Power	Facilities	839.30	$246.35	29.35
	Subtotal	**839.30**	**$246.35**	
Communication	Facilities	3.80	$0.74	19.45
	Subtotal	**3.82**	**$0.74**	
	Total	**3,632.98**	**$385.85**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		**Total**	**%**

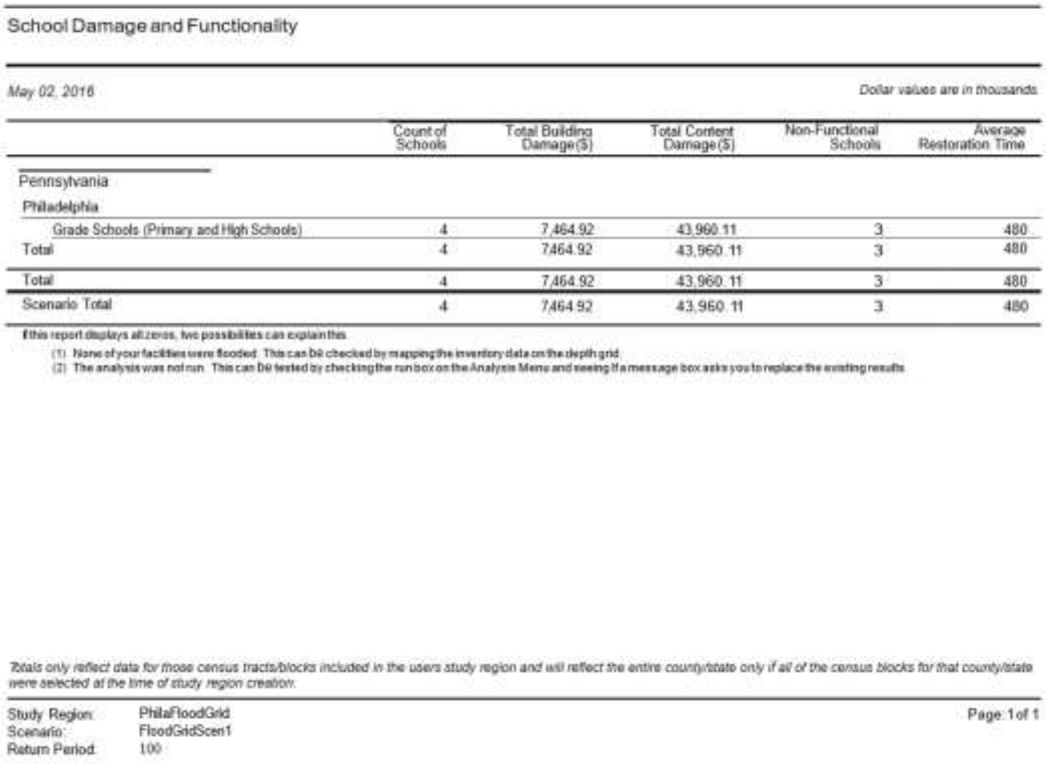
Appendix A: County Listing for the Region

Philadelphia, PA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Pennsylvania					
	Philadelphia	1,526,006	115,983	49,986	165,970
Total State		**1,526,006**	**115,983**	**49,986**	**165,970**
Total Region		**1,526,006**	**115,983**	**49,986**	**165,970**

17 Appendix: HAZUS Flooding Report



School Damage and Functionality

May 02, 2016

Dollar values are in thousands

	Count of Schools	Total Building Damage($)	Total Content Damage($)	Non-Functional Schools	Average Restoration Time
Pennsylvania					
Philadelphia					
Grade Schools (Primary and High Schools)	4	7,464.92	43,960.11	3	480
Total	4	7464.92	43,960.11	3	480
Total	4	7,464.92	43,960.11	3	480
Scenario Total	4	7464.92	43,960.11	3	480

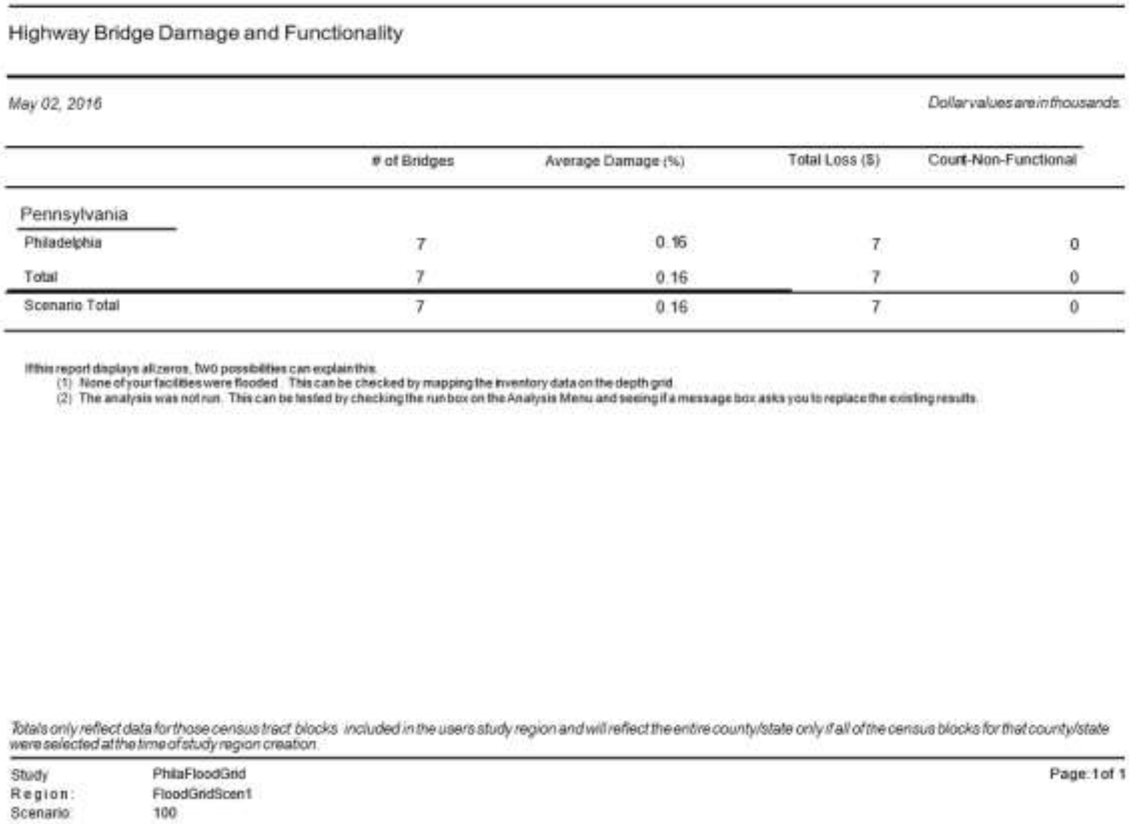
If this report displays all zeros, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Totals only reflect data for those census tracts/blocks included in the users study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: PhilaFloodGrid
Scenario: FloodGridScen1
Return Period: 100

Page: 1 of 1



Highway Bridge Damage and Functionality

May 02, 2016

Dollar values are in thousands

	# of Bridges	Average Damage (%)	Total Loss ($)	Count-Non-Functional
Pennsylvania				
Philadelphia	7	0.16	7	0
Total	7	0.16	7	0
Scenario Total	7	0.16	7	0

If this report displays all zeros, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

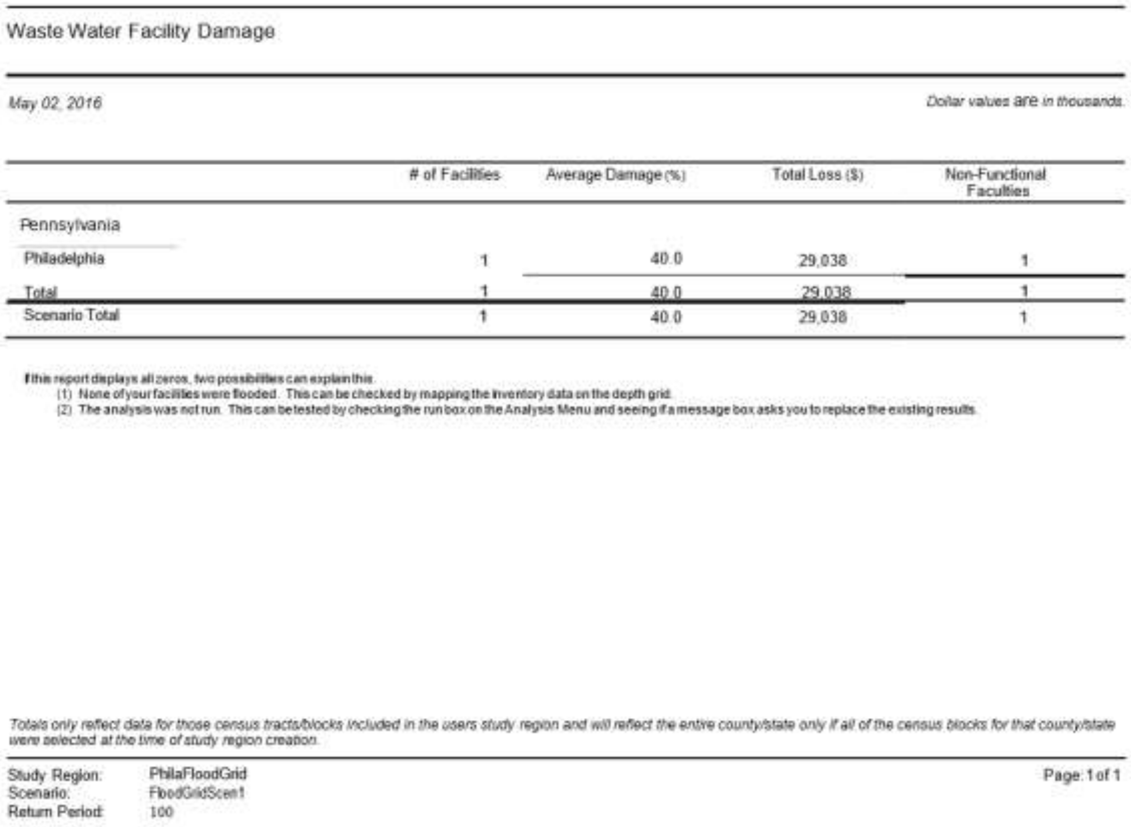
Totals only reflect data for those census tract blocks included in the users study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study PhilaFloodGrid

Region: FloodGridScen1

Scenario: 100

Page: 1 of 1



Waste Water Facility Damage

May 02, 2016

Dollar values are in thousands.

	# of Facilities	Average Damage (%)	Total Loss ($)	Non-Functional Faculties
Pennsylvania				
Philadelphia	1	40.0	29,038	1
Total	1	40.0	29,038	1
Scenario Total	1	40.0	29,038	1

If this report displays all zeros, two possibilities can explain this.

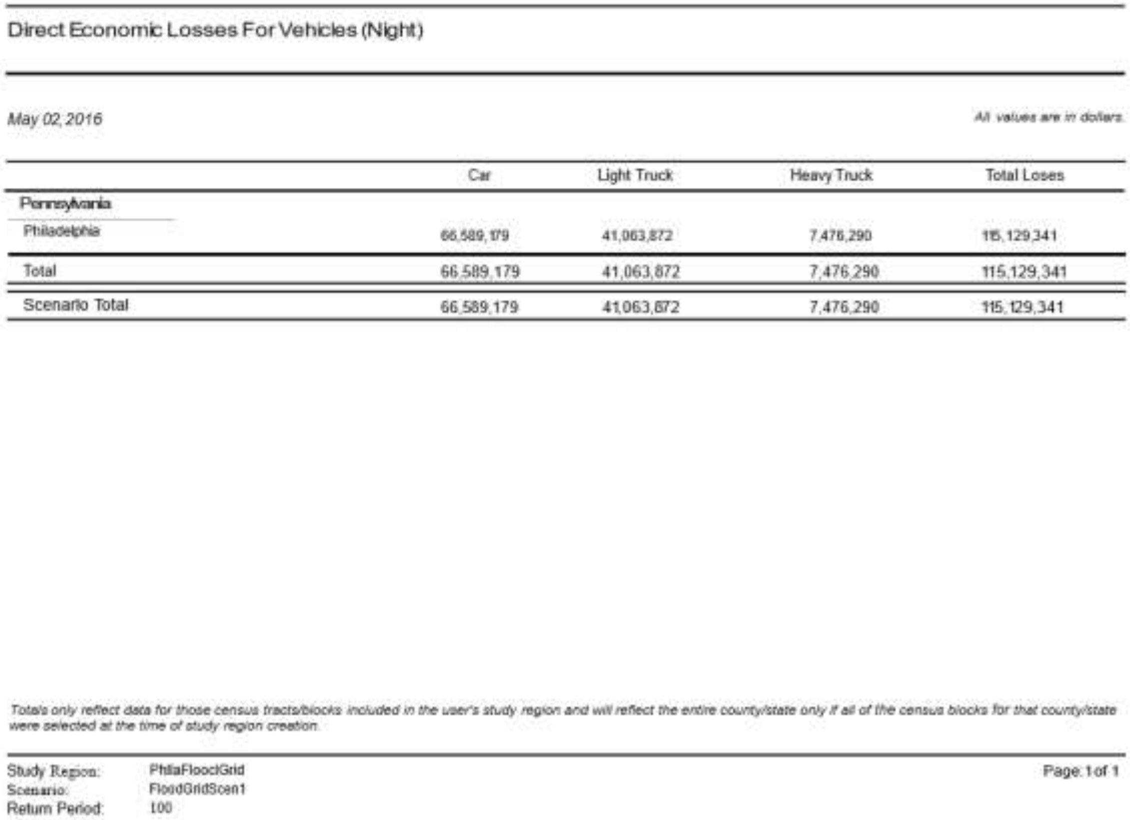
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Totals only reflect data for those census tracts/blocks included in the users study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: PhilaFloodGrid
Scenario: FloodGridScen1
Return Period: 100

Page: 1 of 1



Direct Economic Losses For Vehicles (Night)

May 02, 2016

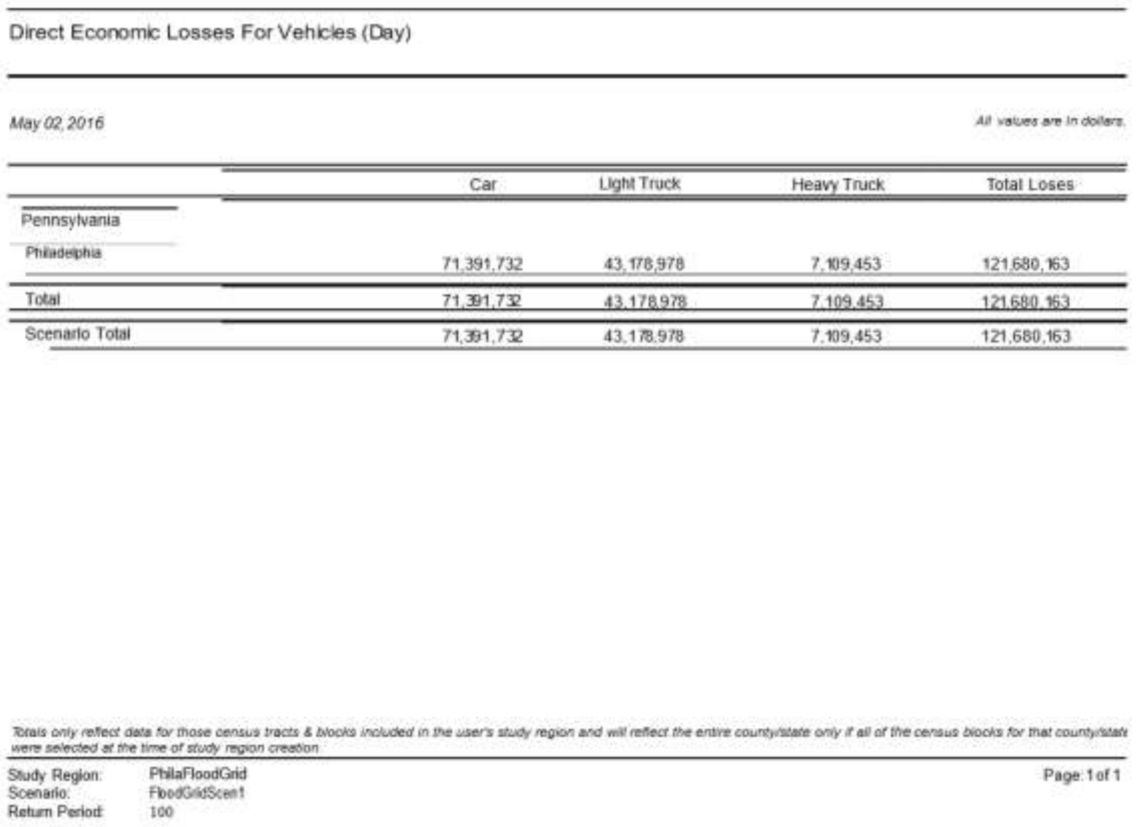
All values are in dollars.

	Car	Light Truck	Heavy Truck	Total Loses
Pennsylvania				
Philadelphia	66,589,179	41,063,872	7,476,290	115,129,341
Total	66,589,179	41,063,872	7,476,290	115,129,341
Scenario Total	66,589,179	41,063,872	7,476,290	115,129,341

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: PhilaFloodGrid
Scenario: FloodGridScen1
Return Period: 100

Page: 1 of 1



Direct Economic Losses For Vehicles (Day)

May 02, 2016

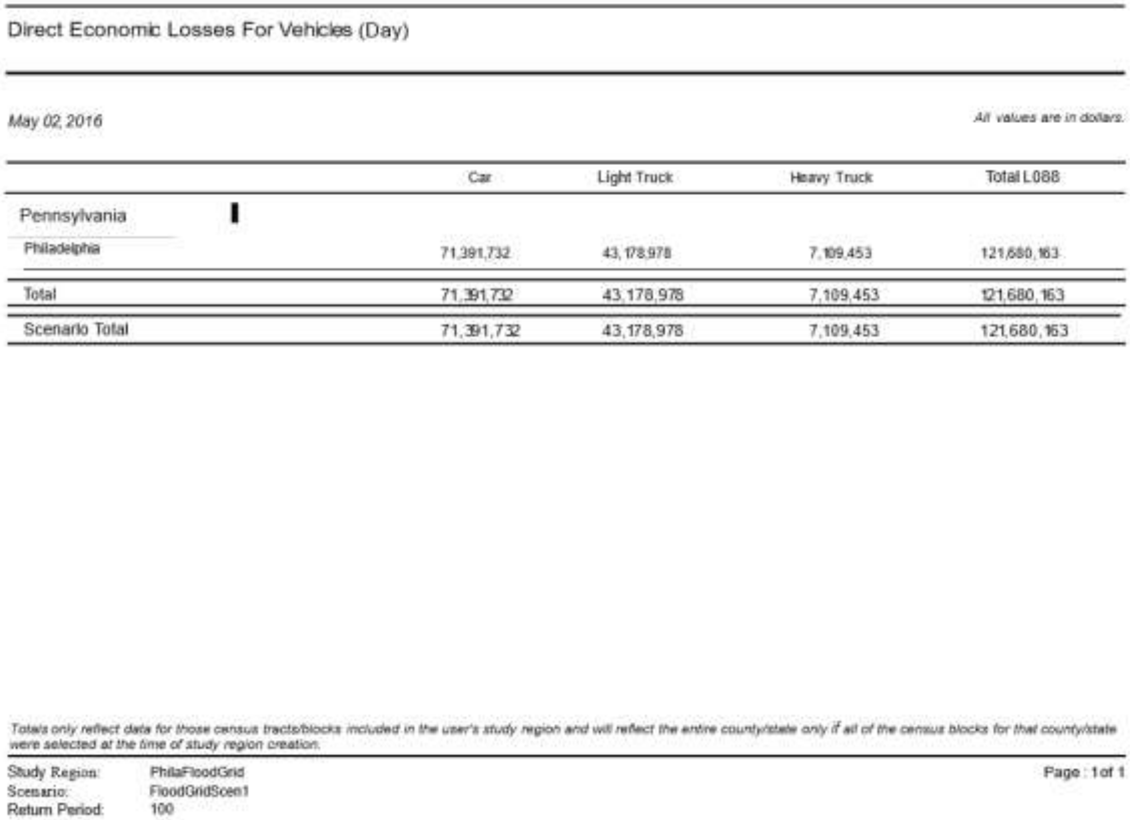
All values are in dollars.

	Car	Light Truck	Heavy Truck	Total Loses
Pennsylvania				
Philadelphia	71,391,732	43,178,978	7,109,453	121,680,163
Total	71,391,732	43,178,978	7,109,453	121,680,163
Scenario Total	71,391,732	43,178,978	7,109,453	121,680,163

Totals only reflect data for those census tracts & blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation

Study Region: PhilaFloodGrid
Scenario: FloodGridScen1
Return Period: 100

Page: 1 of 1



Direct Economic Losses For Vehicles (Day)

May 02, 2016

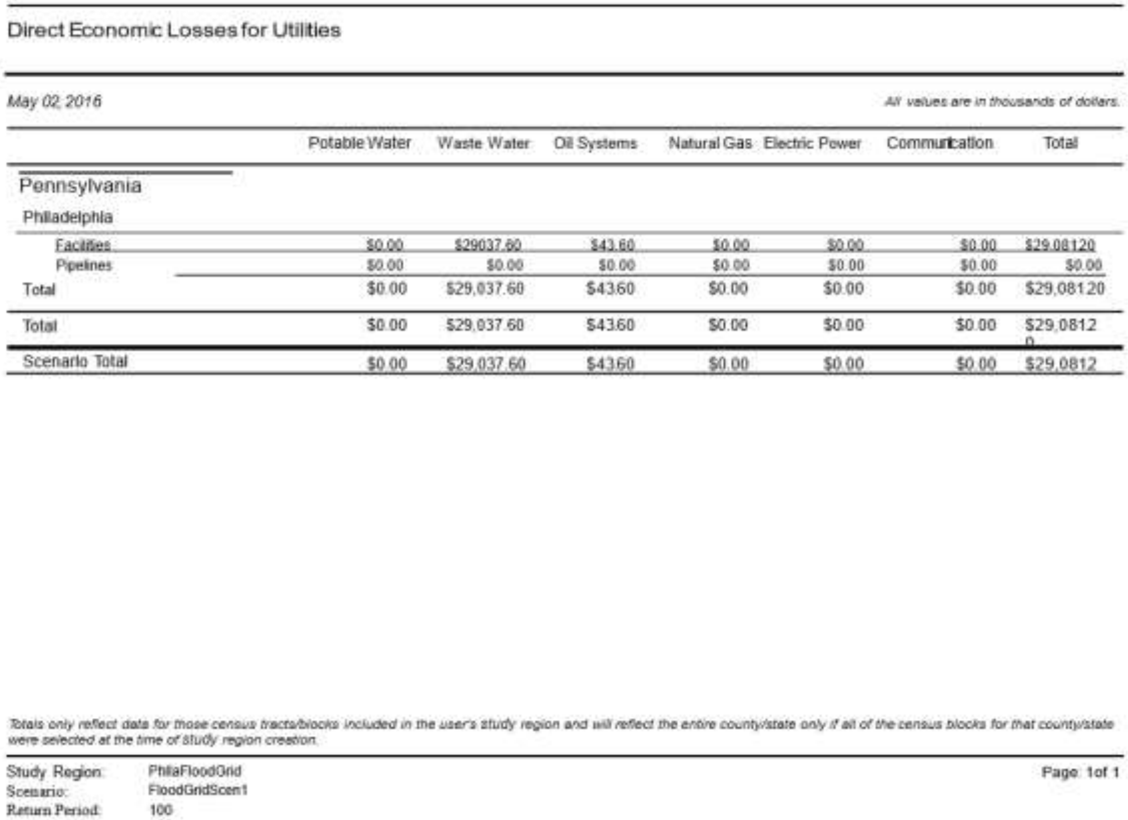
All values are in dollars.

	Car	Light Truck	Heavy Truck	Total Loss
Pennsylvania				
Philadelphia	71,391,732	43,178,978	7,109,453	121,680,163
Total	71,391,732	43,178,978	7,109,453	121,680,163
Scenario Total	71,391,732	43,178,978	7,109,453	121,680,163

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: PhilaFloodGrid
Scenario: FloodGridScen1
Return Period: 100

Page : 1 of 1



Direct Economic Losses for Utilities

May 02, 2016

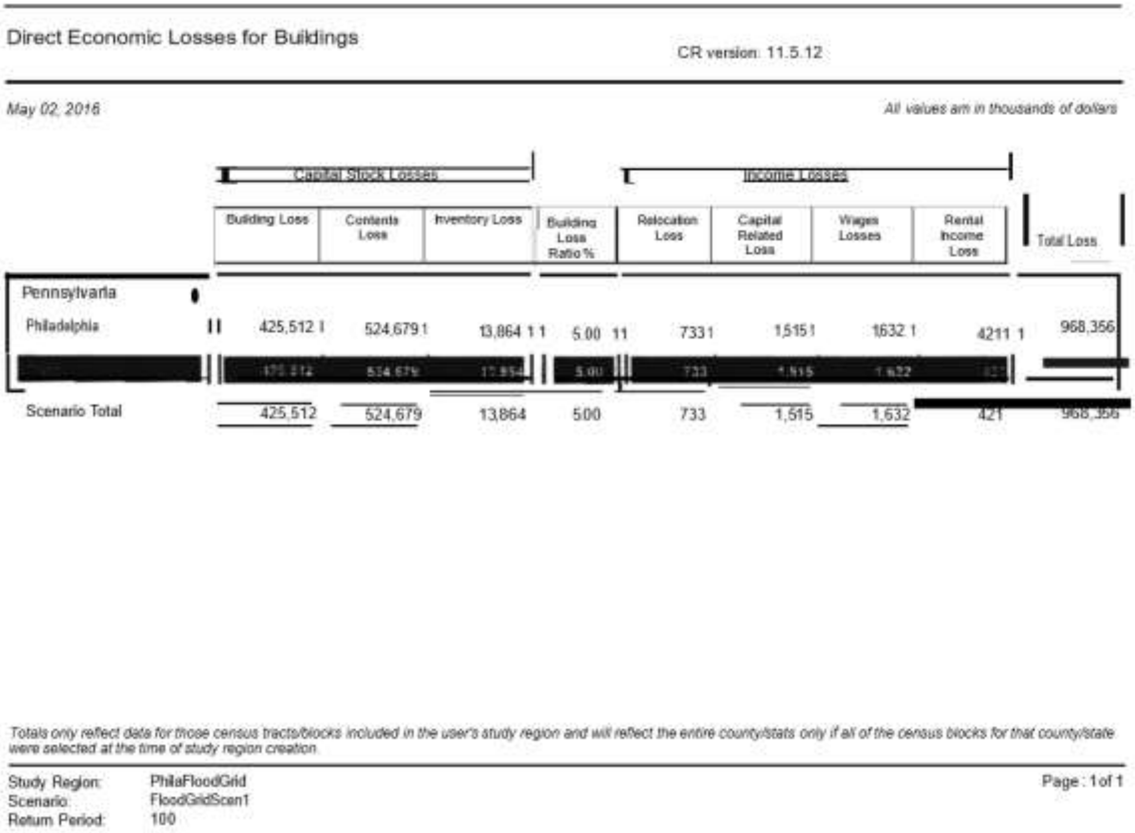
All values are in thousands of dollars.

	Potable Water	Waste Water	Oil Systems	Natural Gas	Electric Power	Communication	Total
Pennsylvania							
Philadelphia							
Facilities	$0.00	$29037.60	$43.60	$0.00	$0.00	$0.00	$29.08120
Pipelines	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total	$0.00	$29,037.60	$4360	$0.00	$0.00	$0.00	$29,081.20
Total	$0.00	$29,037.60	$4360	$0.00	$0.00	$0.00	$29,0812 0
Scenario Total	$0.00	$29,037.60	$4360	$0.00	$0.00	$0.00	$29,0812

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: PhilaFloodGrid
Scenario: FloodGridScen1
Return Period: 100

Page: 1of 1



Direct Economic Losses for Buildings

CR version: 11.5.12

May 02, 2016

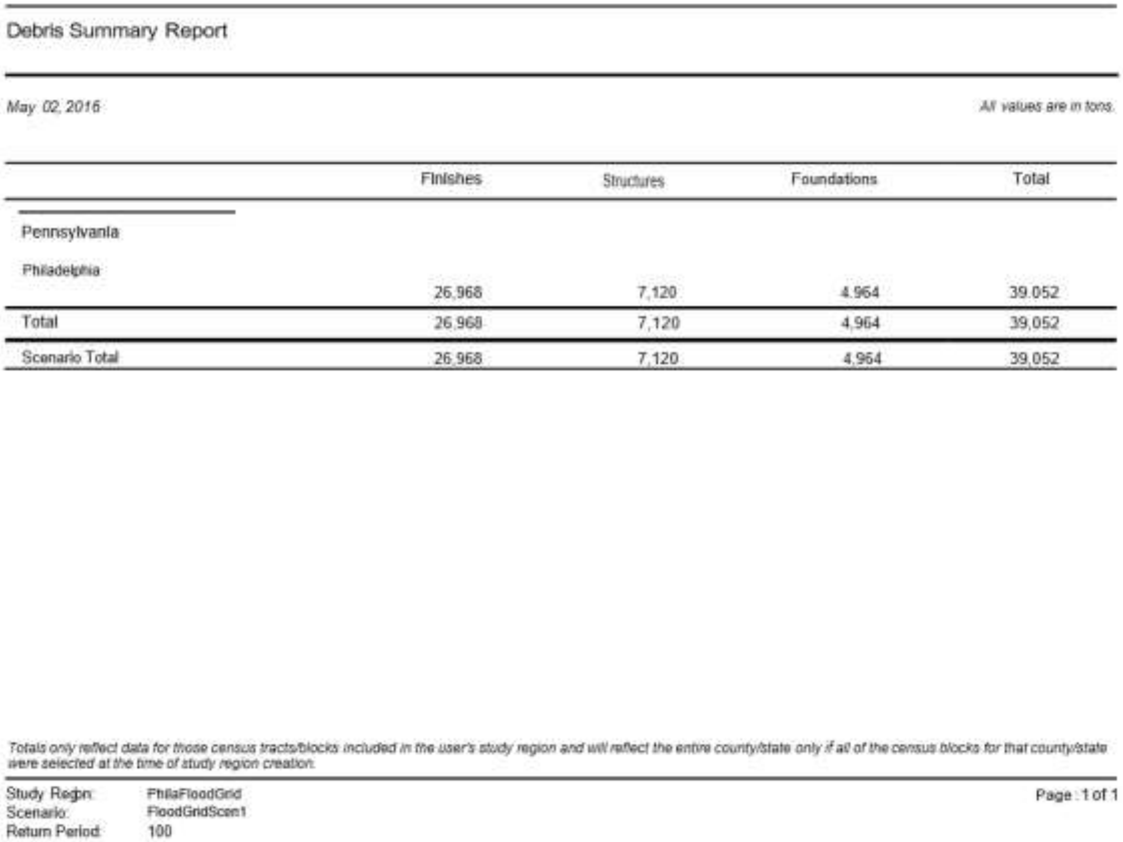
All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Pennsylvania									
Philadelphia	425,512	524,679	13,864	5.00	733	1,515	1632	421	968,356
	425,512	524,679	13,864	5.00	733	1,515	1,622	[illegible]	
Scenario Total	425,512	524,679	13,864	5.00	733	1,515	1,632	421	968,356

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region:	PhilaFloodGrid
Scenario:	FloodGridScen1
Return Period:	100

Page : 1 of 1



Debris Summary Report

May 02, 2016

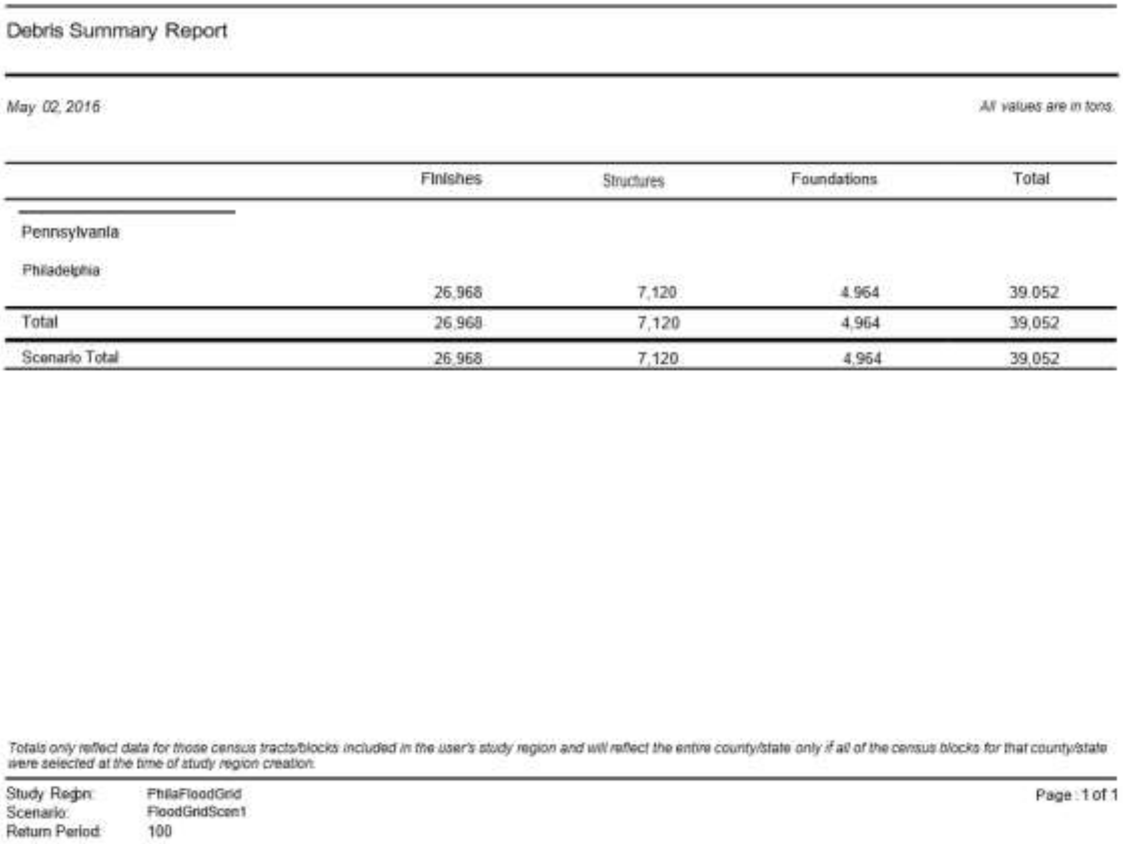
All values are in tons.

	Finishes	Structures	Foundations	Total
Pennsylvania				
Philadelphia	26,968	7,120	4,964	39,052
Total	26,968	7,120	4,964	39,052
Scenario Total	26,968	7,120	4,964	39,052

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: PhilaFloodGrid
Scenario: FloodGridScen1
Return Period: 100

Page : 1 of 1



Debris Summary Report

May 02, 2016

All values are in tons.

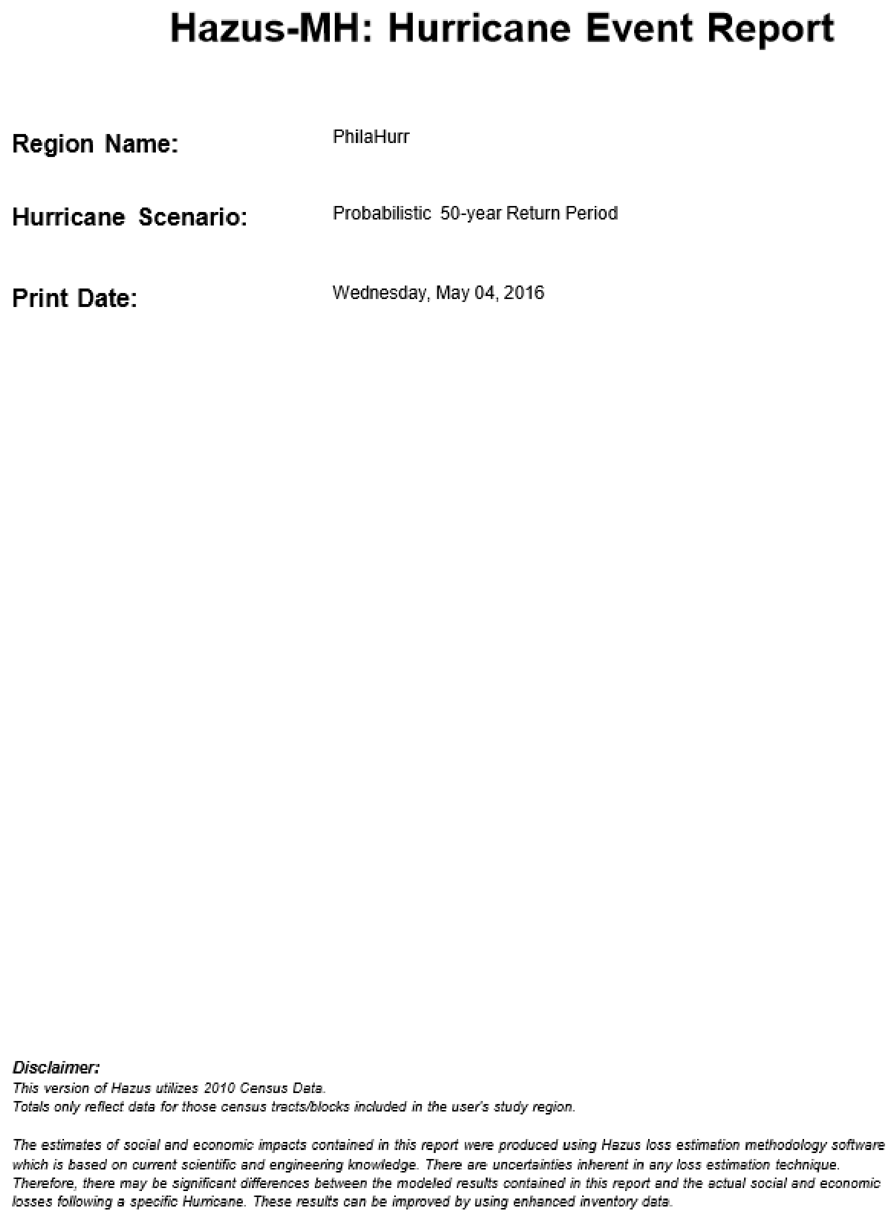
	Finishes	Structures	Foundations	Total
Pennsylvania				
Philadelphia	26,968	7,120	4,964	39,052
Total	26,968	7,120	4,964	39,052
Scenario Total	26,968	7,120	4,964	39,052

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: PhilaFloodGrid
Scenario: FloodGridScen1
Return Period: 100

Page : 1 of 1

18 Appendix: HAZUS Hurricane Reports



Hazus-MH: Hurricane Event Report

Region Name: PhilaHurr

Hurricane Scenario: Probabilistic 50-year Return Period

Print Date: Wednesday, May 04, 2016

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

Table of Contents

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Pennsylvania

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 142.71 square miles and contains 384 census tracts. There are over 599 thousand households in the region and has a total population of 1,526,006 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 534 thousand buildings in the region with a total building replacement value (excluding contents) of 165,971 million dollars (2010 dollars). Approximately 93% of the buildings (and 70% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 534,077 buildings in the region which have an aggregate total replacement value of 165,971 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	115,983,856	69.9%
Commercial	33,895,846	20.4%
Industrial	6,149,002	3.7%
Agricultural	110,433	0.1%
Religious	4,268,826	2.6%
Government	1,006,508	0.6%
Education	4,556,042	2.7%
Total	**165,970,513**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 36 hospitals in the region with a total bed capacity of 9,447 beds. There are 570 schools, 3 fire stations, 28 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 12 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 50 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	353	99.81	1	0.19	0	0.00	0	0.00	0	0.00
Commercial	26,746	99.74	70	0.26	0	0.00	0	0.00	0	0.00
Education	1,181	99.70	4	0.30	0	0.00	0	0.00	0	0.00
Government	651	99.69	2	0.31	0	0.00	0	0.00	0	0.00
Industrial	4,894	99.71	14	0.29	0	0.00	0	0.00	0	0.00
Religion	2,993	99.79	6	0.21	0	0.00	0	0.00	0	0.00
Residential	496,798	99.93	352	0.07	12	0.00	0	0.00	0	0.00
Total	**533,616**		**449**		**12**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 50 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	5,676	99.61	22	0.39	0	0.00	0	0.00	0	0.00
Masonry	177,519	99.81	331	0.19	10	0.01	1	0.00	0	0.00
MH	1,259	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	17,267	99.68	55	0.32	0	0.00	0	0.00	0	0.00
Wood	331,587	99.99	27	0.01	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 9,447 hospital beds available for use. On the day of the hurricane, the model estimates that 9447 hospital beds (only 100.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	3	0	0	3
Hospitals	36	0	0	36
Police Stations	28	0	0	28
Schools	570	0	0	570

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 949 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 949 tons, Brick/Wood comprises 100% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 38 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters . The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,526,006) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 18.4 million dollars, which represents 0.01 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 18 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 96% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	17,642.32	479.48	66.77	183.81	18,372.38
	Content	33.60	0.00	0.00	0.00	33.60
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**17,675.92**	**479.48**	**66.77**	**183.81**	**18,405.98**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	24.16	0.00	0.00	0.00	24.16
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**24.16**	**0.00**	**0.00**	**0.00**	**24.16**
Total						
	Total	**17,700.08**	**479.48**	**66.77**	**183.81**	**18,430.15**

Appendix A: County Listing for the Region

Pennsylvania
  - Philadelphia

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Pennsylvania				
Philadelphia	1,526,006	115,983,856	49,986,657	165,970,513
Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**
Study Region Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**

Hazus-MH: Hurricane Event Report

Region Name:	PhilaHurr
Hurricane Scenario:	Probabilistic 100-year Return Period
Print Date:	Wednesday, May 04, 2016

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

Table of Contents

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Pennsylvania

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 142.71 square miles and contains 384 census tracts. There are over 599 thousand households in the region and has a total population of 1,526,006 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 534 thousand buildings in the region with a total building replacement value (excluding contents) of 165,971 million dollars (2010 dollars). Approximately 93% of the buildings (and 70% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 534,077 buildings in the region which have an aggregate total replacement value of 165,971 million (2006 dollars). Table **1** presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	115,983,856	69.9%
Commercial	33,895,846	20.4%
Industrial	6,149,002	3.7%
Agricultural	110,433	0.1%
Religious	4,268,826	2.6%
Government	1,006,508	0.6%
Education	4,556,042	2.7%
Total	**165,970,513**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 36 hospitals in the region with a total bed capacity of 9,447 beds. There are 570 schools, 3 fire stations, 28 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 67 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 100 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	353	99.58	1	0.41	0	0.01	0	0.00	0	0.00
Commercial	26,681	99.50	132	0.49	2	0.01	0	0.00	0	0.00
Education	1,179	99.47	6	0.53	0	0.00	0	0.00	0	0.00
Government	649	99.42	4	0.58	0	0.00	0	0.00	0	0.00
Industrial	4,880	99.44	28	0.56	0	0.00	0	0.00	0	0.00
Religion	2,988	99.62	11	0.38	0	0.00	0	0.00	0	0.00
Residential	495,598	99.69	1,499	0.30	64	0.01	0	0.00	0	0.00
Total	**532,328**		**1,682**		**67**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 100 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	5,656	99.26	42	0.74	0	0.00	0	0.00	0	0.00
Masonry	176,872	99.44	927	0.52	60	0.03	2	0.00	0	0.00
MH	1,259	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	17,219	99.40	102	0.59	1	0.01	0	0.00	0	0.00
Wood	331,064	99.83	548	0.17	2	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 9,447 hospital beds available for use. On the day of the hurricane, the model estimates that 9447 hospital beds (only 100.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	3	0	0	3
Hospitals	36	23	0	36
Police Stations	28	0	0	28
Schools	570	0	0	570

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 8,510 tons of debris will be generated. Of the total amount, 250 tons (3%) is Other Tree Debris. Of the remaining 8,260 tons, Brick/Wood comprises 99% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 327 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 84 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters . The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,526,006) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 86.2 million dollars, which represents 0.05 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 86 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 94% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	79,416.00	3,483.37	662.40	1,010.66	84,572.43
	Content	872.59	0.00	0.00	0.00	872.59
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**80,288.59**	**3,483.37**	**662.40**	**1,010.66**	**85,445.01**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	345.57	23.11	0.00	0.07	368.75
	Rental	352.12	0.00	0.00	0.00	352.12
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**697.70**	**23.11**	**0.00**	**0.07**	**720.87**
Total						
	Total	**80,986.28**	**3,506.48**	**662.40**	**1,010.73**	**86,165.89**

Appendix A: County Listing for the Region

Pennsylvania
  - Philadelphia

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Pennsylvania				
Philadelphia	1,526,006	115,983,856	49,986,657	165,970,513
Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**
Study Region Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**

Hazus-MH: Hurricane Event Report

Region Name: PhilaHurr

Hurricane Scenario: Probabilistic 200-year Return Period

Print Date: Wednesday, May 04, 2016

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

Table of Contents

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Pennsylvania

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 142.71 square miles and contains 384 census tracts. There are over 599 thousand households in the region and has a total population of 1,526,006 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 534 thousand buildings in the region with a total building replacement value (excluding contents) of 165,971 million dollars (2010 dollars). Approximately 93% of the buildings (and 70% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 534,077 buildings in the region which have an aggregate total replacement value of 165,971 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	115,983,856	69.9%
Commercial	33,895,846	20.4%
Industrial	6,149,002	3.7%
Agricultural	110,433	0.1%
Religious	4,268,826	2.6%
Government	1,006,508	0.6%
Education	4,556,042	2.7%
Total	**165,970,513**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 36 hospitals in the region with a total bed capacity of 9,447 beds. There are 570 schools, 3 fire stations, 28 police stations and no emergency operation facilities.

Building Damage

General Building Stock Damage

Hazus estimates that about 366 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 200 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	350	98.92	4	1.00	0	0.07	0	0.02	0	0.00
Commercial	26,531	98.94	270	1.01	15	0.05	0	0.00	0	0.00
Education	1,173	98.95	12	1.04	0	0.01	0	0.00	0	0.00
Government	646	98.87	7	1.12	0	0.01	0	0.00	0	0.00
Industrial	4,852	98.85	55	1.12	1	0.03	0	0.00	0	0.00
Religion	2,974	99.15	25	0.84	0	0.01	0	0.00	0	0.00
Residential	490,889	98.74	5,923	1.19	340	0.07	9	0.00	0	0.00
Total	**527,414**		**6,297**		**356**		**10**		**0**	

Table 3: Expected Building Damage by Building Type : 200 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	5,615	98.54	82	1.45	1	0.02	0	0.00	0	0.00
Masonry	174,874	98.32	2,696	1.52	284	0.16	8	0.00	0	0.00
MH	1,259	99.99	0	0.00	0	0.00	0	0.00	0	0.00
Steel	17,115	98.81	196	1.13	10	0.06	0	0.00	0	0.00
Wood	328,464	99.05	3,102	0.94	49	0.01	0	0.00	0	0.00

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 366 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 200 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	350	98.92	4	1.00	0	0.07	0	0.02	0	0.00
Commercial	26,531	98.94	270	1.01	15	0.05	0	0.00	0	0.00
Education	1,173	98.95	12	1.04	0	0.01	0	0.00	0	0.00
Government	646	98.87	7	1.12	0	0.01	0	0.00	0	0.00
Industrial	4,852	98.85	55	1.12	1	0.03	0	0.00	0	0.00
Religion	2,974	99.15	25	0.84	0	0.01	0	0.00	0	0.00
Residential	490,889	98.74	5,923	1.19	340	0.07	9	0.00	0	0.00
Total	**527,414**		**6,297**		**356**		**10**		**0**	

Table 3: Expected Building Damage by Building Type : 200 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	5,615	98.54	82	1.45	1	0.02	0	0.00	0	0.00
Masonry	174,874	98.32	2,696	1.52	284	0.16	8	0.00	0	0.00
MH	1,259	99.99	0	0.00	0	0.00	0	0.00	0	0.00
Steel	17,115	98.81	196	1.13	10	0.06	0	0.00	0	0.00
Wood	328,464	99.05	3,102	0.94	49	0.01	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 9,447 hospital beds available for use. On the day of the hurricane, the model estimates that 9447 hospital beds (only 100.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	3	0	0	3
Hospitals	36	23	0	36
Police Stations	28	0	0	28
Schools	570	0	0	570

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 26,418 tons of debris will be generated. Of the total amount, 737 tons (3%) is Other Tree Debris. Of the remaining 25,681 tons, Brick/Wood comprises 97% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 992 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 876 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters . The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,526,006) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 230.7 million dollars, which represents 0.14 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 231 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 95% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	203,758.36	7,767.37	1,389.74	2,001.73	214,917.20
	Content	4,040.99	0.00	183.82	5.09	4,229.90
	Inventory	0.00	0.00	29.39	0.50	29.89
	Subtotal	**207,799.35**	**7,767.37**	**1,602.95**	**2,007.31**	**219,176.99**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	6,975.53	131.71	3.93	4.96	7,116.12
	Rental	4,380.14	0.00	0.00	0.00	4,380.14
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**11,355.67**	**131.71**	**3.93**	**4.96**	**11,496.27**
Total						
	Total	**219,155.02**	**7,899.08**	**1,606.88**	**2,012.28**	**230,673.25**

Appendix A: County Listing for the Region

Pennsylvania
  - Philadelphia

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Pennsylvania				
Philadelphia	1,526,006	115,983,856	49,986,657	165,970,513
Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**
Study Region Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Pennsylvania				
Philadelphia	1,526,006	115,983,856	49,986,657	165,970,513
Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**
Study Region Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**

Table of Contents

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Pennsylvania

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 142.71 square miles and contains 384 census tracts. There are over 599 thousand households in the region and has a total population of 1,526,006 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 534 thousand buildings in the region with a total building replacement value (excluding contents) of 165,971 million dollars (2010 dollars). Approximately 93% of the buildings (and 70% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 534,077 buildings in the region which have an aggregate total replacement value of 165,971 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	115,983,856	69.9%
Commercial	33,895,846	20.4%
Industrial	6,149,002	3.7%
Agricultural	110,433	0.1%
Religious	4,268,826	2.6%
Government	1,006,508	0.6%
Education	4,556,042	2.7%
Total	**165,970,513**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 36 hospitals in the region with a total bed capacity of 9,447 beds. There are 570 schools, 3 fire stations, 28 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 2,150 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 10 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 500 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	339	95.83	12	3.49	2	0.49	1	0.18	0	0.01
Commercial	25,941	96.74	780	2.91	87	0.33	8	0.03	0	0.00
Education	1,151	97.13	33	2.76	1	0.11	0	0.00	0	0.00
Government	632	96.74	20	3.11	1	0.14	0	0.00	0	0.00
Industrial	4,737	96.52	154	3.14	13	0.27	3	0.06	0	0.00
Religion	2,916	97.22	81	2.70	3	0.08	0	0.00	0	0.00
Residential	471,315	94.80	23,815	4.79	1,999	0.40	23	0.00	10	0.00
Total	**507,031**		**24,896**		**2,106**		**34**		**10**	

Table 3: Expected Building Damage by Building Type : 500 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	5,475	96.09	211	3.70	12	0.21	0	0.00	0	0.00
Masonry	167,570	94.21	8,900	5.00	1,354	0.76	35	0.02	2	0.00
MH	1,258	99.90	1	0.08	0	0.02	0	0.00	0	0.00
Steel	16,743	96.66	508	2.93	64	0.37	7	0.04	0	0.00
Wood	316,402	95.41	14,648	4.42	558	0.17	0	0.00	6	0.00

Essential Facility Damage

Before the hurricane, the region had 9,447 hospital beds available for use. On the day of the hurricane, the model estimates that 9447 hospital beds (only 100.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	3	0	0	3
Hospitals	36	23	0	36
Police Stations	28	0	0	28
Schools	570	0	0	570

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 77,490 tons of debris will be generated. Of the total amount, 1,941 tons (3%) is Other Tree Debris. Of the remaining 75,549 tons, Brick/Wood comprises 97% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 2935 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,164 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters . The model estimates 149 households to be displaced due to the hurricane. Of these, 20 people (out of a total population of 1,526,006) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 603.5 million dollars, which represents 0.36 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 603 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 93% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	505,336.15	25,117.88	5,964.43	5,947.95	542,366.42
	Content	18,172.95	2,003.33	2,188.82	146.27	22,511.38
	Inventory	0.00	43.52	322.01	4.58	370.12
	Subtotal	**523,509.10**	**27,164.74**	**8,475.27**	**6,098.81**	**565,247.91**
Business Interruption Loss						
	Income	0.00	421.07	18.77	6.74	446.58
	Relocation	21,930.08	1,027.54	107.10	69.08	23,133.80
	Rental	14,235.18	173.33	16.29	0.77	14,425.58
	Wage	0.00	152.43	31.02	15.84	199.30
	Subtotal	**36,165.26**	**1,774.37**	**173.18**	**92.44**	**38,205.25**
Total						
	Total	**559,674.35**	**28,939.11**	**8,648.46**	**6,191.25**	**603,453.16**

Appendix A: County Listing for the Region

Pennsylvania
- Philadelphia

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Pennsylvania				
Philadelphia	1,526,006	115,983,856	49,986,657	165,970,513
Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**
Study Region Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**

Hazus-MH: Hurricane Event Report

Region Name: PhilaHurr

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Wednesday, May 04, 2016

Table of Contents

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Pennsylvania

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 142.71 square miles and contains 384 census tracts. There are over 599 thousand households in the region and has a total population of 1,526,006 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 534 thousand buildings in the region with a total building replacement value (excluding contents) of 165,971 million dollars (2010 dollars). Approximately 93% of the buildings (and 70% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 534,077 buildings in the region which have an aggregate total replacement value of 165,971 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	115,983,856	69.9%
Commercial	33,895,846	20.4%
Industrial	6,149,002	3.7%
Agricultural	110,433	0.1%
Religious	4,268,826	2.6%
Government	1,006,508	0.6%
Education	4,556,042	2.7%
Total	**165,970,513**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 36 hospitals in the region with a total bed capacity of 9,447 beds. There are 570 schools, 3 fire stations, 28 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 5,249 buildings will be at least moderately damaged. This is over 1% of the total number of buildings in the region. There are an estimated 49 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 1000 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	326	91.96	23	6.38	4	1.14	2	0.48	0	0.03
Commercial	25,047	93.40	1,511	5.63	234	0.87	25	0.09	0	0.00
Education	1,111	93.78	67	5.67	6	0.54	0	0.01	0	0.00
Government	612	93.71	37	5.70	4	0.57	0	0.01	0	0.00
Industrial	4,599	93.70	264	5.39	37	0.75	8	0.16	0	0.01
Religion	2,809	93.67	177	5.91	12	0.41	0	0.00	0	0.00
Residential	448,281	90.17	43,964	8.84	4,800	0.97	69	0.01	48	0.01
Total	**482,784**		**46,044**		**5,097**		**103**		**49**	

Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	5,267	92.43	383	6.72	48	0.84	0	0.01	0	0.00
Masonry	159,214	89.52	15,577	8.76	2,975	1.67	83	0.05	13	0.01
MH	1,255	99.65	4	0.28	1	0.06	0	0.00	0	0.01
Steel	16,198	93.51	930	5.37	172	0.99	22	0.13	0	0.00
Wood	301,719	90.98	28,219	8.51	1,629	0.49	16	0.00	32	0.01

Essential Facility Damage

Before the hurricane, the region had 9,447 hospital beds available for use. On the day of the hurricane, the model estimates that 5079 hospital beds (only 54.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	3	0	0	3
Hospitals	36	23	0	23
Police Stations	28	0	0	28
Schools	570	0	0	570

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 137,204 tons of debris will be generated. Of the total amount, 2,517 tons (2%) is Other Tree Debris. Of the remaining 134,687 tons, Brick/Wood comprises 98% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 5287 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,520 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters . The model estimates 630 households to be displaced due to the hurricane. Of these, 177 people (out of a total population of 1,526,006) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 1064.1 million dollars, which represents 0.64 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 1,064 million dollars. 3% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 88% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	822,259.38	55,258.01	11,729.71	13,996.58	903,243.69
	Content	46,414.19	8,893.54	5,410.27	1,794.47	62,512.48
	Inventory	0.00	165.53	760.09	13.06	938.69
	Subtotal	**868,673.58**	**64,317.09**	**17,900.08**	**15,804.11**	**966,694.86**
Business Interruption Loss						
	Income	0.00	7,398.68	87.00	2,140.75	9,626.42
	Relocation	37,059.11	6,348.46	407.34	1,853.88	45,668.79
	Rental	26,394.64	3,232.94	70.32	193.76	29,891.65
	Wage	0.00	5,050.09	143.95	7,046.92	12,240.96
	Subtotal	**63,453.75**	**22,030.17**	**708.61**	**11,235.30**	**97,427.83**
Total						
	Total	**932,127.32**	**86,347.26**	**18,608.69**	**27,039.41**	**1,064,122.69**

Appendix A: County Listing for the Region

Pennsylvania
- Philadelphia

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Pennsylvania				
Philadelphia	1,526,006	115,983,856	49,986,657	165,970,513
Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**
Study Region Total	**1,526,006**	**115,983,856**	**49,986,657**	**165,970,513**

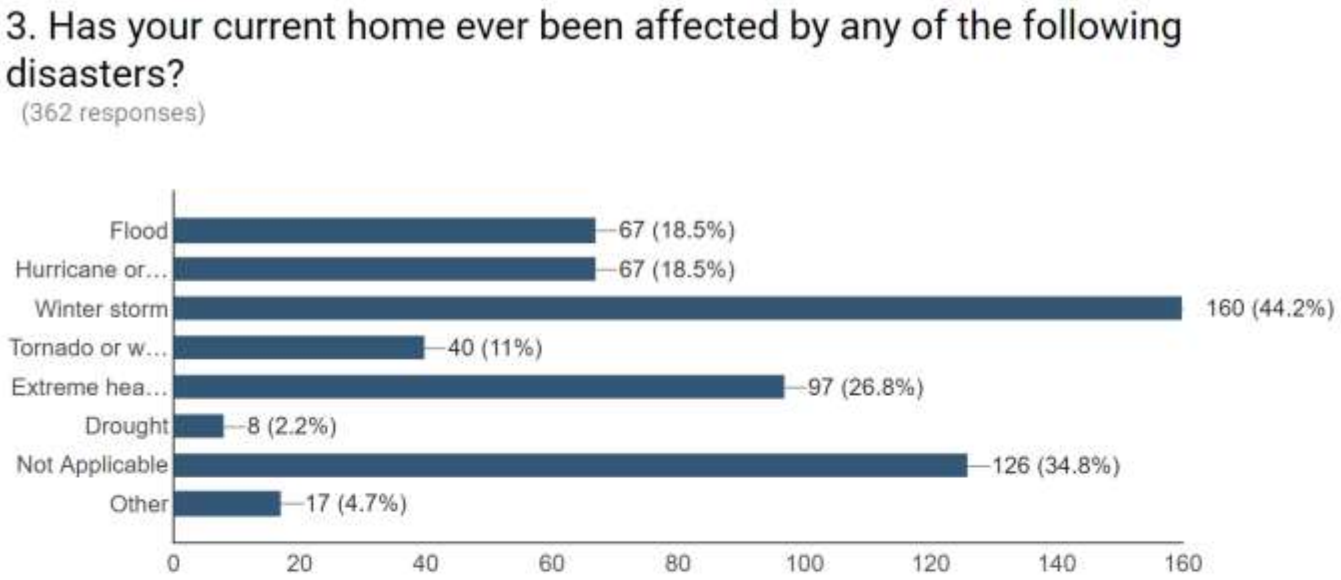
19 Appendix: Public Outreach

Hazard Mitigation Public Survey Results

Question 1: Are you over 18? *Respondents had to be 18 to complete the survey*

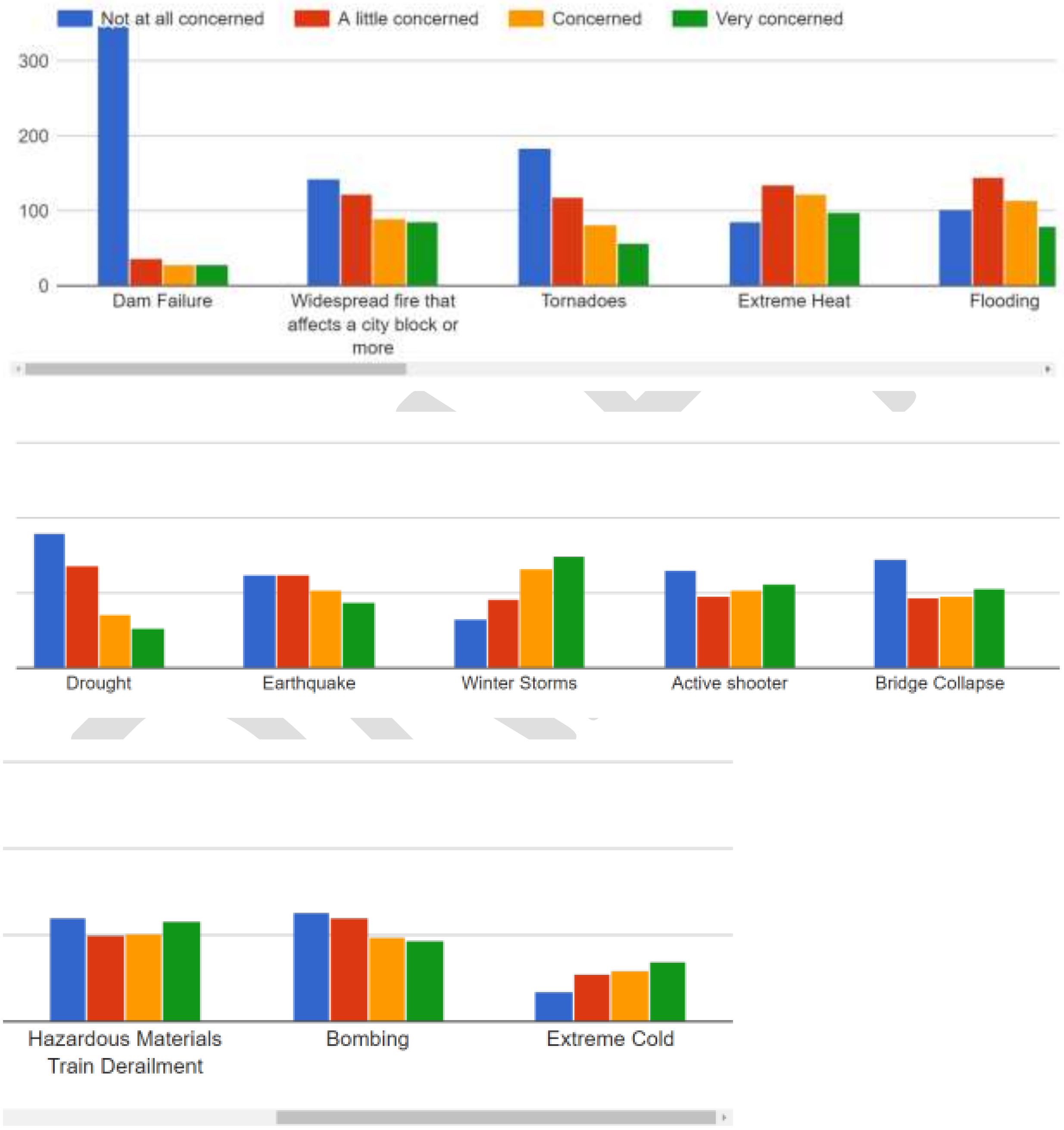
Question 2: What is your zipcode? *99% of zipcodes responded - fill in the blank dataset too large to display*

Question 3:



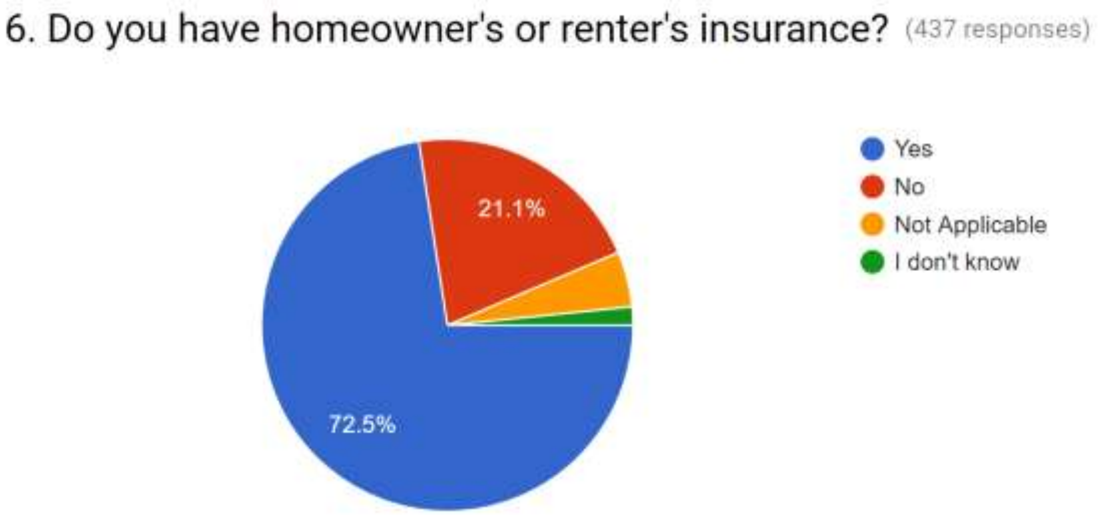
Question 4:

4. Please tell us how concerned you are about the following disasters affecting your neighborhood.

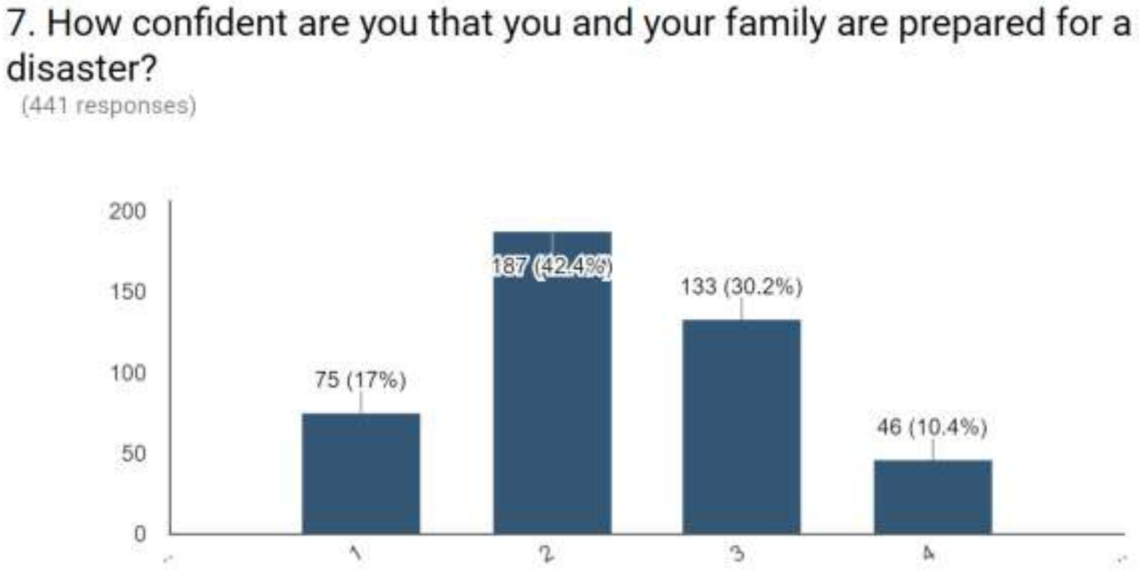


Question 5: Is there a hazard not listed you are concerned about? *Majority of responses were no – fill in the blank dataset too large to display*

Question 6:


6. Do you have homeowner's or renter's insurance? (437 responses)

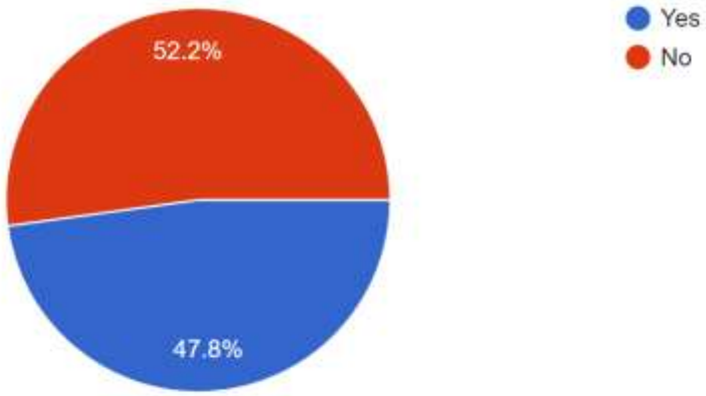
Question 7:


7. How confident are you that you and your family are prepared for a disaster?
(441 responses)

Question 8:

8. Do you have an emergency plan in place for you and your family?

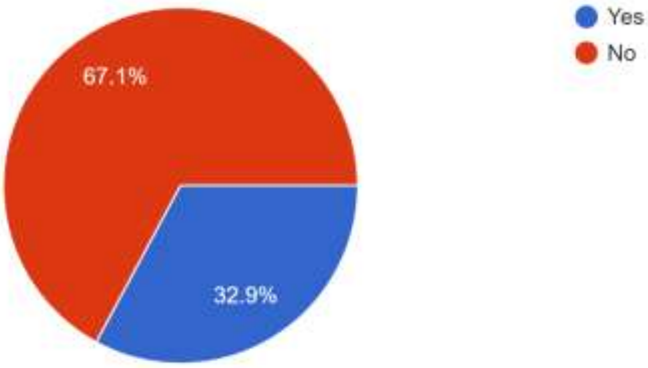
(441 responses)



Question 9:

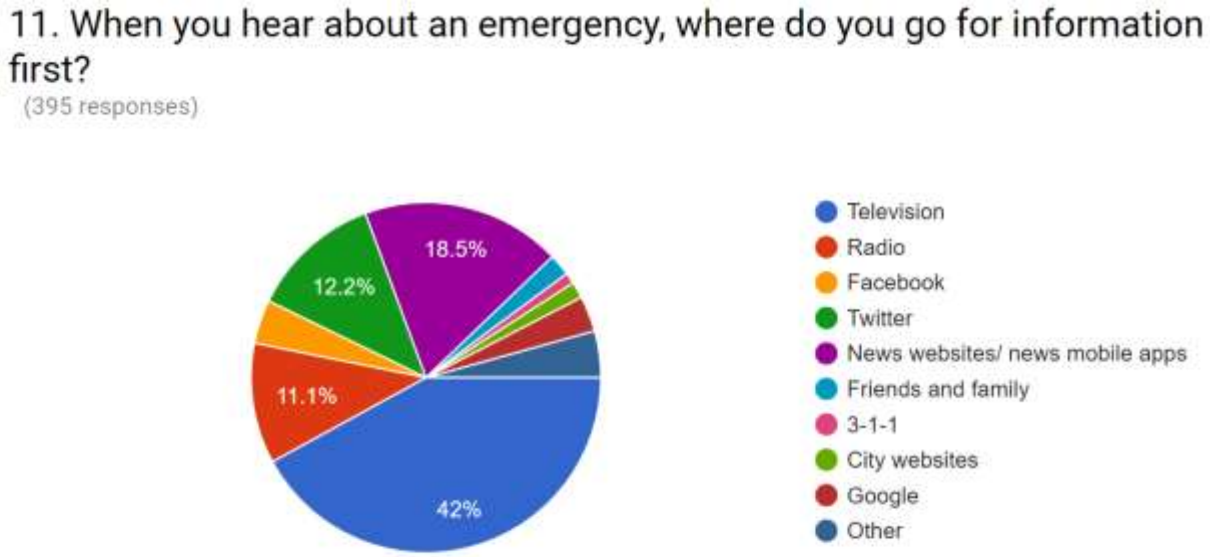
9. Do you have an emergency kit with water, medications, and food for you and your family for three days?

(441 responses)



Question 10: All government emergency services, including medical assistance, evacuation plans, and access to emergency shelters, are designed to be accessible to all. What specific concerns, if any, do you have about your ability to access emergency services in a disaster? *Fill in the blank dataset too large to display*

Question 11:



11. When you hear about an emergency, where do you go for information first?

(395 responses)

Question 12: Is there anything else you'd like us to know? *Majority of responses were no – fill in the blank dataset too large to display*

Thank you for joining us today for the Philadelphia Office of Emergency Management Hazard Mitigation Plan Public Meeting. We appreciate your joining us and learning about the hazards that affect Philadelphia and sharing your concerns with us.

Your Name	Your Zip Code	Your email if you would like us to contact you for upcoming events.
Leonard Stewart	19153	audreyist@comcast.net
Henry Fisher	19153	

OEM Hazard Mitigation Plan Public Meeting
Eastwick Branch, Philadelphia Free Library

June 8, 2016 6:00-7:00pm

Media Sign In Sheet

Name	Affiliation	Contact Information/Email
Samaria Bailey	Phila Tribune	Samariabailey1@gmail.com

OEM Hazard Mitigation Plan Public Meeting
Eastwick Branch, Philadelphia Free Library

June 8, 2016 6:00-7:00pm

For Immediate Release: June 2, 2016

Media Advisory

Office of Emergency Management to Hold Community Meeting Regarding Hazards in the City of Philadelphia.

Who: Philadelphia Office of Emergency Management

What: Meeting to inform and solicit feedback from the public regarding the City’s planned revision of the Hazard Mitigation Plan. The Federal Emergency Management Agency (FEMA) requires Hazard Mitigation Plan updates every 5 years. The plan was last finalized in 2012, and addresses a list of hazards that may impact the City. The purpose of the hazard mitigation program is to identify projects, plans, and actions that can reduce or eliminate risks to people and property.

The Office of Emergency Management will give a presentation on the development of the Hazard Mitigation Plan. The presentation will also include OEM’s READYHome workshop including personal and family preparedness tips. Attendees will have time to provide feedback on how natural and human caused hazards affect them and their community.

A list of hazards of concern in the plan can be found in our Hazard Mitigation Public Survey available at www.phila.gov/ready. We encourage residents of the city to take the survey.

When: June 8th, 6:00 p.m. - 7:00 p.m.

Where: Eastwick Neighborhood Library. 2851 Island Ave, Philadelphia, PA 19153

Why: The Office of Emergency Management will hold a series of meetings from June until mid-October throughout Philadelphia during the plan writing process. The public is encouraged to visit www.phila.gov/ready to:

- Find out more information on hazards that can affect Philadelphia, and what individuals and businesses can do to become better prepared
- Fill out the Hazard Mitigation Public Survey
- Access a complete list of upcoming meetings, meeting notes, and plan drafts

# # #

Philadelphia
OEM

For Immediate Release: June 2, 2016

Media Advisory

Office of Emergency Management to Hold Community Meeting Regarding Hazards in the City of Philadelphia.

Who: Philadelphia Office of Emergency Management

What: Meeting to inform and solicit feedback from the public regarding the City's planned revision of the Hazard Mitigation Plan. The Federal Emergency Management Agency (FEMA) requires Hazard Mitigation Plan updates every 5 years. The plan was last finalized in 2012, and addresses a list of hazards that may impact the City. The purpose of the hazard mitigation program is to identify projects, plans, and actions that can reduce or eliminate risks to people and property.

The Office of Emergency Management will give a presentation on the development of the Hazard Mitigation Plan. The presentation will also include OEM's READYHome workshop including personal and family preparedness tips. Attendees will have time to provide feedback on how natural and human caused hazards affect them and their community.

A list of hazards of concern in the plan can be found in our Hazard Mitigation Public Survey available at www.phila.gov/ready. We encourage residents of the city to take the survey.

When: June 8th, 6:00 p.m. - 7:00 p.m.

Where: Eastwick Neighborhood Library. 2851 Island Ave, Philadelphia, PA 19153

Why: The Office of Emergency Management will hold a series of meetings from June until mid-October throughout Philadelphia during the plan writing process. The public is encouraged to visit www.phila.gov/ready to:

- Find out more information on hazards that can affect Philadelphia, and what individuals and businesses can do to become better prepared
- Fill out the Hazard Mitigation Public Survey
- Access a complete list of upcoming meetings, meeting notes, and plan drafts

# # #

For Immediate Release: September 21, 2016

Media Advisory

Office of Emergency Management to Hold Community Meeting Regarding Hazards in the City of Philadelphia.

Who: Philadelphia Office of Emergency Management

What: Meeting to inform and solicit feedback from the public regarding the City's planned revision of the Hazard Mitigation Plan. The Federal Emergency Management Agency (FEMA) requires Hazard Mitigation Plan updates every 5 years. The plan was last finalized in 2012, and addresses a list of hazards that may impact the City. The purpose of the hazard mitigation program is to identify projects, plans, and actions that can reduce or eliminate risks to people and property.
The Office of Emergency Management will give a presentation on the development of the Hazard Mitigation Plan. The presentation will also include OEM's READYHome workshop including personal and family preparedness tips.. Attendees will have time to provide feedback on how natural and human caused hazards affect them and their community.
A list of hazards of concern in the plan can be found in our Hazard Mitigation Public Survey available at www.phila.gov/ready. We encourage residents of the city to take the survey.

When: September 26th, 6:00 p.m.- 7:00 p.m.

Where: Free Library, Fishtown Branch 1217 E. Montgomery Avenue

Why: The Office of Emergency Management will hold a series of meetings from June until mid-October throughout Philadelphia during the plan writing process. The public is encouraged to visit www.phila.gov/ready to:

- Find out more information on hazards that can affect Philadelphia, and what individuals and businesses can do to become better prepared
- Fill out the Hazard Mitigation Public Survey
- Access a complete list of upcoming meetings, meeting notes, and plan drafts

###

Philadelphia
OEM

For Immediate Release: June 21, 2016

Office of Emergency Management to Hold Community Meeting in Roxborough Regarding Hazards in the City of Philadelphia.

Who: Philadelphia Office of Emergency Management
What: Meeting to inform and solicit feedback from the public regarding the City's planned revision of the Hazard Mitigation Plan. The Federal Emergency Management Agency (FEMA) requires Hazard Mitigation Plan updates every 5 years. The plan was last finalized in 2012, and addresses a list of hazards that may impact the City. The purpose of the hazard mitigation program is to identify projects, plans, and actions that can reduce or eliminate risks to people and property.
The Office of Emergency Management will give a presentation on the development of the Hazard Mitigation Plan. The presentation will also include OEM's READYHome workshop including personal and family preparedness tips. Attendees will have time to provide feedback on how natural and human caused hazards affect them and their community.
A list of hazards of concern in the plan can be found in our Hazard Mitigation Public Survey available at www.phila.gov/ready. We encourage residents of the city to take the survey.
When: June 29th, 6:30 p.m. - 7:30 p.m.
Where: Roxborough Branch Library, 6245 Ridge Avenue, Philadelphia, PA 19128
Why: The Office of Emergency Management will hold a series of meetings from June until mid-October throughout Philadelphia during the plan writing process. The public is encouraged to visit www.phila.gov/ready to:

- Find out more information on hazards that can affect Philadelphia, and what individuals and businesses can do to become better prepared
- Fill out the Hazard Mitigation Public Survey
- Access a complete list of upcoming meetings, meeting notes, and plan drafts

###

City of Philadelphia @PhiladelphiaGov

Tonight at @FreeLibrary's Fishtown branch, @PhilaOEM holds a community meeting & needs your feedback about planning! bit.ly/2d6nY9T

9/26/16, 1:30 PM

Philadelphia OEM @PhilaOEM

Community meeting tonight in @fishtown open to all #Philly residents. Discussing Hazard Mitigation @starnewsphilly ow.ly/KSFI304zoxM

9/26/16, 10:33 AM

Philadelphia OEM @PhilaOEM

Looking for great turnout in Fishtown Mon for our Hazard Mitigation meeting. All Philly residents welcome @fishtown ow.ly/57tJ304sGaU

9/23/16, 8:49 AM

Philadelphia OEM @PhilaOEM

We're visiting our neighbors in Fishtown this Monday to talk & get feedback on our Hazard Mitigation Plan. Join us! ow.ly/57tJ304sGaU

9/22/16, 10:41 AM

Philadelphia OEM · 6/28/16

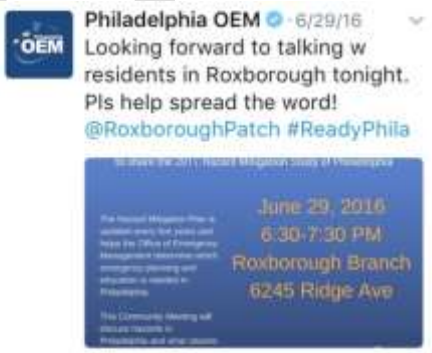
Come see us at Free Library, Roxborough Branch tomorrow to talk hazard concerns & mitigation ow.ly/IvHj301lpig

Philadelphia OEM @PhilaOEM

We are set up for the Hazard Mitigation Community Meeting @FreeLibrary Rox Branch in 15 minutes

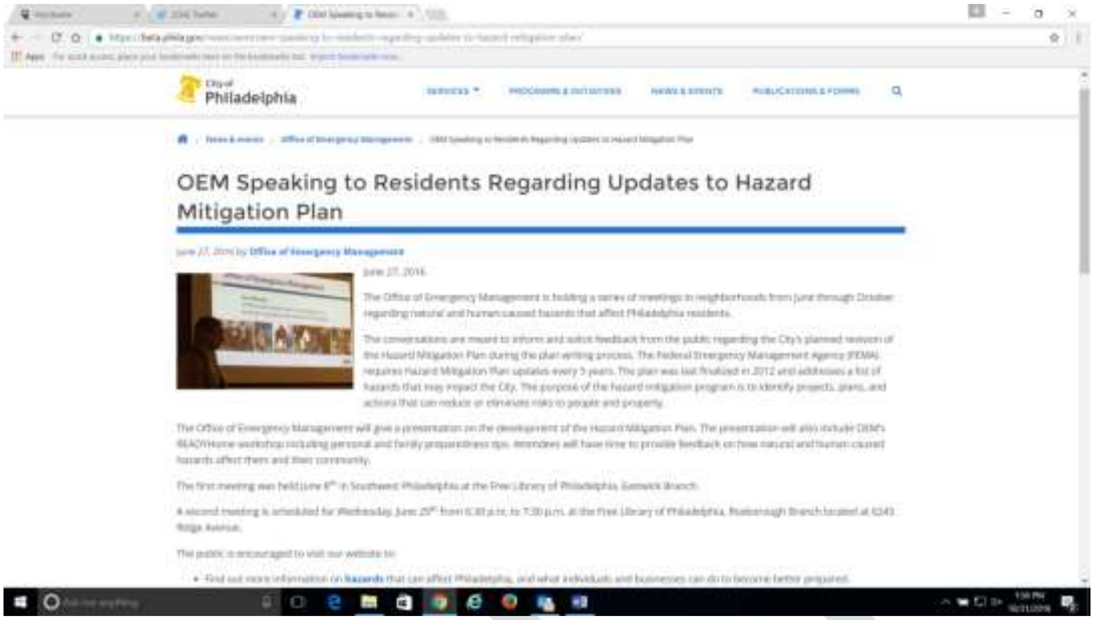
Philadelphia OEM · 6/29/16

Philly neighbors: Come to our community talk in Roxborough tonight, learn how to be prepared ow.ly/AMr0301KFKT



Philadelphia OEM · 6/29/16

Looking forward to talking w residents in Roxborough tonight. Pls help spread the word! @RoxboroughPatch #ReadyPhila



OEM Speaking to Residents Regarding Updates to Hazard Mitigation Plan

June 27, 2016 by **Office of Emergency Management**

June 27, 2016

The Office of Emergency Management is holding a series of meetings in neighborhoods from June through October regarding natural and human caused hazards that affect Philadelphia residents.

The conversations are meant to inform and solicit feedback from the public regarding the City's planned revision of the Hazard Mitigation Plan during the plan writing process. The Federal Emergency Management Agency (FEMA) requires Hazard Mitigation Plan updates every 5 years. The plan was last finalized in 2012 and addresses a list of hazards that may impact the City. The purpose of the hazard mitigation program is to identify projects, plans, and actions that can reduce or eliminate risks to people and property.

The Office of Emergency Management will give a presentation on the development of the Hazard Mitigation Plan. The presentation will also include OEM's READYHome workshop including personal and family preparedness tips. Attendees will have time to provide feedback on how natural and human caused hazards affect them and their community.

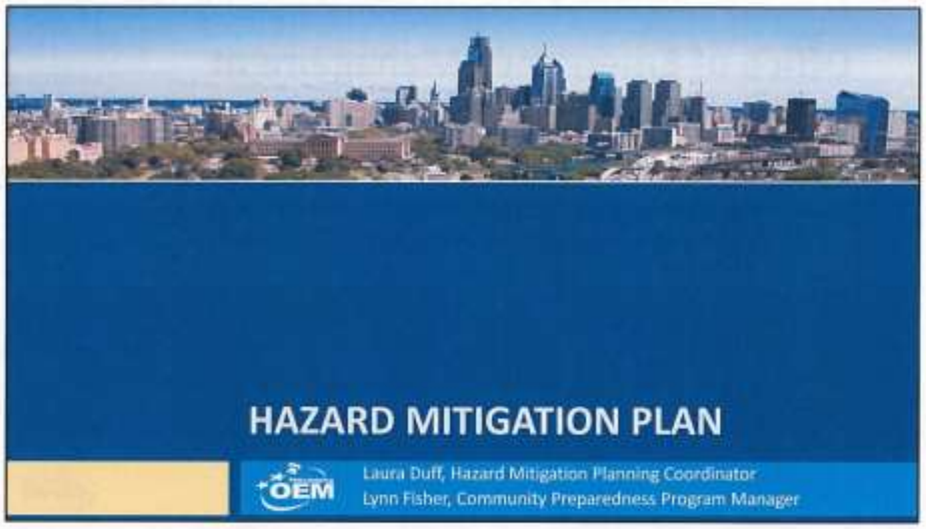
The first meeting was held June 8th in Southwest Philadelphia at the Free Library of Philadelphia, Eastwick Branch.

A second meeting is scheduled for Wednesday, June 29th from 6:30 p.m. to 7:30 p.m. at the Free Library of Philadelphia, Roxborough Branch located at 6245 Ridge Avenue.

The public is encouraged to visit our website to:

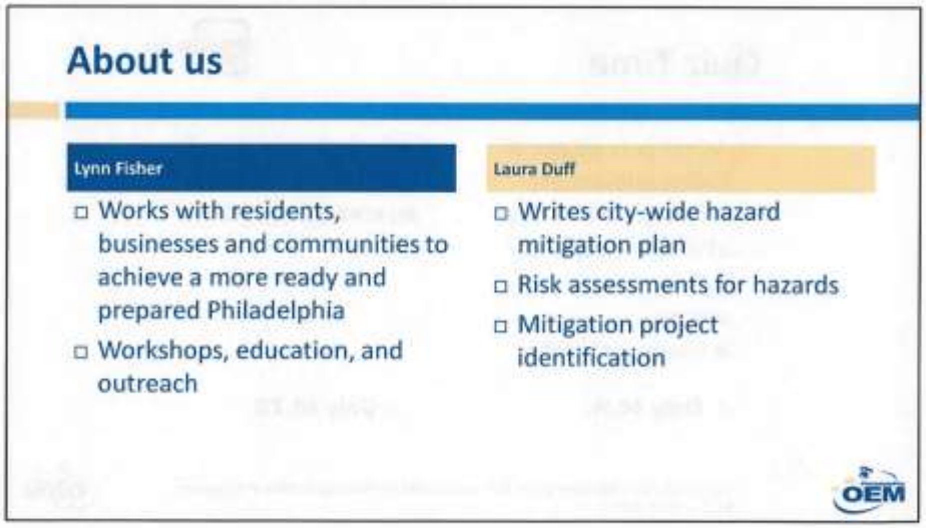
- Find out more information on hazards that can affect Philadelphia, and what individuals and businesses can do to become better prepared.

20 Appendix: Hazard Mitigation Public Presentation



HAZARD MITIGATION PLAN

Laura Duff, Hazard Mitigation Planning Coordinator
Lynn Fisher, Community Preparedness Program Manager



About us

Lynn Fisher

- ☐ Works with residents, businesses and communities to achieve a more ready and prepared Philadelphia
- ☐ Workshops, education, and outreach

Laura Duff

- ☐ Writes city-wide hazard mitigation plan
- ☐ Risk assessments for hazards
- ☐ Mitigation project identification

Office of Emergency Management

Our Mission:
OEM focuses people, plans, and programs to promote a prepared and resilient Philadelphia.

Quiz Time

Q: What percentage of Philadelphians are prepared with 3 days of disaster supplies?

- Food
- Water
- Emergency Supplies

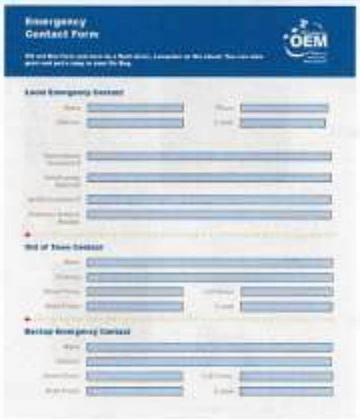
A: **Only 34.%**

Q: What percentage of Philadelphians have an emergency plan in place?

A: **Only 48.7%**

*Data from 2017 Hazard Mitigation Survey conducted by Philadelphia Office of Emergency Management, 2016

Family Emergency Plan

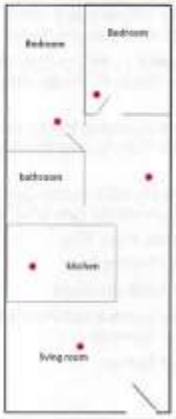


Emergency Contact Form

Local Emergency Contact

Out of Town Contact

Backup Emergency Contact



What is in a Go Bag?

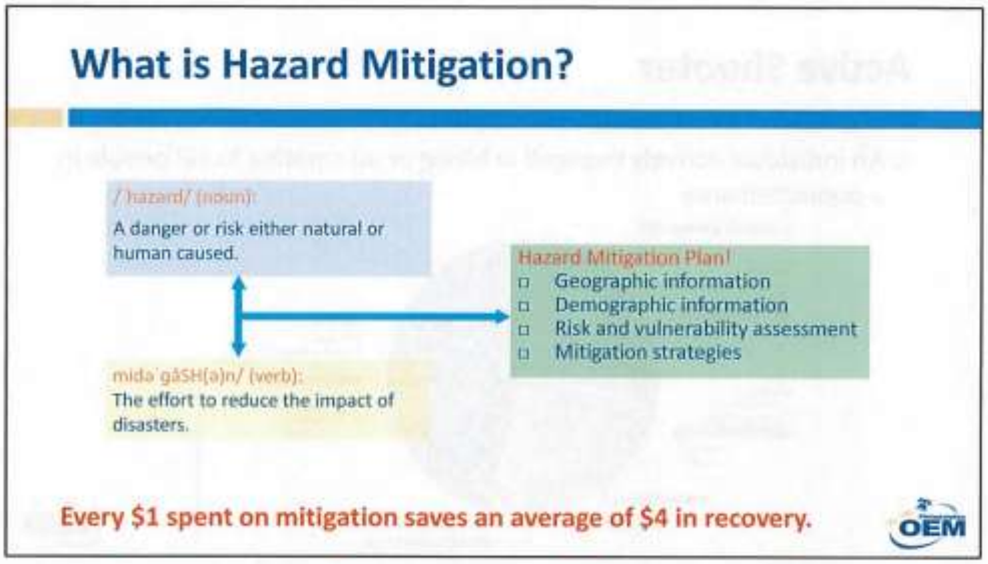
- **Easy to carry:** Backpack or small suitcase on wheels.
- **Make copies of important documents:** Health insurance cards, Medicare/Medicaid cards, photo id, proof of address, homeowners/rental insurance, deed for your home, and title for your car.
- **Store information:** Waterproof & portable container; cloud or flash drive.

Where will you go?

- **First choice** – Family or Friends (You may be the most comfortable).
- **Second choice** - City Emergency Evacuation Shelters, designated public schools.
- Shelters are assessed based on incident type, power supply, and flooding hazards.
- All shelters are ADA accessible and assistive technology is available.
  - Communication Kits
  - Mobility Technology
  - Special Medical Needs
  - Portable Generators Prioritized for Assistive Devices
  - Portable Ramps

What mitigation means to us

- As residents:
  - Go Bag
  - Family Plan
  - Know where to go
  - Sign up for alerts
- As planners:
  - Prepare and protect
  - Plan and recover
  - Mitigate risks



What is Hazard Mitigation?

/ˈhazərd/ (noun):

A danger or risk either natural or human caused.

midəˈgāSH(ə)n/ (verb):

The effort to reduce the impact of disasters.

Hazard Mitigation Plan!

- ☐ Geographic information
- ☐ Demographic information
- ☐ Risk and vulnerability assessment
- ☐ Mitigation strategies

Every $1 spent on mitigation saves an average of $4 in recovery.

OEM

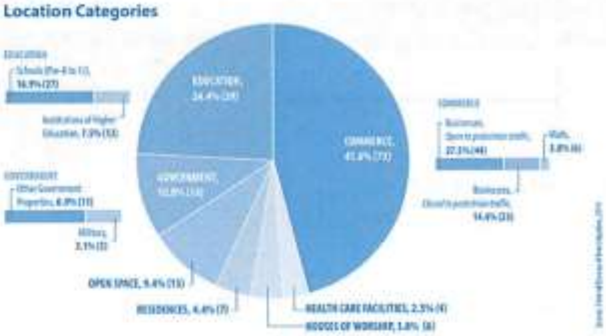
What hazards are included in the Plan?

Natural Hazards	Human Caused Hazards
☐ Drought ☐ Earthquake ☐ Extreme Cold ☐ Extreme Heat ☐ Floods ☐ Hurricane/Tropical Storm ☐ Windstorms/Tornadoes ☐ Winter Storms	☐ Active Shooter ☐ Infrastructure Failure (Bridges, Dams, and Buildings) ☐ Hazardous Materials Train Derailment ☐ Improvised Explosive Device ☐ Urban Conflagration

OEM

Active Shooter

- An individual actively engaged in killing or attempting to kill people in a populated area



Improvised Explosive Device

- The use of a "homemade" bomb and/or destructive device to destroy, incapacitate, harass, or distract
- Effects depend on construction and location

Philadelphia Mitigation Efforts

- Philadelphia Police Department:
  - Suspicious activity and object monitoring
- Philadelphia Fire Department
  - RAMS training
- Office of Emergency Management
  - Activate the Family Assistance Plan
    - Open Family Assistance Center
    - Coordinate patient tracking with EMS and local hospitals
    - Facilitate family reunification and notifications

Active Shooter/IED

What you can do

- If you see something, say something
- Call 911

To prevent terrorist activity or an attack:

- PPD is seeking information regarding suspicious activity in your area.
- They need your help and support.
- Forward any information to them, no matter how insignificant it may appear.

To report a tip; dial **215.686.TIPS.**

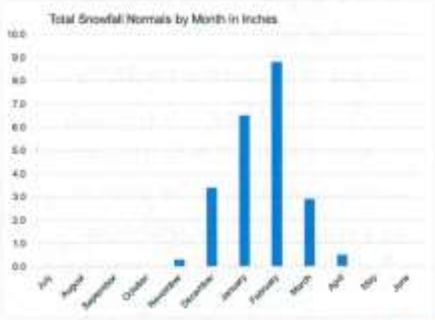
Active Shooter/IED

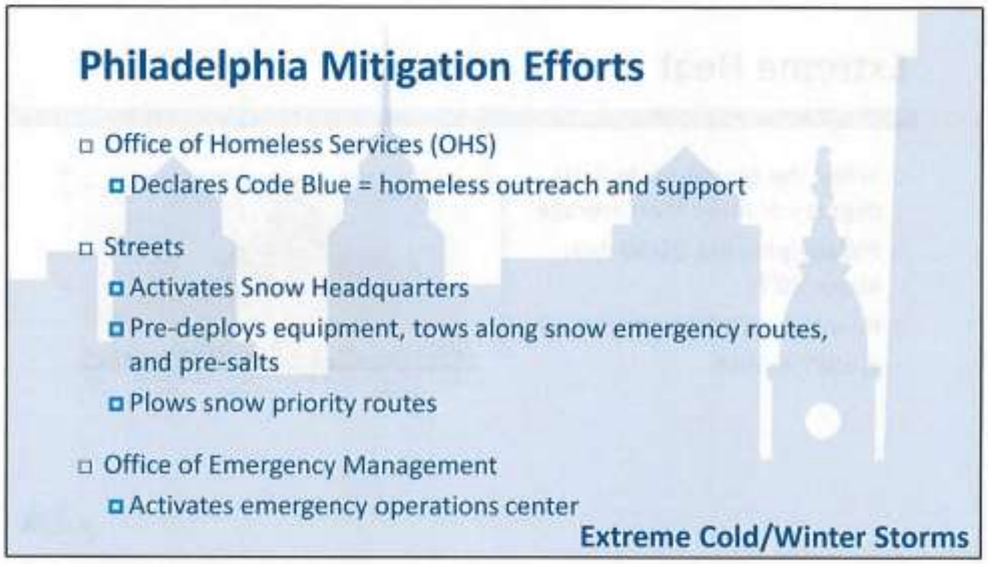
Extreme Cold

- ☐ Days where the mean daily temperature falls below 32°F
- ☐ 207 days since 2012 with average temperature below 32
- ☐ How cold was the coldest day?
  - ☐ 1934 (-11°F)
- ☐ How long was the longest freezing streak?
  - ☐ 15 days in 1979 and 1961

Winter Storms

- ☐ Can include heavy snow, ice, strong winds, and freezing temperatures
- ☐ Average 22.3 inches of snow annually
- ☐ When was the largest snowfall?
  - ☐ 1996, 30.7
- ☐ Most recent snowfall: 2016, 22.4
- ☐ Typically occur between December and March

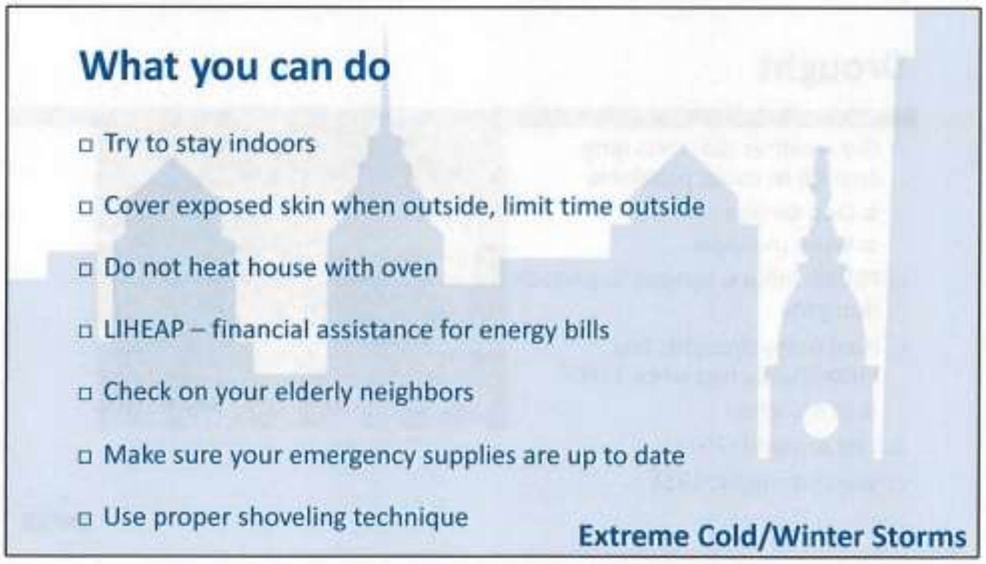




Philadelphia Mitigation Efforts

- Office of Homeless Services (OHS)
  - Declares Code Blue = homeless outreach and support
- Streets
  - Activates Snow Headquarters
  - Pre-deploys equipment, tows along snow emergency routes, and pre-salts
  - Plows snow priority routes
- Office of Emergency Management
  - Activates emergency operations center

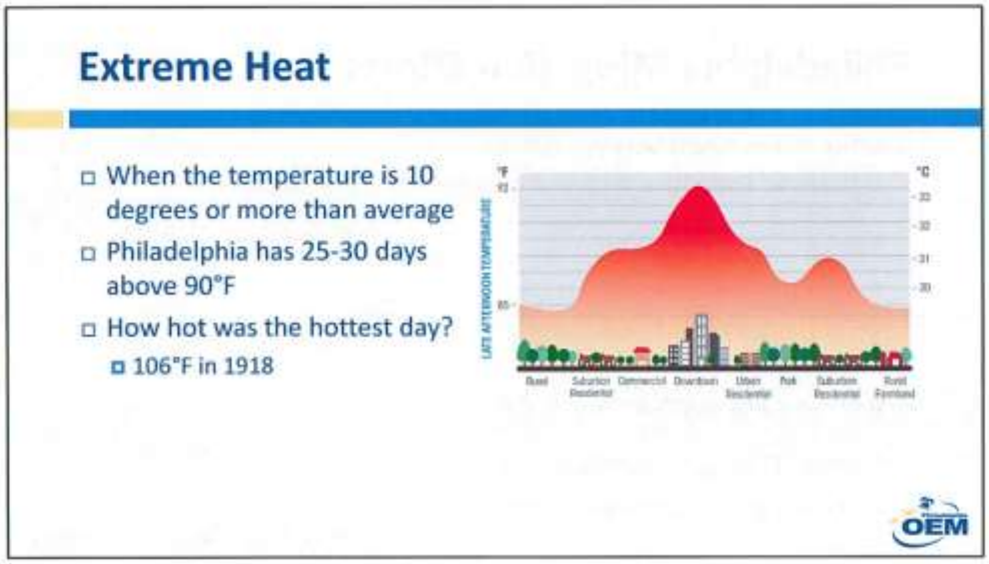
Extreme Cold/Winter Storms



What you can do

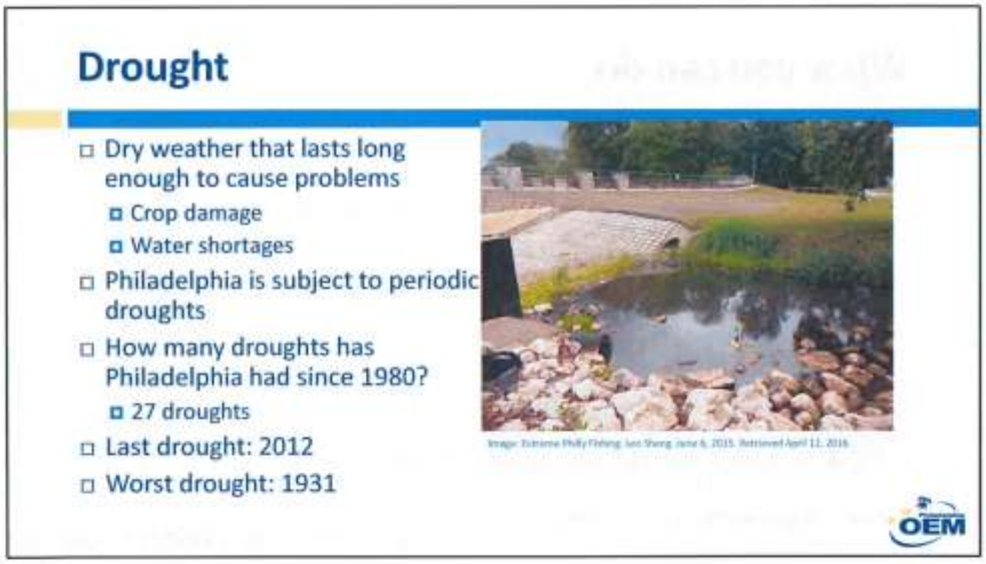
- Try to stay indoors
- Cover exposed skin when outside, limit time outside
- Do not heat house with oven
- LIHEAP – financial assistance for energy bills
- Check on your elderly neighbors
- Make sure your emergency supplies are up to date
- Use proper shoveling technique

Extreme Cold/Winter Storms



Extreme Heat

- ☐ When the temperature is 10 degrees or more than average
- ☐ Philadelphia has 25-30 days above 90°F
- ☐ How hot was the hottest day?
  - ☐ 106°F in 1918



Drought

- ☐ Dry weather that lasts long enough to cause problems
  - ☐ Crop damage
  - ☐ Water shortages
- ☐ Philadelphia is subject to periodic droughts
- ☐ How many droughts has Philadelphia had since 1980?
  - ☐ 27 droughts
- ☐ Last drought: 2012
- ☐ Worst drought: 1931

Image: Extreme Philly Fishing. Leo Sheng. June 6, 2015. Retrieved April 11, 2016.

Philadelphia Mitigation Efforts

- Office of Homeless Support (OHS)
  - Homeless outreach and water distribution
- OHS and OEM
  - Cooling centers at public libraries and rec centers
- Philadelphia Water Department
  - Reduce erosion along riverbanks
  - Regulate drinking water

Extreme Heat/Drought

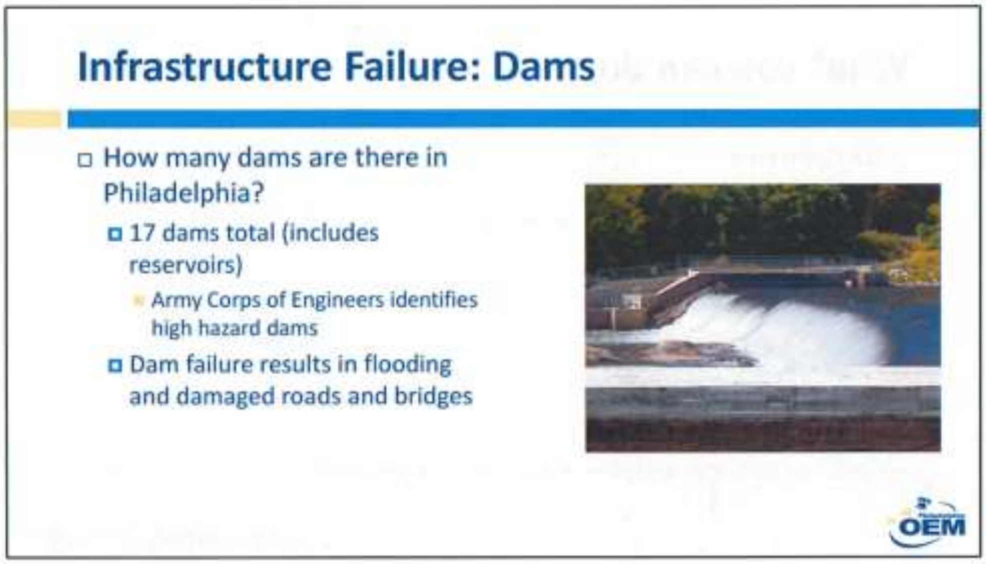
What you can do

- Stay hydrated
- Use window fans or air conditioning
- Limit activity outside
- Check on elderly neighbors
- Plant trees
- Limit recreational water use when recommended

Extreme Heat/Drought

Infrastructure Failure: Bridges

- Occur because of:
  - Widespread rusting
  - Deterioration
  - Stress fractures
  - Heavy traffic loads
  - Strong winds
- Bridge inspectors identify structurally deficient bridges



Infrastructure Failure: Dams

- How many dams are there in Philadelphia?
  - 17 dams total (includes reservoirs)
    - Army Corps of Engineers identifies high hazard dams
  - Dam failure results in flooding and damaged roads and bridges

Infrastructure Failure: Buildings

- Occur because of:
    - Poor construction or maintenance
    - Accidents
    - Heavy snowfall
    - Strong winds
    - Earthquakes

Philadelphia Mitigation Efforts

- PWD:
    - Inspects city owned or licensed dams
    - Maintain dam upkeep
- Streets:
    - City owned bridge inspection and repair
- Licenses & Inspections (L&I):
    - Identifies imminently dangerous structures through inspections

Infrastructure Failure

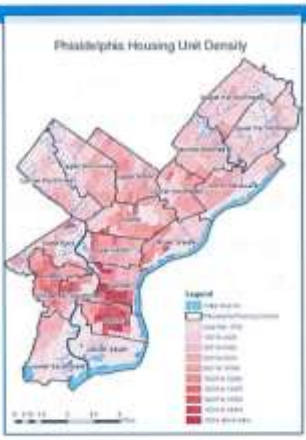
What you can do

- ☐ If you own your property, maintain it
- ☐ Contact 3-1-1 to report infrastructure concerns
- ☐ Have a family emergency plan
- ☐ Follow emergency public messaging
- ☐ Go Bag

Infrastructure Failure

Urban Conflagration

- ☐ Extensive, widespread fires that damage property and potentially endanger lives
  - ☐ A block or more
- ☐ Housing density can encourage fire spread



Hazardous Materials Train Derailment

- Can occur because of:
  - Issues with the track
  - Communications issues
  - Human error
  - Mechanical or electrical failures
  - Weather

Data: Federal Railroad Administration. Office of Safety Analysis: Accident by State/Railroad. 1975 to 2015. Online.

Philadelphia Mitigation Efforts

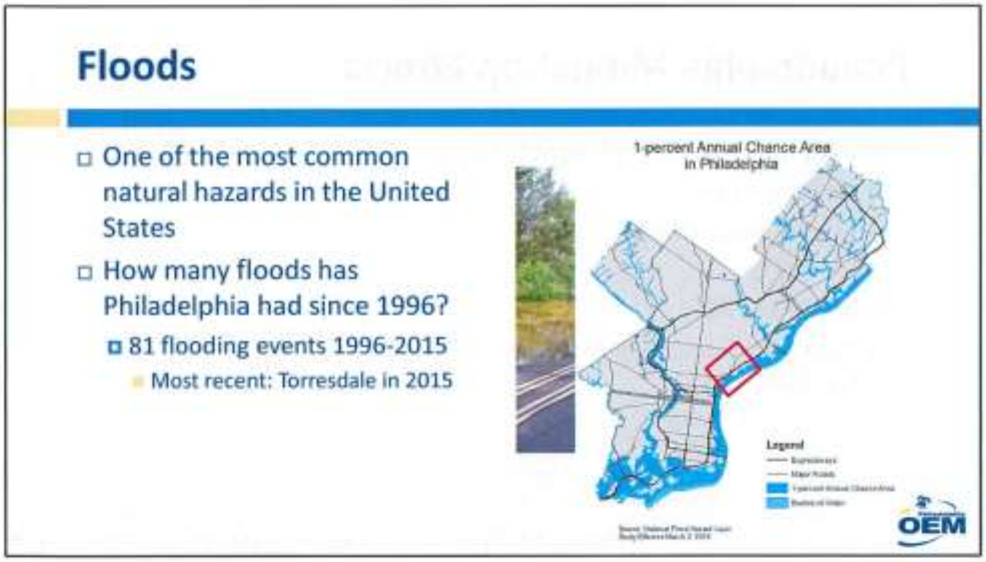
- Philadelphia Fire Department (PFD):
  - Maintain hydrants
  - Fire code inspections
  - Education
- OEM, PPD, PFD:
  - Participate in mutual training and exercises

Urban Conflagration/Hazardous Materials Train Derailment

What you can do

- ☐ Install and test smoke alarms
- ☐ Have a family emergency plan
- ☐ Follow emergency public messaging
- ☐ Go Bag

Urban Conflagration/Hazardous Materials Train Derailment



Floods

- ☐ One of the most common natural hazards in the United States
- ☐ How many floods has Philadelphia had since 1996?
  - ☐ 81 flooding events 1996-2015
    - Most recent: Torresdale in 2015

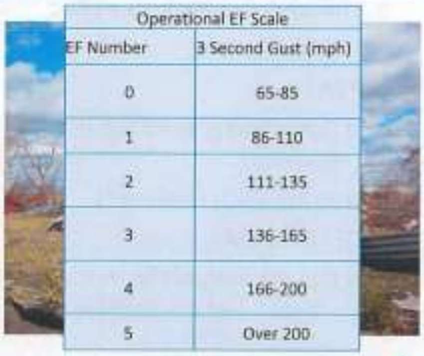
Wind Storms and Tornadoes

Wind Storm

- Wind speeds over 34 mph
- How many windstorms between 1950 and 2015?
  - 2,074 wind storms

Tornado

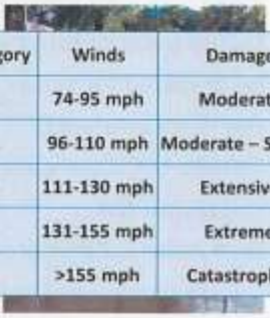
- EF-Scale: 0 to 5
- How many tornadoes between 1950 and 2015?
  - 8 tornadoes



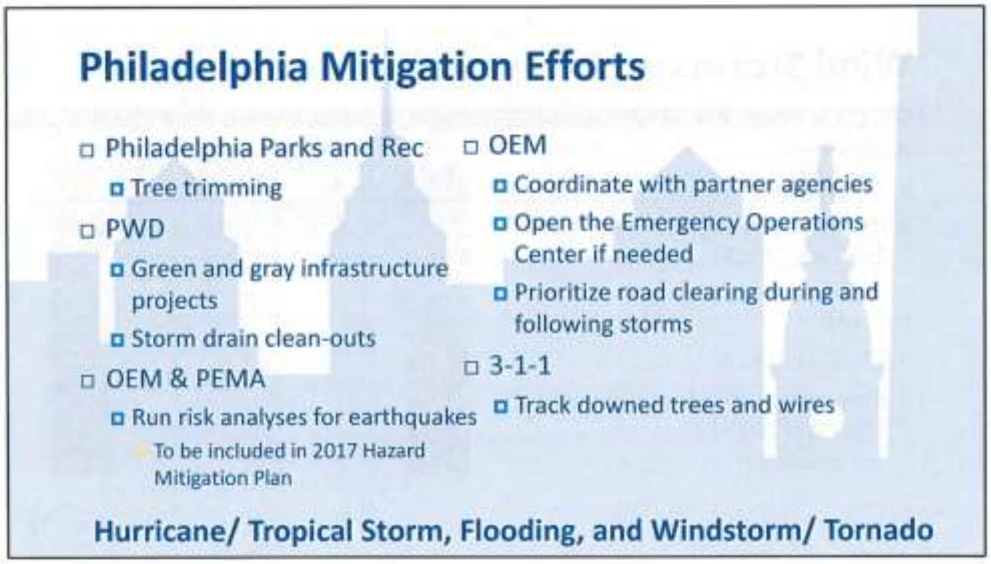
Operational EF Scale	
EF Number	3 Second Gust (mph)
0	65-85
1	86-110
2	111-135
3	136-165
4	166-200
5	Over 200

Hurricane and Tropical Storm

- Hurricane season: June 1 to November 30
- Past occurrences:
  - 32 coastal storms in or near Philadelphia
- What was the most intense hurricane to ever hit Philadelphia?
  - Category 1 storm



Category	Winds	Damage
1	74-95 mph	Moderate
2	96-110 mph	Moderate – Severe
3	111-130 mph	Extensive
4	131-155 mph	Extreme
5	>155 mph	Catastrophic



Philadelphia Mitigation Efforts

- ☐ Philadelphia Parks and Rec
  - Tree trimming
- ☐ PWD
  - Green and gray infrastructure projects
  - Storm drain clean-outs
- ☐ OEM & PEMA
  - Run risk analyses for earthquakes
    - To be included in 2017 Hazard Mitigation Plan
- ☐ OEM
  - Coordinate with partner agencies
  - Open the Emergency Operations Center if needed
  - Prioritize road clearing during and following storms
- ☐ 3-1-1
  - Track downed trees and wires

Hurricane/ Tropical Storm, Flooding, and Windstorm/ Tornado

What you can do

- ☐ Make sure your emergency supplies are up to date
- ☐ Secure outdoor furniture and play equipment
- ☐ Be prepared for power outages and downed trees
- ☐ Get flood insurance
- ☐ Install a backflow valve
- ☐ Know your risk
- ☐ Turn around, don't drown

Hurricane/ Tropical Storm, Flooding, and Windstorm/ Tornado

Earthquakes

- The shaking, rolling, or sudden shock of the Earth's surface
- Past earthquakes:
  - Since 1737: 81 epicenters
- What was the largest (magnitude) earthquake Philadelphia ever experienced?
  - Largest: 4.1 in 1871
  - Most recent: 2.2 in 2012

Richter Magnitude	Earthquake Effects
>3.5	Generally not felt, but recorded
3.5 - 5.4	Often felt, but rarely causes damage
5.5 - 6.0	At most, slight damage to well-designed buildings; damage to poorly constructed buildings
6.1 - 6.9	Moderate damage
7.0 - 7.9	Major earthquake; serious damage over large areas
8.0<	Great earthquake; serious damage.

OEM

Philadelphia Mitigation Efforts

- OEM & PEMA
  - Run risk analyses for earthquakes
    - To be included in 2017 Hazard Mitigation Plan update

Earthquake

What you can do

- Fix heavy furniture to wall

Earthquake

How to Stay Informed:

- Stay tuned to KYW AM and other local TV and radio media outlets:
- Call 311 for updates on the emergency.
- If you have cable, tune into Channel 64, the government access channel.
- Emergency Alert System
- Get updates from the OEM website at: www.phila.gov/ready
- Follow @PhilaOEM on social media

Sign Up

In the future:
Streets alerts
PWD alerts

Sign up for text and email alerts!

www.phila.gov/ready

Get Involved

What keeps you up at night?

Whether it be freezing temperatures, flooding, or thunderstorms, we want to know what hazards make you worry. Let us know at www.phila.gov/ready or scan the QR code for a direct link.

Thank you.

Check our website for the most recent updates of the Hazard Mitigation Plan!

Lynn Fisher
Community Preparedness
Program Manager

Laura Duff
Hazard Mitigation Planning
Coordinator

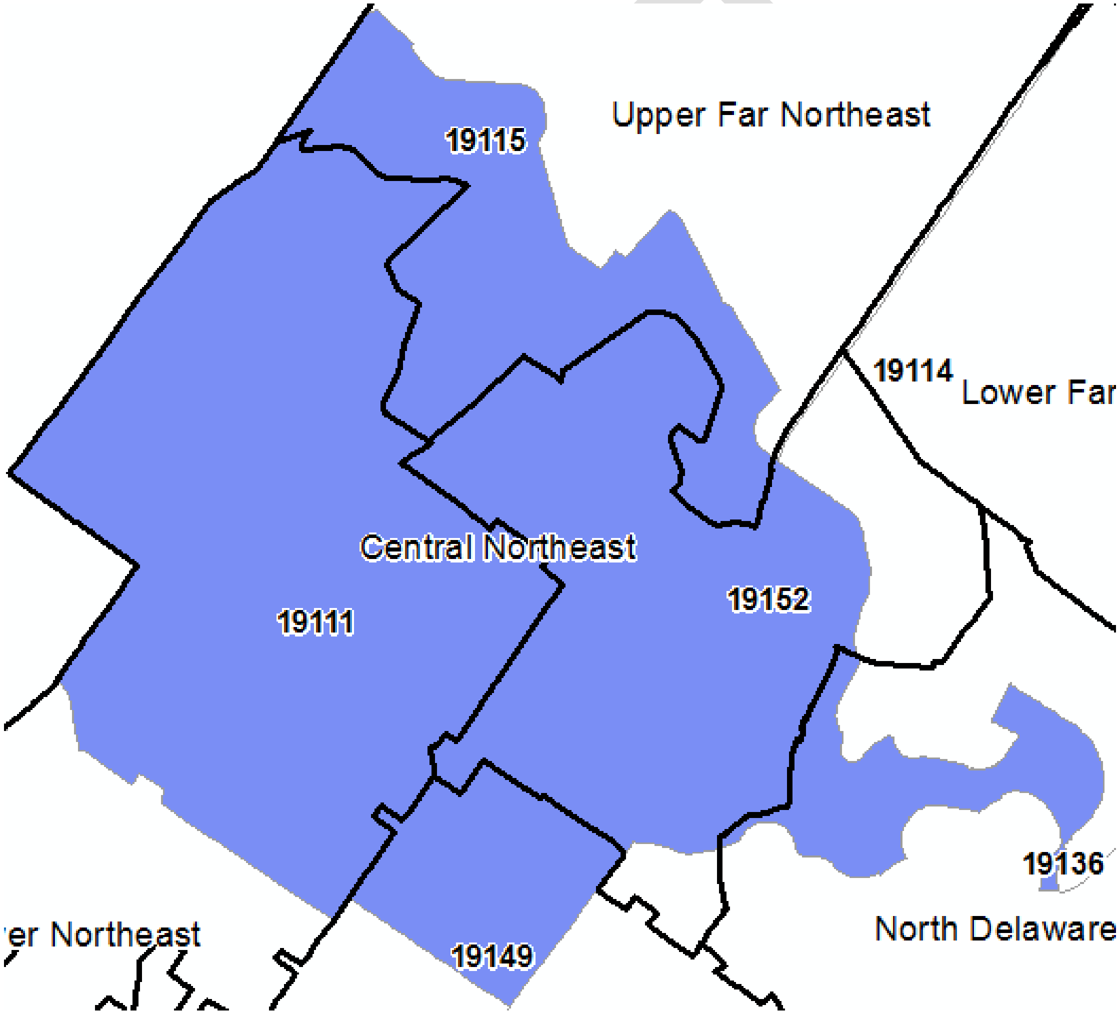
21 Community Annexes

21.1.1 <u>Central Northeast Planning District</u>

21.1.1.1 Geography and Hydrology

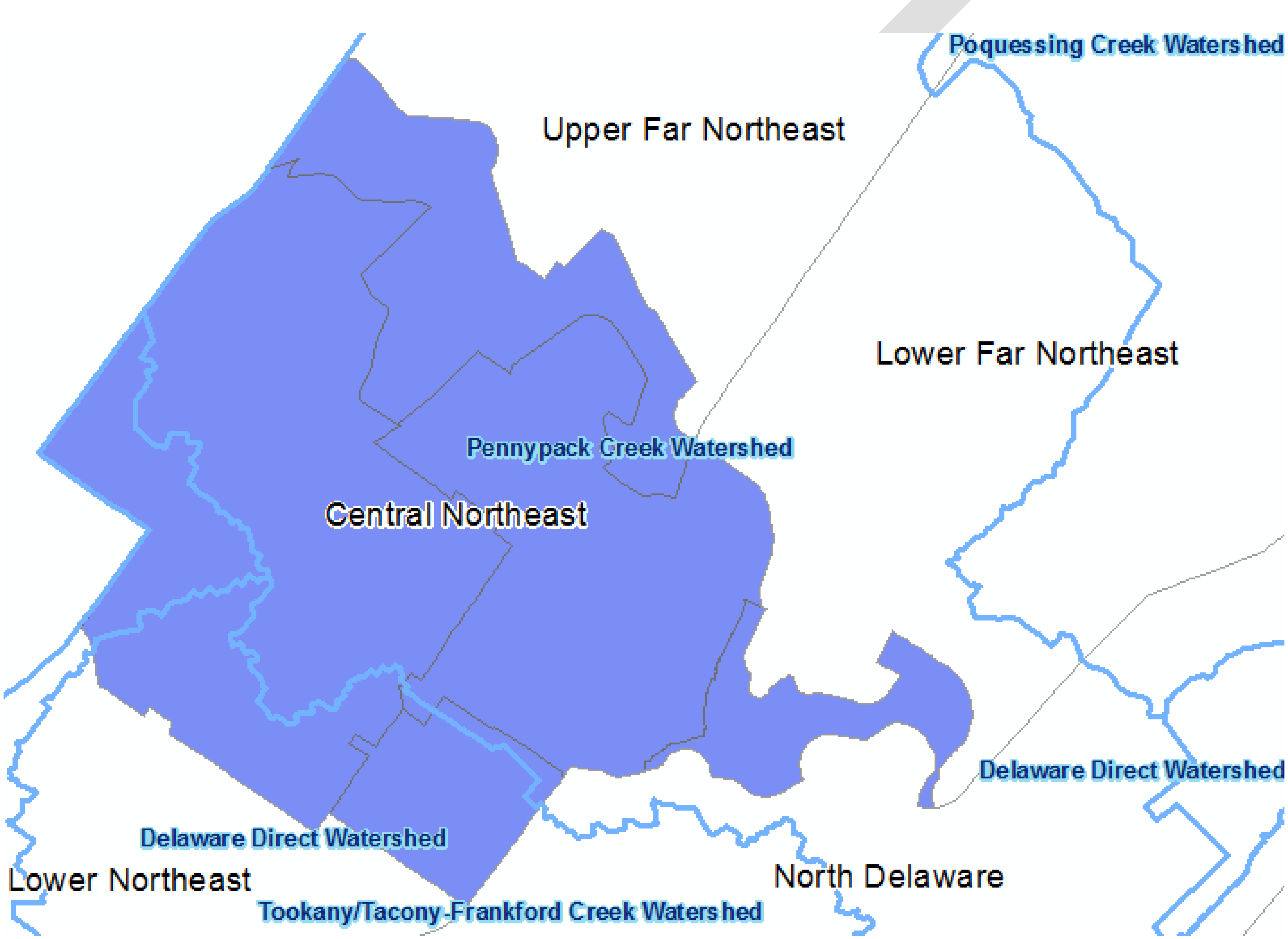
The Central Northeast Planning District contains addresses in the zip codes 19136, 19149, 19152, 19111, and 19115.

Zip codes in the Central Northeast Planning District



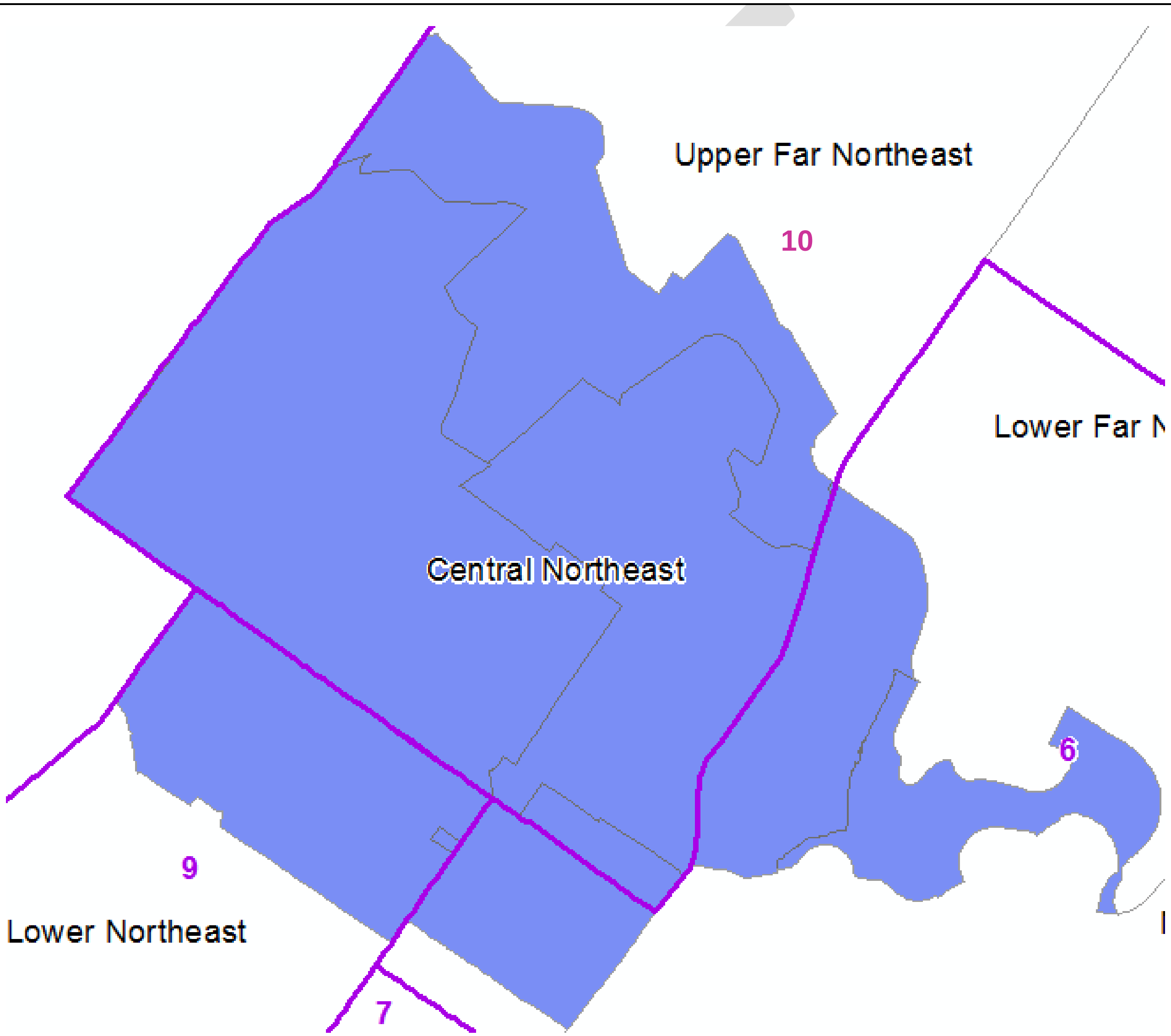
The Central Northeast planning district falls partially in the Delaware Direct, Pennypack Creek, and Tookany/Tacony-Frankford Watersheds.

Watersheds in the Central Northeast Planning District



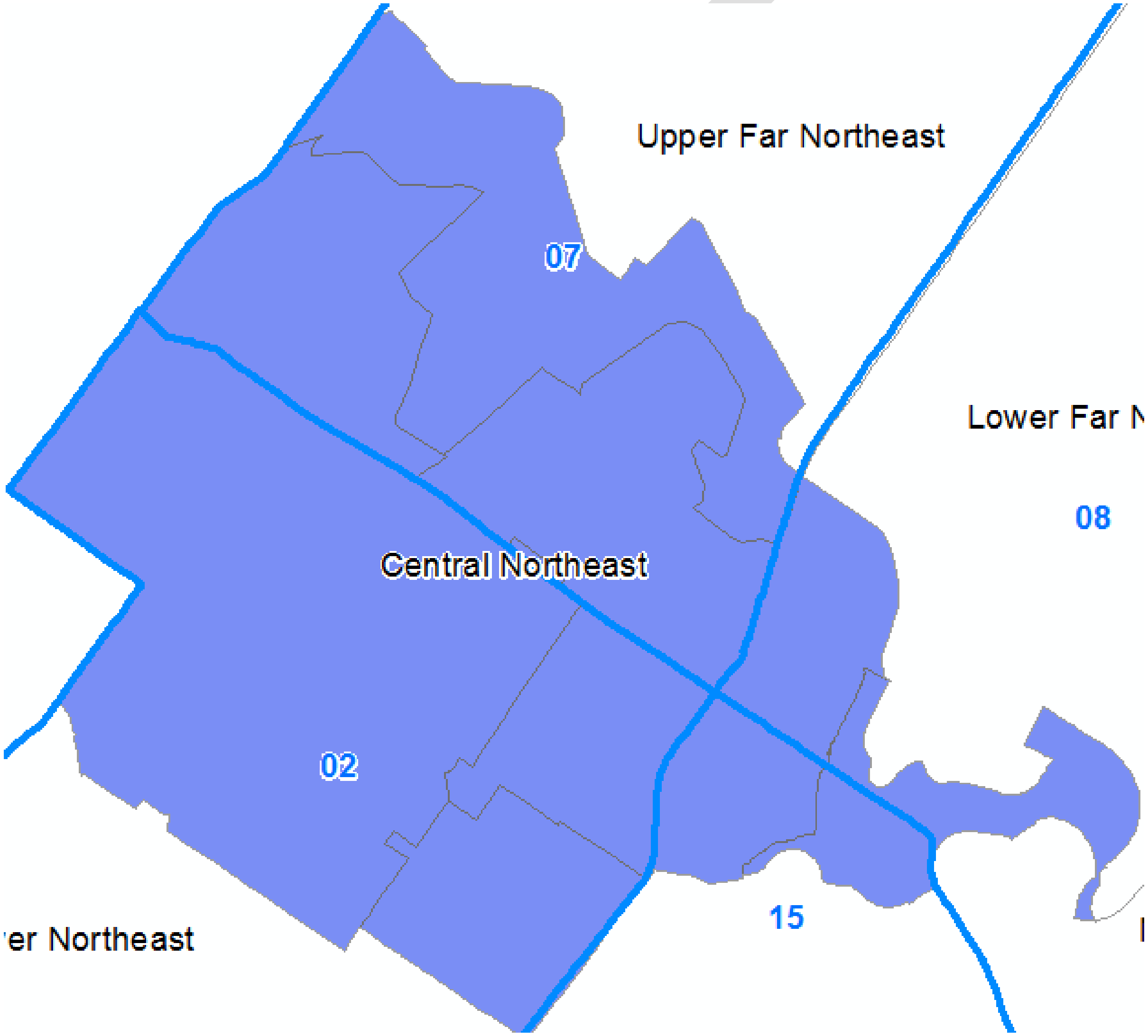
The Central Northeast Planning District resides within the 10th, 9th, and 6th Council Districts of Philadelphia.

Council Districts in Central Northeast Planning District



The Central Northeast Planning District falls mostly within the 7th and 2nd Police Districts, and also crosses into the 8th and 15th Police Districts.

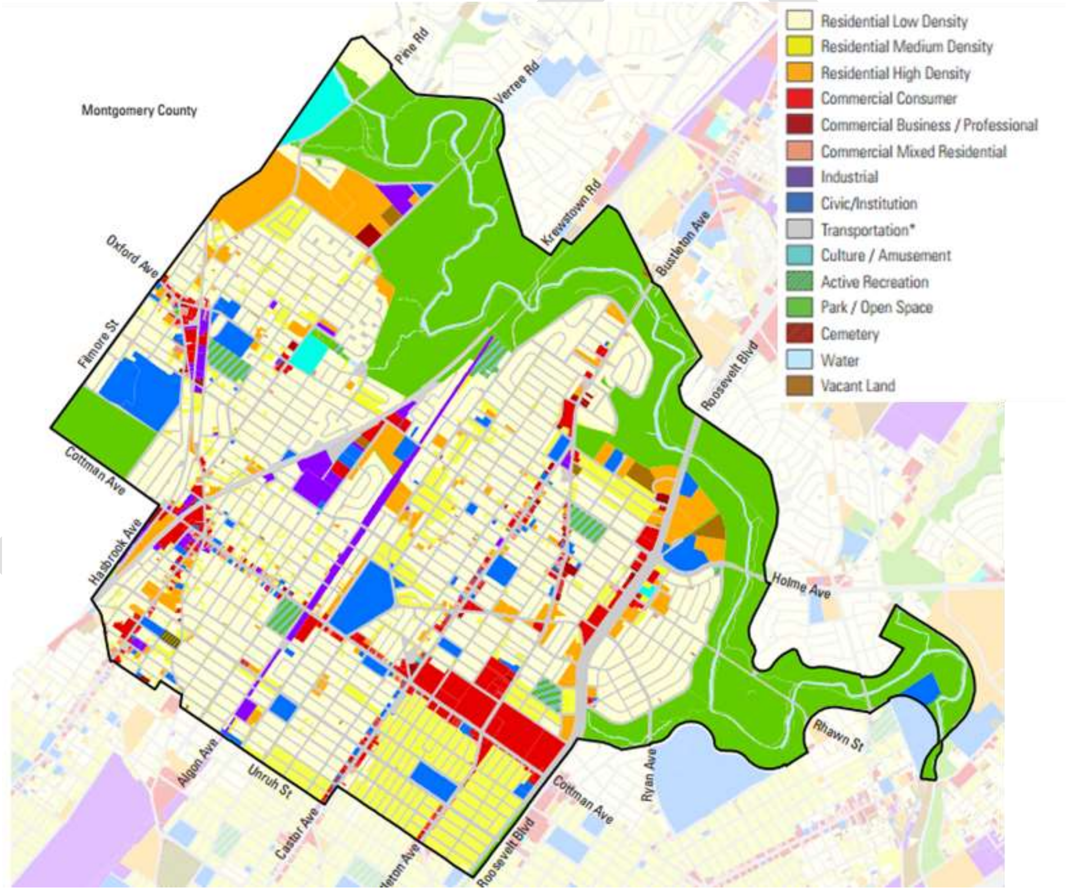
Police Districts in the Central Northeast Planning District



21.1.1.2 Current and Future Land Use

The PCPC forecasts that the Central Northeast will see modest population and employment growth over the next ten years[359]. Most residential places in the Central Northeast are stable and PCPC suggests that commercial corridors and centers accommodates any future growth.[360] [361]

Philadelphia Central Northeast Planning District Existing Land Use

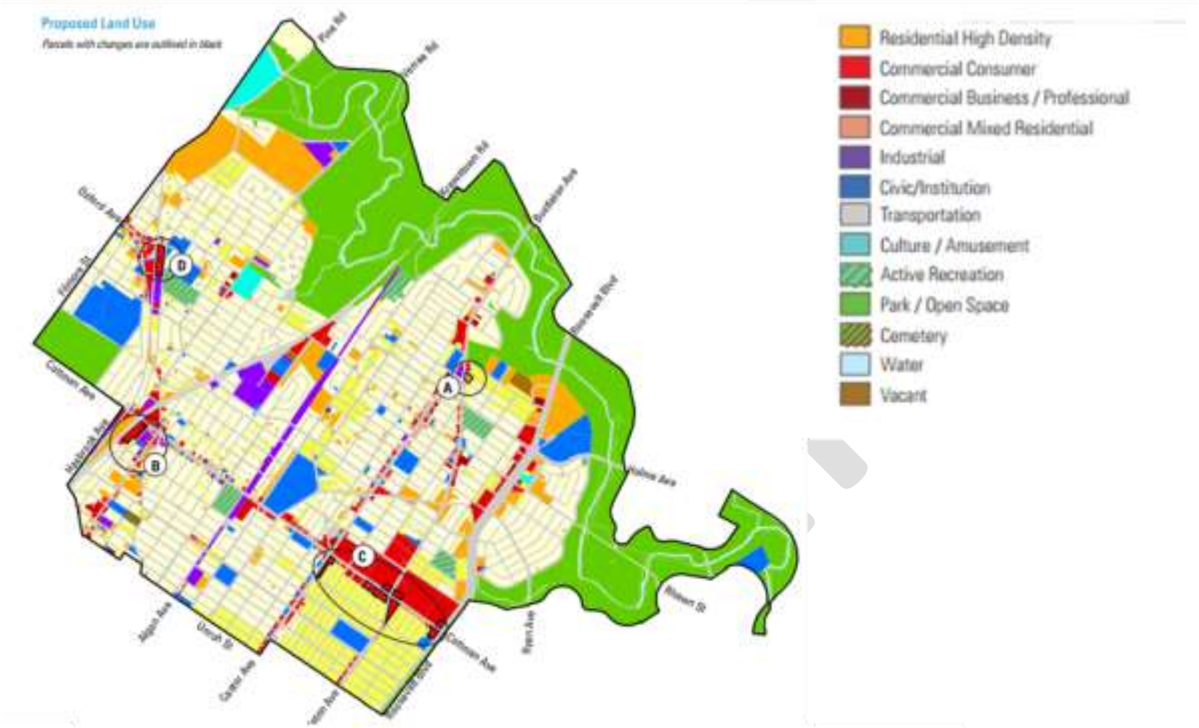


---

[359] City of Philadelphia, Philadelphia 2035. Central Northeast District Plan. Retrieved November 20, 2015.

[360] Ibid.

Philadelphia Central Northeast Planning District Future Land Use



A. Bustleton Avenue
Accommodate increased demand for housing along a transit-served corridor.

B. Five Points
Encourage future reinvestment to strengthen the town center streetscape while introducing a complementary mix of uses.

C. Cottman and the Boulevard
Allow more intensive commercial and mixed use reinvestment to enable the regional center to adapt to changing lifestyles, commuting patterns, and business practices.

D. Fox Chase
Capitalize on underutilized sites to add new parking resources and enable growth of the town center.

---

[361] All graphics, charts, and recommendations come from the City of Philadelphia: Philadelphia 2035 Central Northeast District Plan. Retrieved November 20, 2015.

21.1.1.3 Social Characteristics

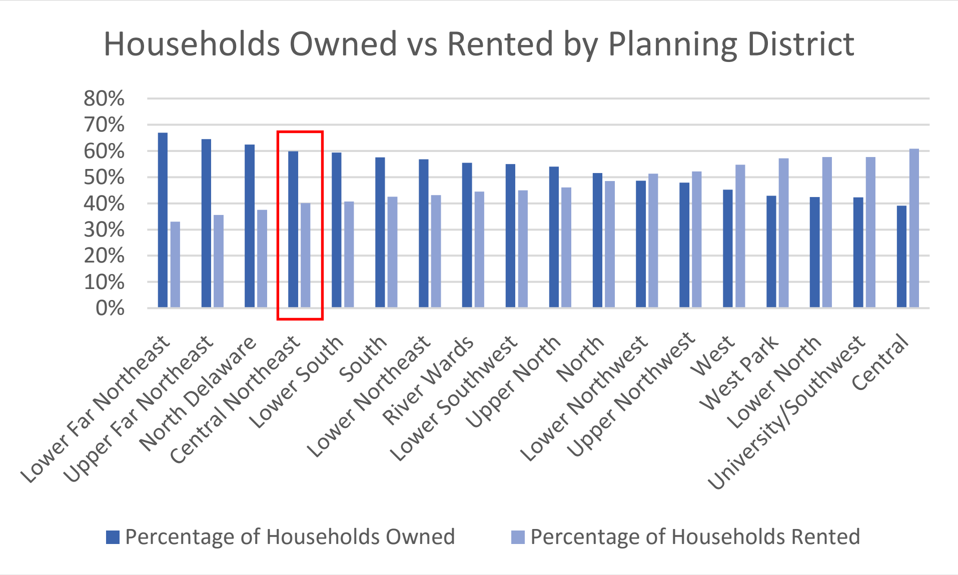
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

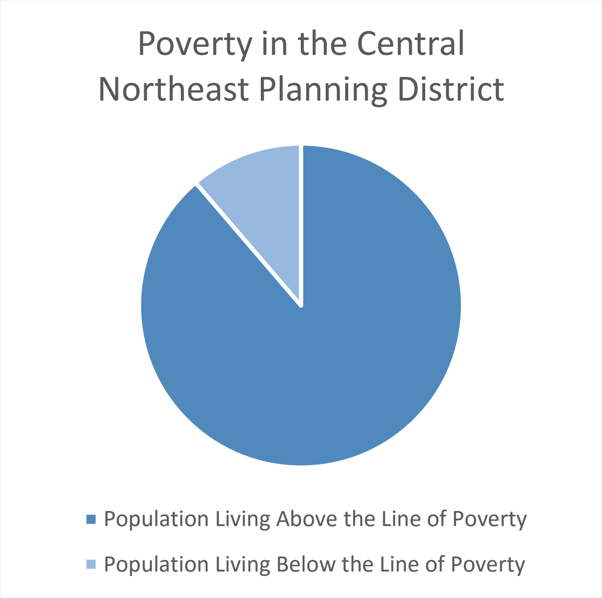
Population, Gender and Age Characteristics of the Central Northeast Planning District	
Population	164,978
- Male population	76,657
- Female population	85,321
Median Age	42.44
- Age dependency ratio (the percentage of the population under 15 and over 64)	64.52
- Population under 15	32.54%
- Population over 64	31.96%

21.1.1.4 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Central Northeast Planning District	
Number of households	63,744
- Households owned	41,099
- Households rented	22,645
No vehicle access	7,876
Population below the federal line of poverty	11.28%





21.1.1.5 Disability

Of those individuals residing within the Central Northeast Planning District, 15.24 percent reported having a disability. Disabilities reported by individuals in the Central Northeast Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	**Percentage of Population**
Hearing difficulty	5.7%
Vision difficulty	6.1%
Cognitive difficulty	6.6%
Ambulatory Difficulty	6.6%
Self-care Difficulty	6.5%
Independent Living Difficulty	6.4%

21.1.1.6 Central Northeast Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Central Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

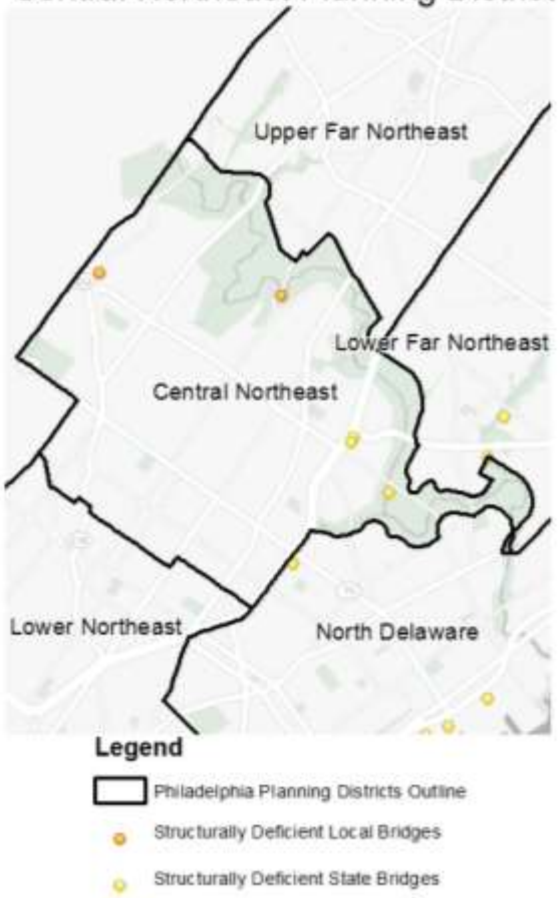
Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[362] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[363] [364] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the Central Northeast Planning District.[365]

Structurally Deficient Bridges in the Central Northeast Planning District



---

[362] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[363] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[364] Ibid.

[365] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

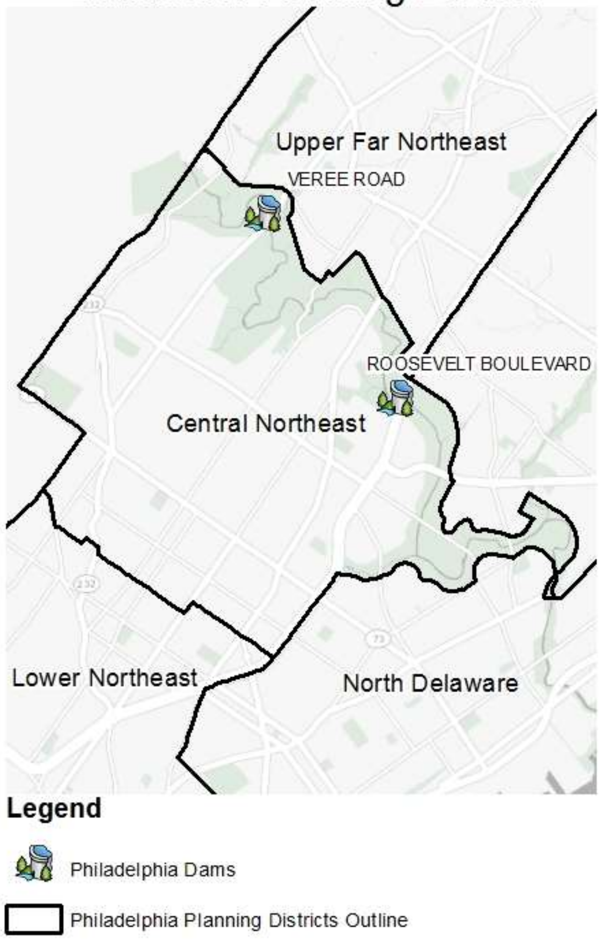
Structurally Deficient Bridges in the Central Northeast Planning District		
Name	**Location**	**Year Built**
Pennypack Creek	Krewstown Rd	1907
SEPTA (Newtown Branch)	Pine Rd	1964
Roosevelt Blvd	Pennypack Circle	1964
Roosevelt Blvd	Cottman Ave and Roosevelt Blvd	1967
Pennypack Creek	Rhawn St and Roosevelt Blvd	1930

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. The table below shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.

Dam Name	Waterway	High Hazard?	Permitted Owner
Verre Road	Pennypack Creek	No	City of Philadelphia
Roosevelt Boulevard	Pennypack Creek	No	City of Philadelphia

Dams in the Central Northeast Planning District

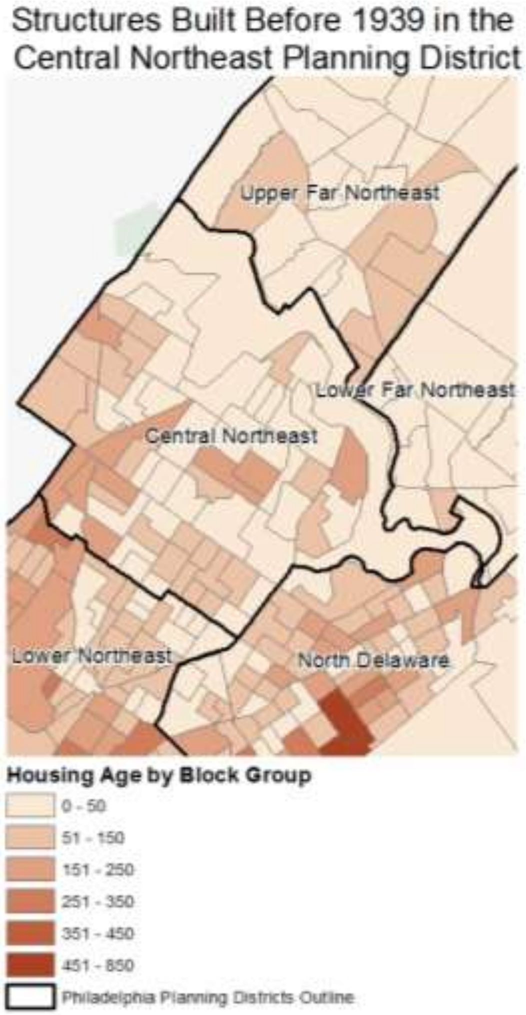


Building Collapse

Buildings may collapse for a variety of reasons, including:

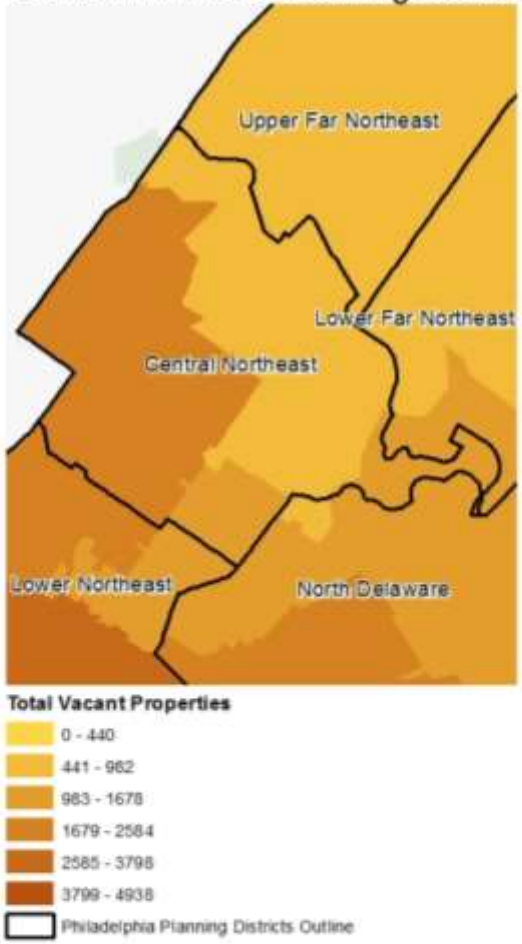
- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the Central Northeast Planning District built before 1939.



Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the Central Northeast.

Vacant Properties in the Central Northeast Planning District

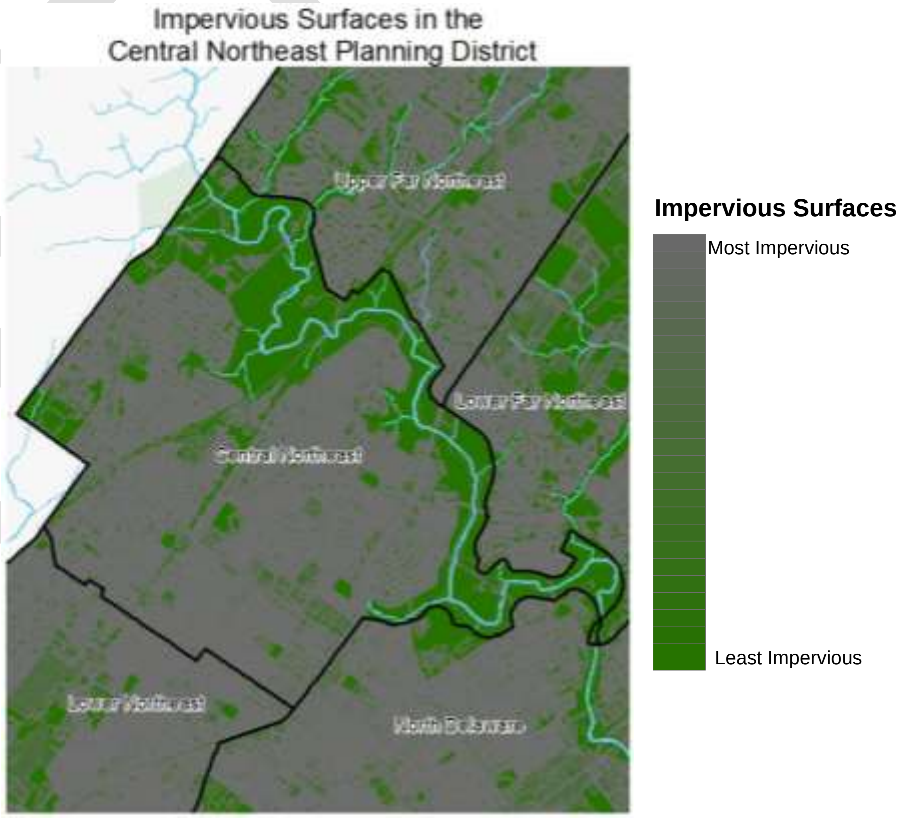


Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the Central Northeast.

Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[366] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

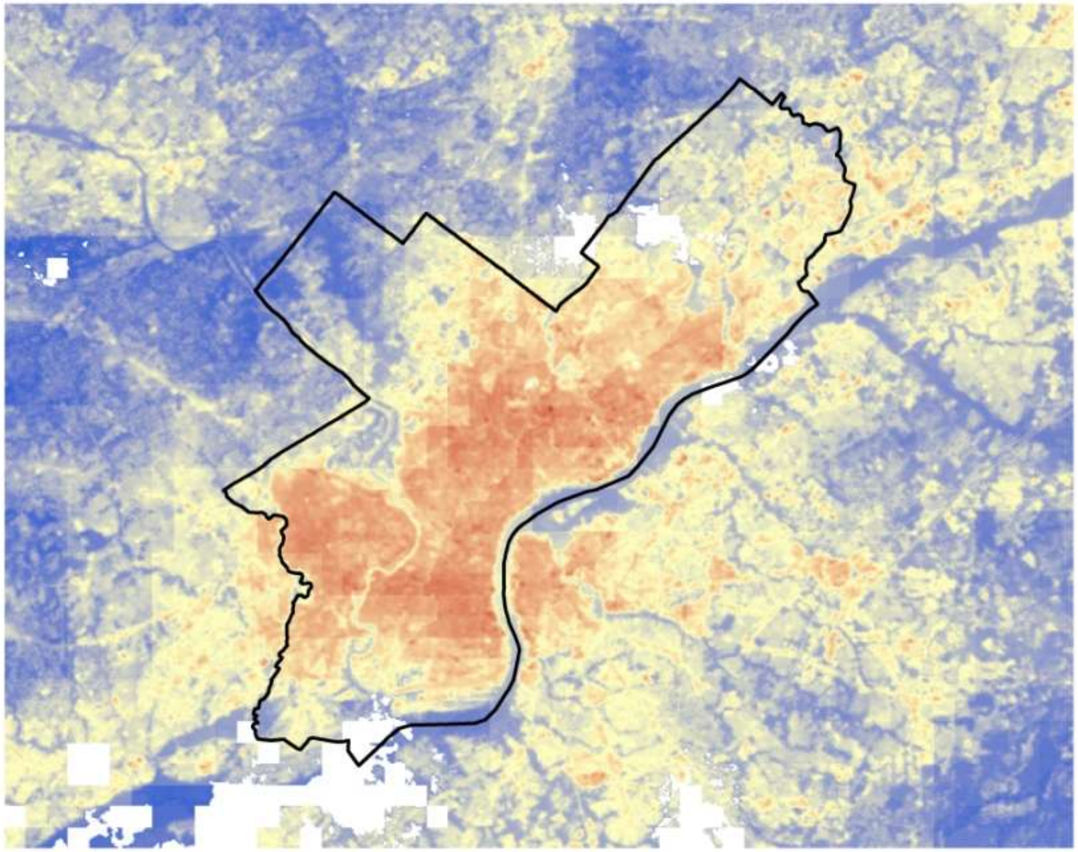
Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[367] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Central Northeast.



---

[366] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[367] "Heat Island Effect". US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[368] As the map shows, the Lower Far Northeast is not located in the areas which experience the highest heat island effects, but the Lower Far Northeast still feels some of the effects of such an event more than the surrounding counties.



---

[368] "Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002". URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[369]

Flood Hazard Areas in the Central Northeast

Winter flooding includes 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. All forms of flooding can damage

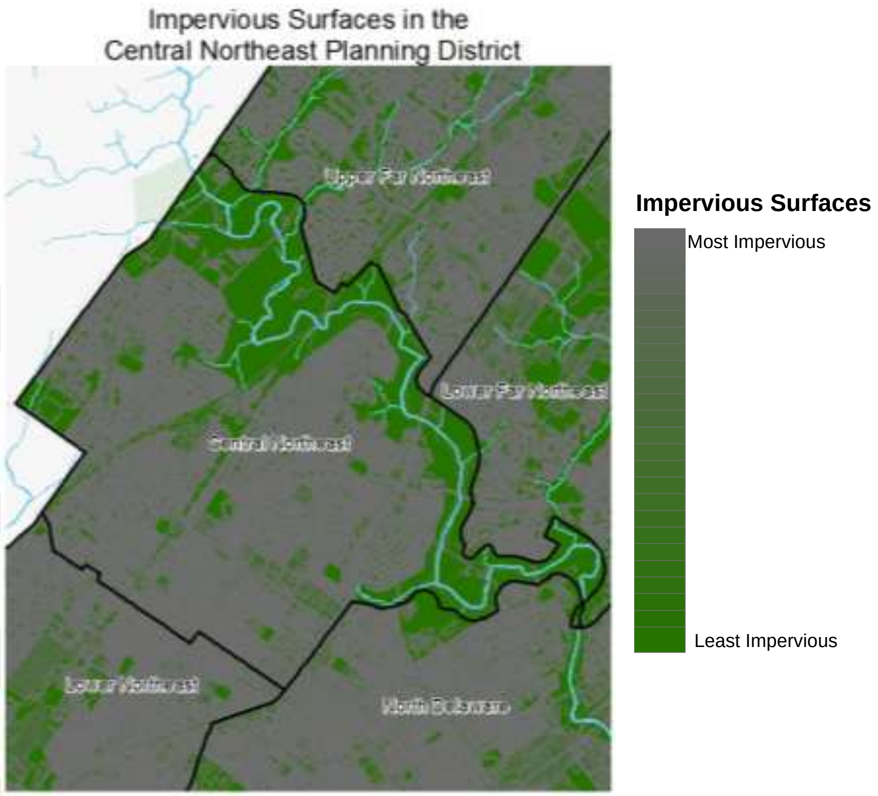
---

[369] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

infrastructure.[370] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

A small portion of the Central Northeast falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the Central Northeast there are 41 of policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.



Flash flooding is a concern for some areas of the Central Northeast, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Central Northeast. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.

---

[370] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

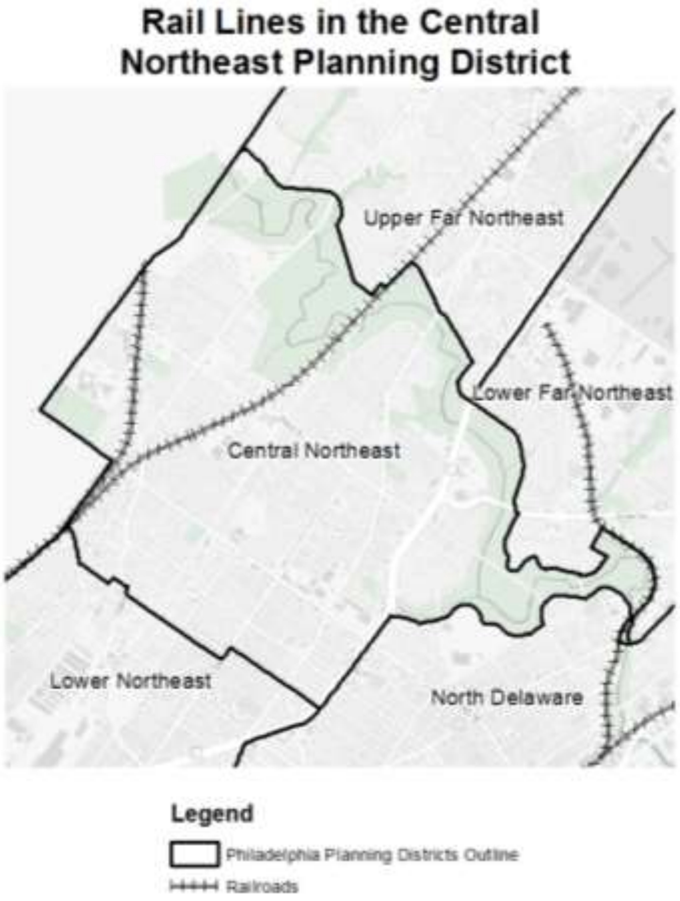
Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[371]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.



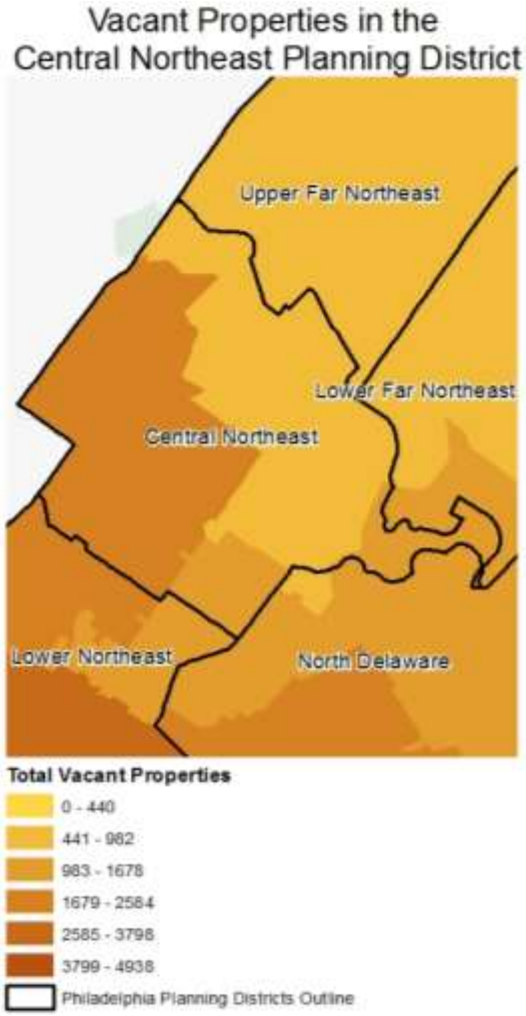
---

[371] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[372] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see [Urban Conflagration]() under the [Risk Assessment]() section of the 2017 Hazard Mitigation Plan.

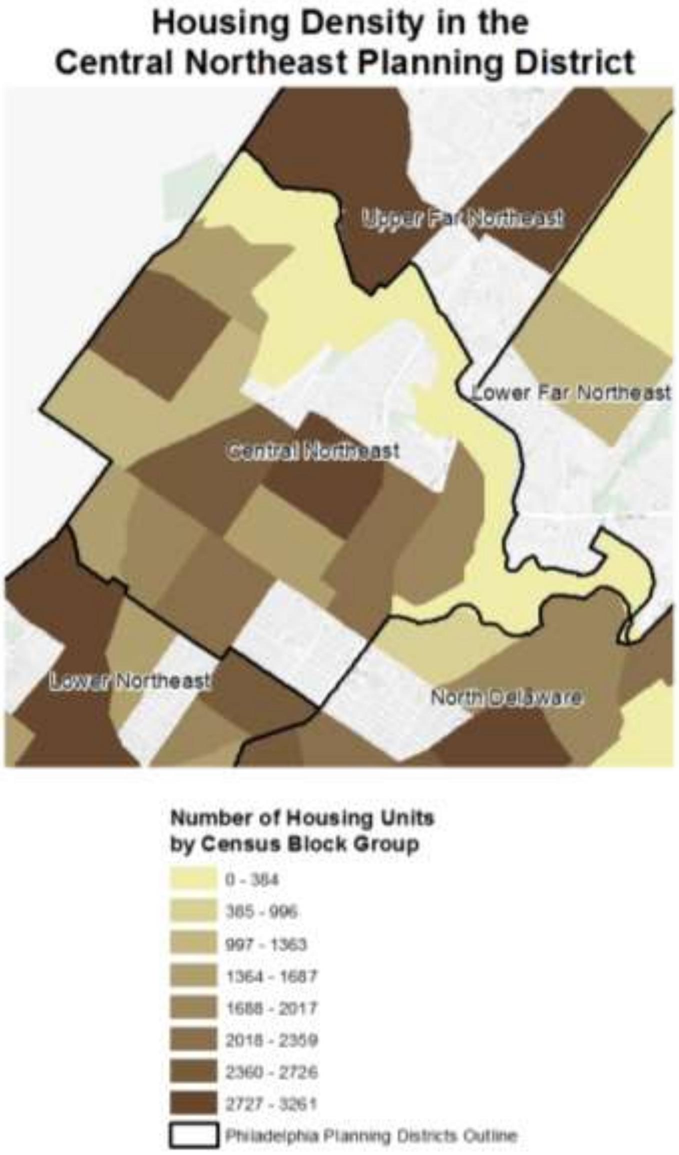
Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[373] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The Central Northeast has comparatively fewer vacant properties than many other parts of Philadelphia, and therefore has a slightly lower risk for urban conflagration.



---

[372] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.
[373] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the Central Northeast's housing density. Data was unavailable for those portions of the map left uncolored.

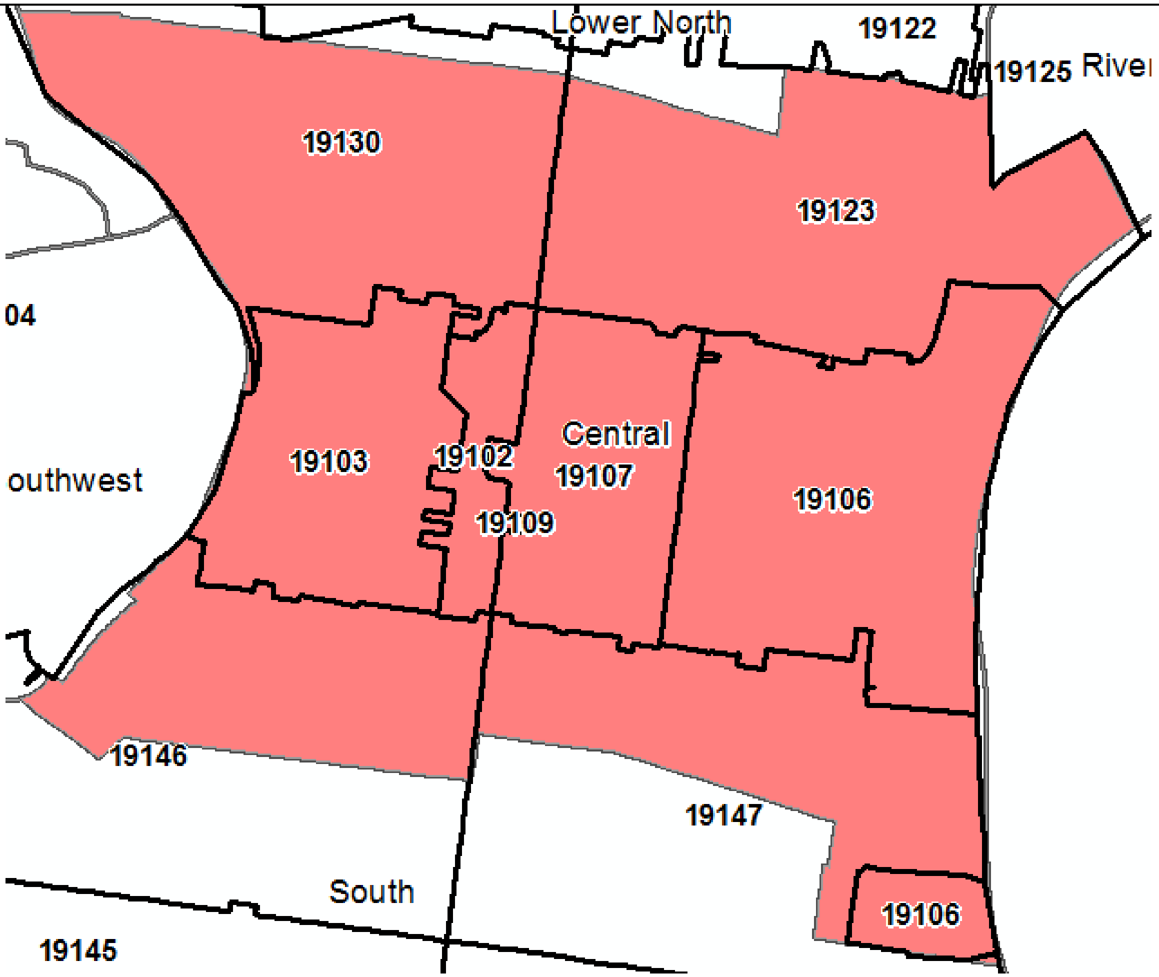


21.1.2 Central Planning District

21.1.2.1 Geography and Hydrology

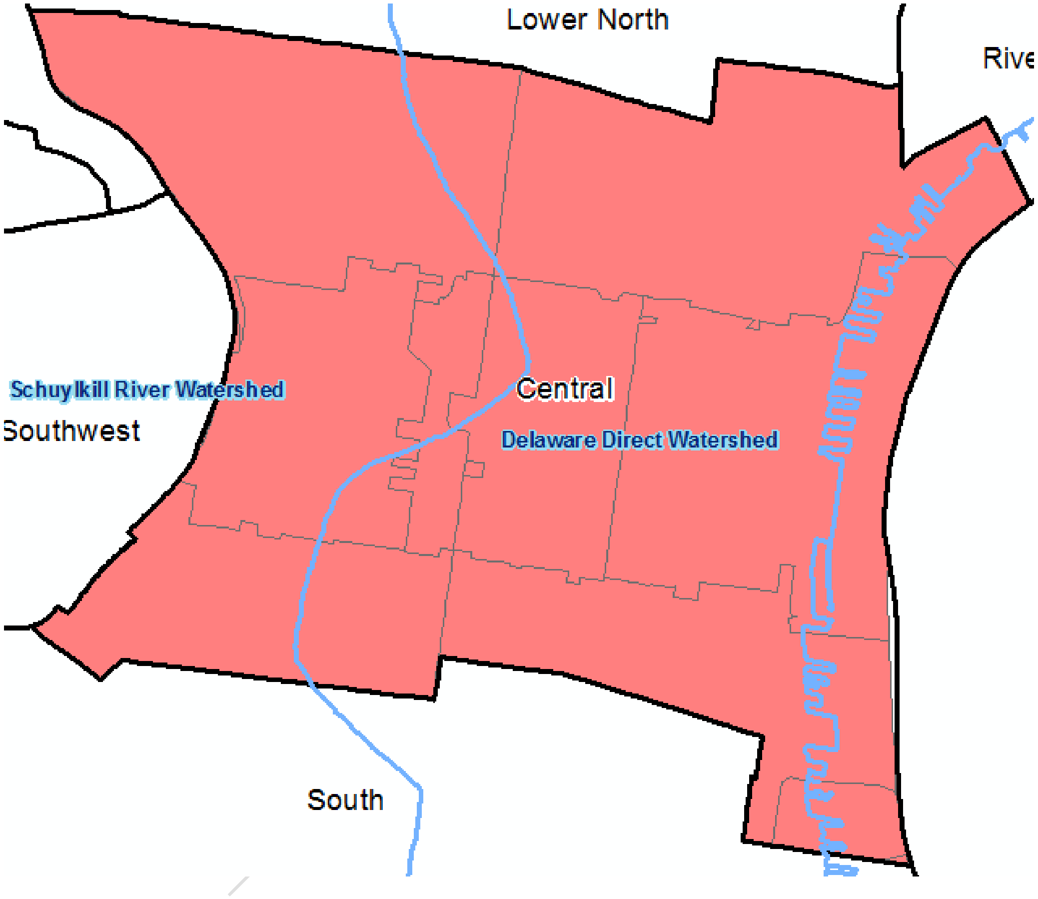
The Central planning district contains addresses in the zip codes 19130, 19103, 19102, 19109, 19123, 19106, 19146, 19147, and 19106.

Zip codes in the Central Planning District



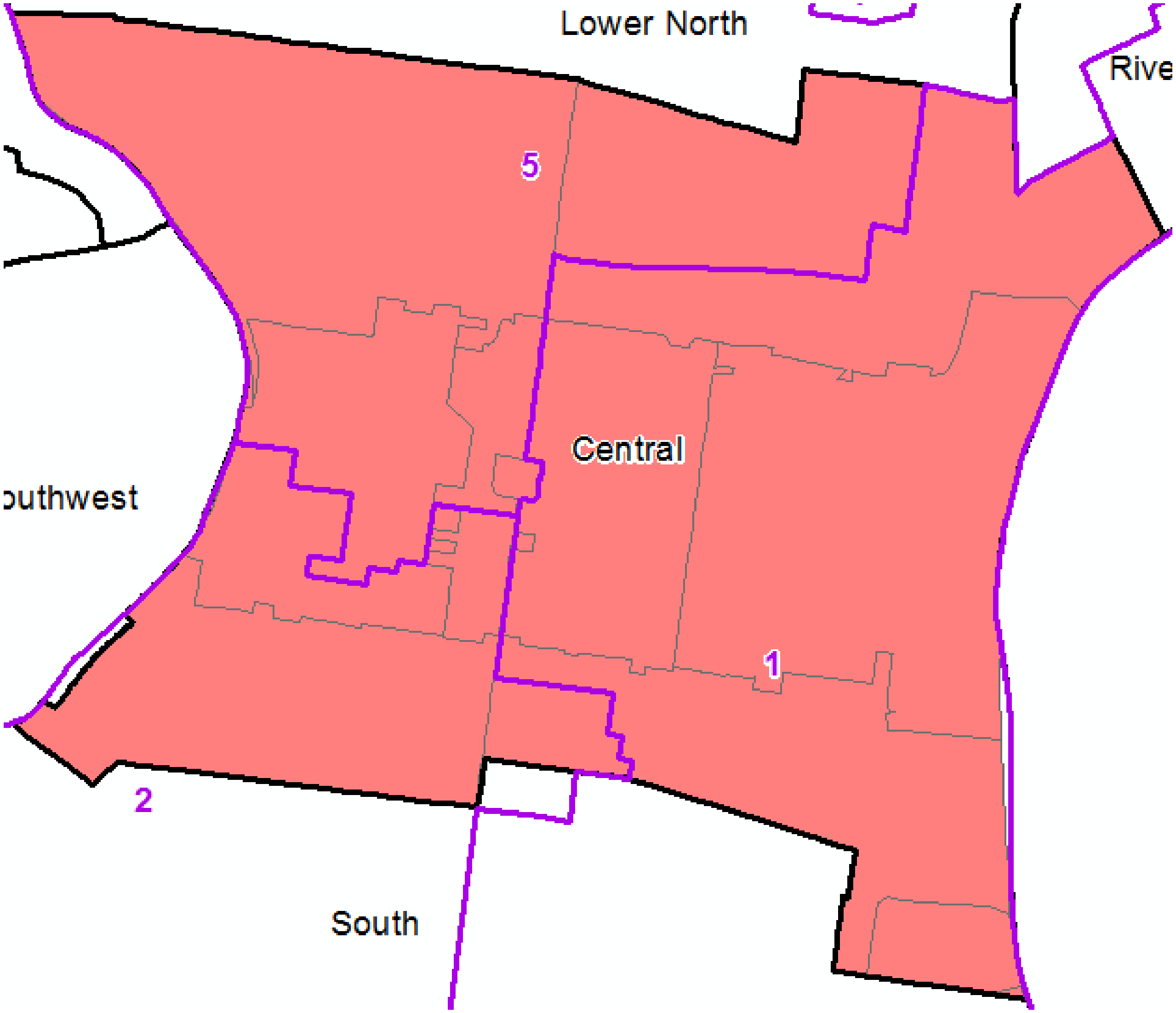
The Central planning district falls partially in the Schuylkill River and Delaware Direct Watersheds.

Watersheds in the Central Planning District



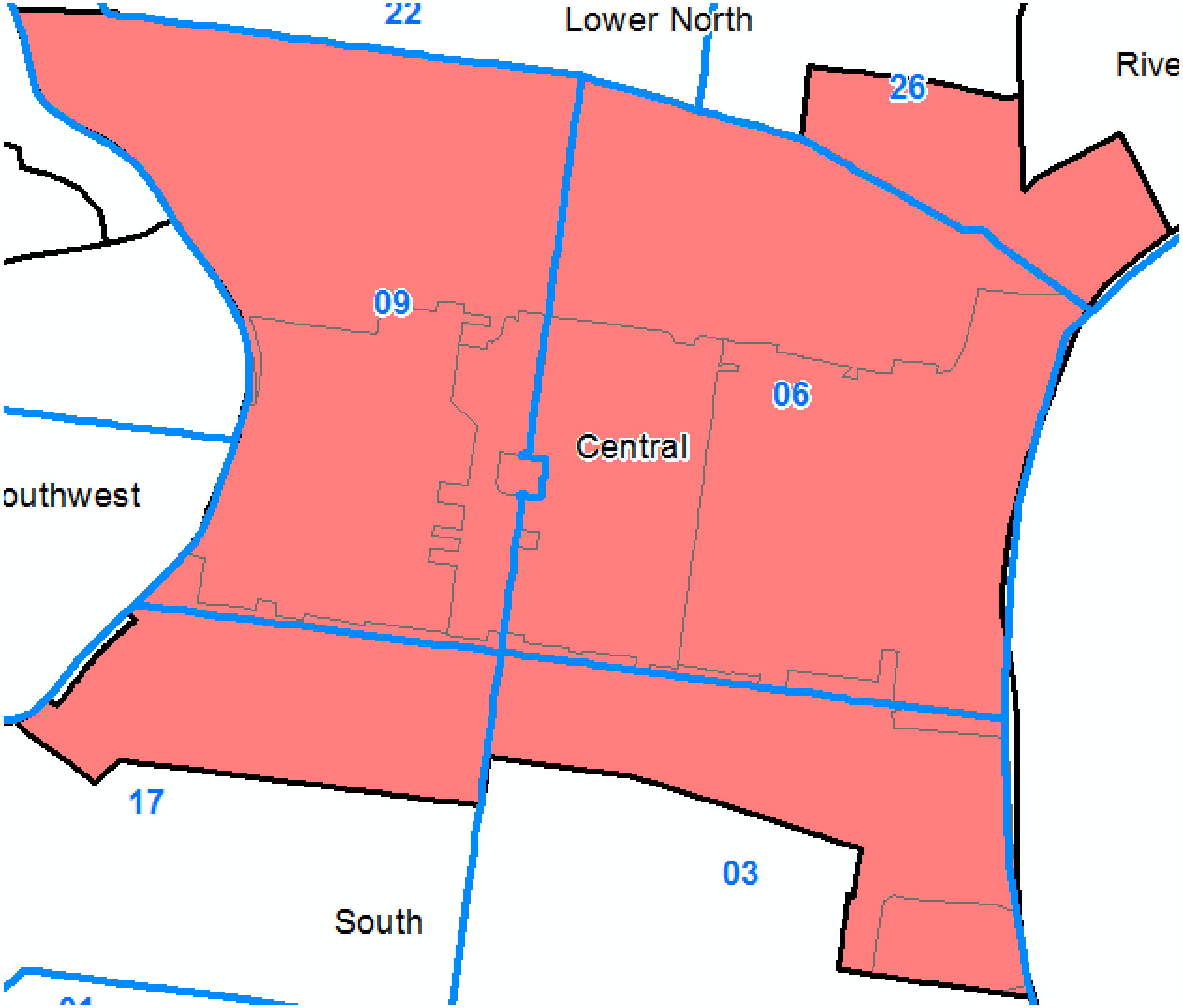
The Central planning district resides within the 5th, 1st, and 2nd Council Districts of Philadelphia.

Council Districts in Central Planning District



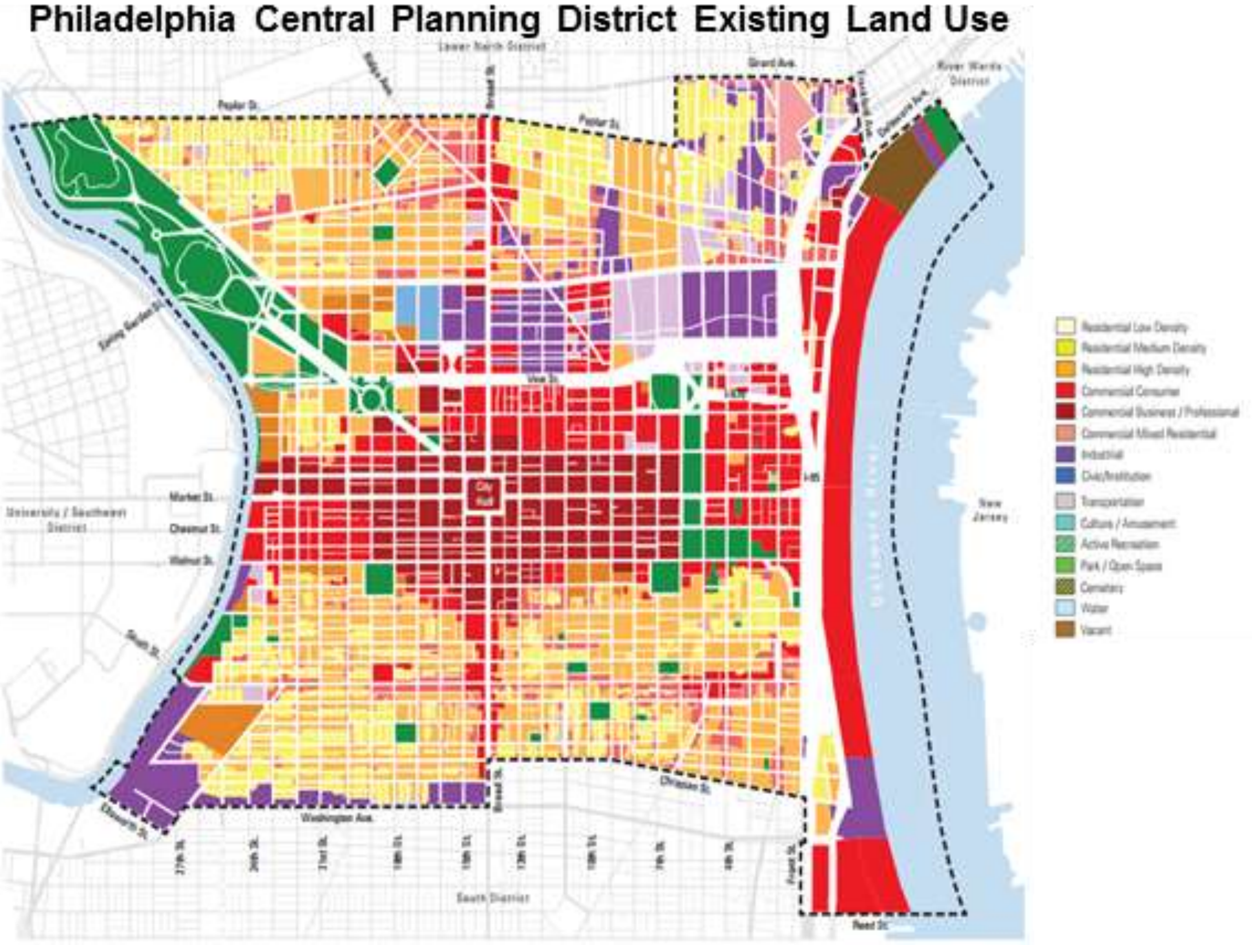
The Central planning district falls mostly within the 9th and 6th Police Districts, and also crosses into the 17th, 26th, and 3rd Police Districts.

Police Districts in the Central Planning District



21.1.2.2 Current and Future Land Use

The Central District will most likely see moderate growth over the next 10 years. Future land use recommendations take into account stable residential neighborhoods and commercial areas, as well as where growth can be accommodated, existing plans, and community feedback.[374] [375]



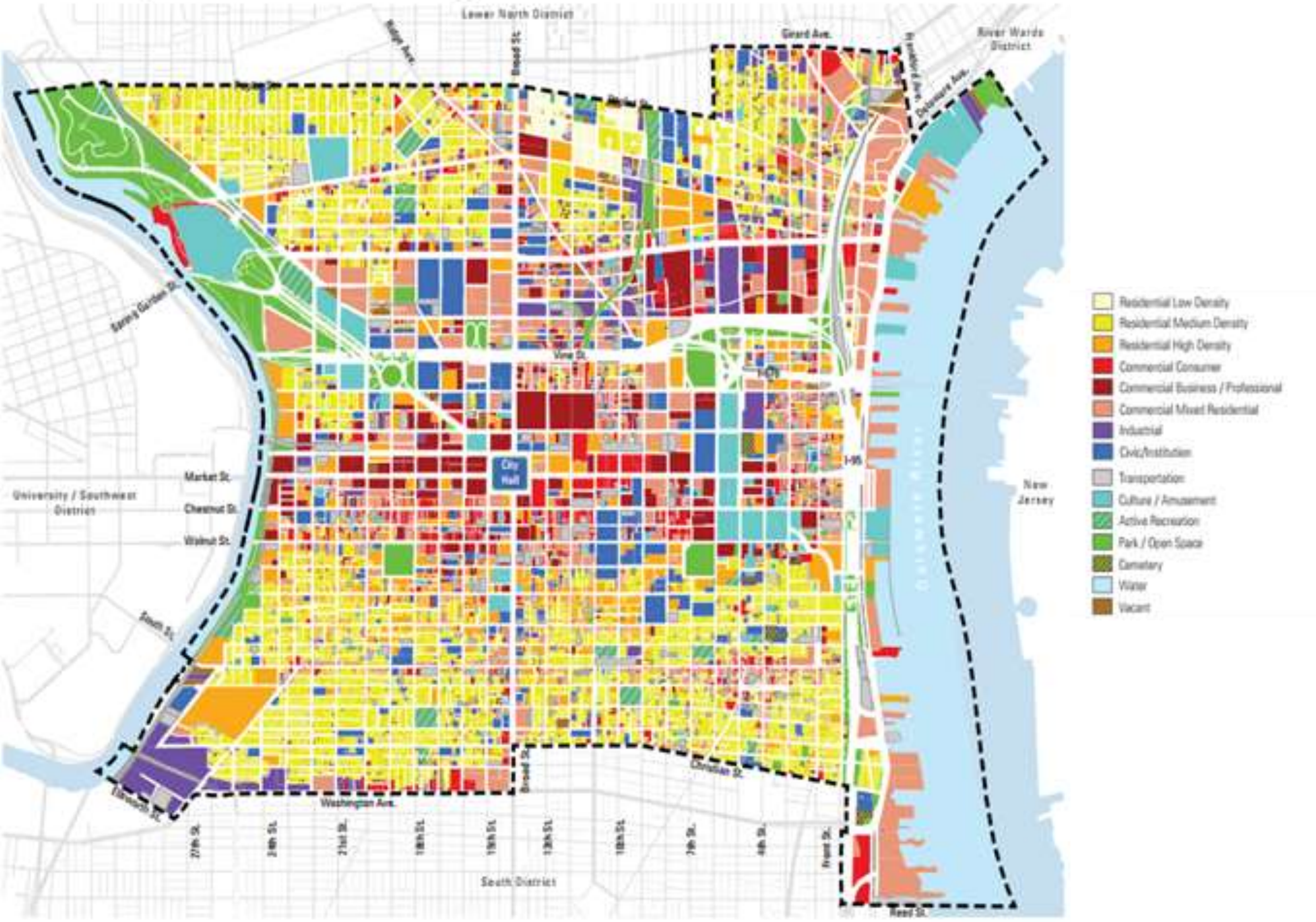
Philadelphia Central Planning District Existing Land Use

---

[374] City of Philadelphia, Philadelphia 2035. Central District Plan. Retrieved November 20, 2015.

[375] All graphics, charts, and recommendations come from the City of Philadelphia: Philadelphia 2035 Central District Plan. Retrieved November 20, 2015.

Philadelphia Central Planning District Future Land Use



21.1.2.3 Social Characteristics

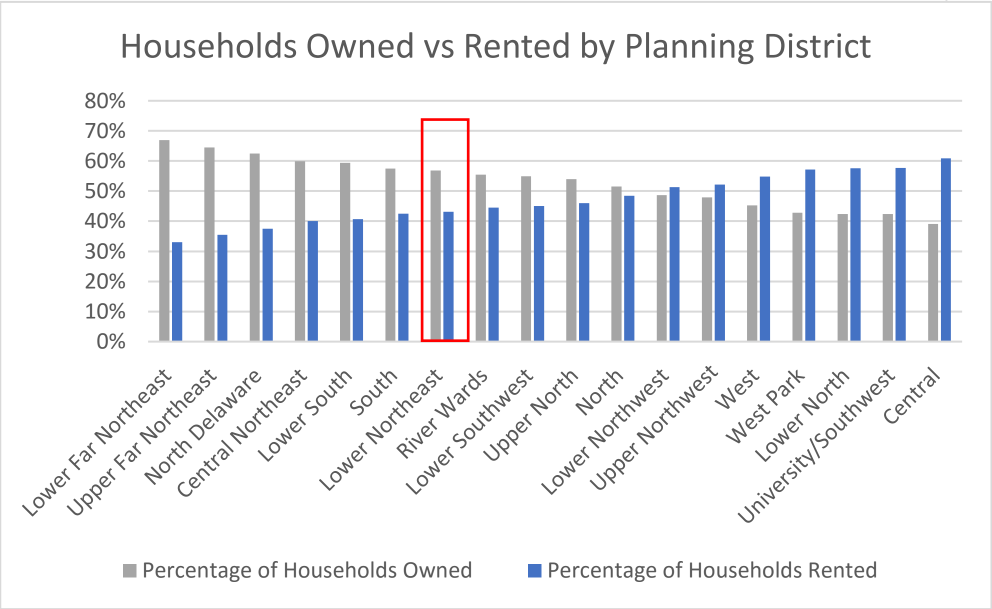
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

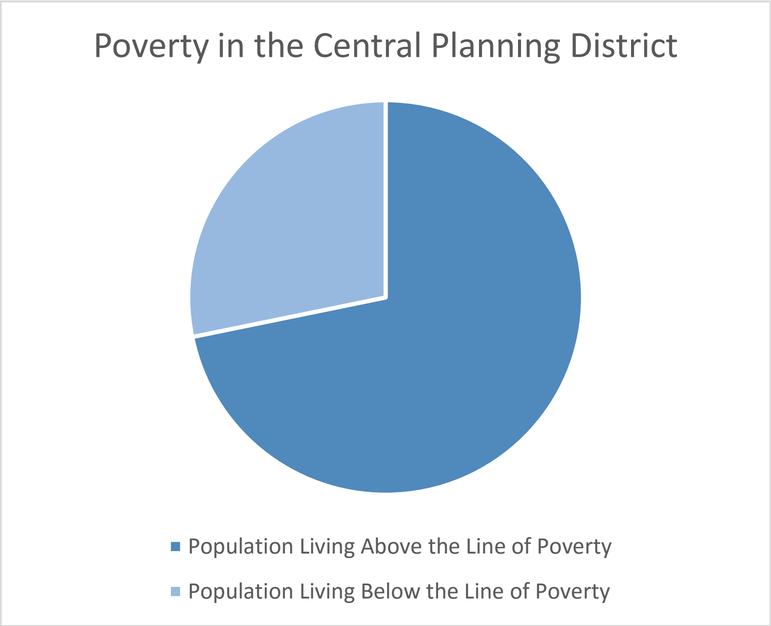
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	293,966
- Male population	142,307
- Female population	151,659
Median Age	31.0
- Age dependency ratio (the percentage of the population under 15 and over 64)	31.7%
- Population under 15	16.8%
- Population over 64	14.9%

21.1.2.4 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Central Planning District	
Number of households	123,472
- Households owned	48,278
- Households rented	75,194
No vehicle access	12,801
Population below the federal line of poverty	28.2%





21.1.2.5 Disability

Of those individuals residing within the Central Planning District, 10.7 percent reported having a disability. Disabilities reported by individuals in the Central Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	5.8%
Vision difficulty	6.1%
Cognitive difficulty	6.4%
Ambulatory Difficulty	6.4%
Self-care Difficulty	6.5%
Independent Living Difficulty	6.5%

21.1.2.6 Central Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[376] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[377] [378] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the Central Planning District.[379]

---

[376] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.
[377] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.
[378] Ibid.
[379] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the Central Planning District

Name	Location	Year Built
24th St at Chestnut St	24th St at Chestnut St	1864
Abolished Conrail	15th St, north of Callowhill	1898
Vine St Expressway	18th St	1958
Vine St Expressway	19th St	1957
Vine St Expressway	20th St	1959
Vine St Expressway	21st St	1958
Chestnut St	Schuylkill River, west of City Hall	1912
Market St	Schuylkill River	1932
CSX Railroad	Market St	1932
21st St and JFK Blvd	21st St and JFK Blvd	1957
22nd St and JFK Blvd	22nd St and JFK Blvd	1958
23rd St and JFK Blvd	23rd St and JFK Blvd	1957
Reading Railroad	Broad St	1895

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. The table below shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.

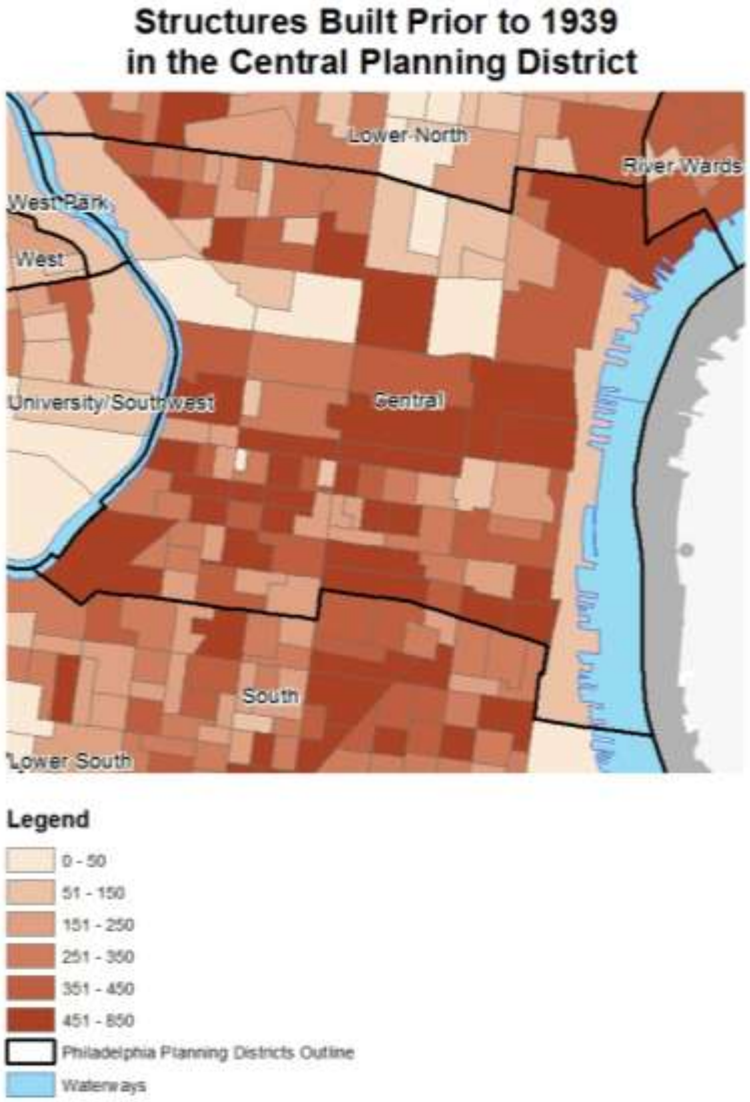
Dam Name	Waterway	High Hazard?	Permitted Owner
Fairmount	Schuylkill River	No	Philadelphia Water Department

Building Collapse

Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the Central Planning District built before 1939.



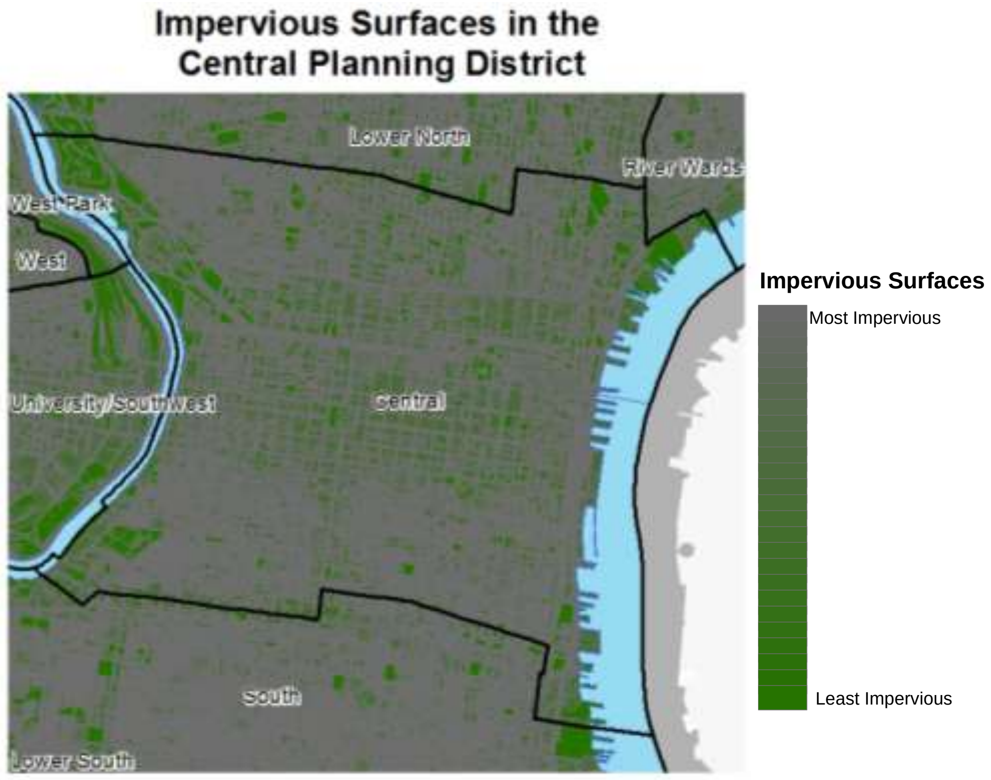
Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the Central Planning District. The Central Planning District has comparatively fewer vacant properties than many other parts of Philadelphia.

Vacancy in the Central Planning District

Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the Central Planning District.

Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[380] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.



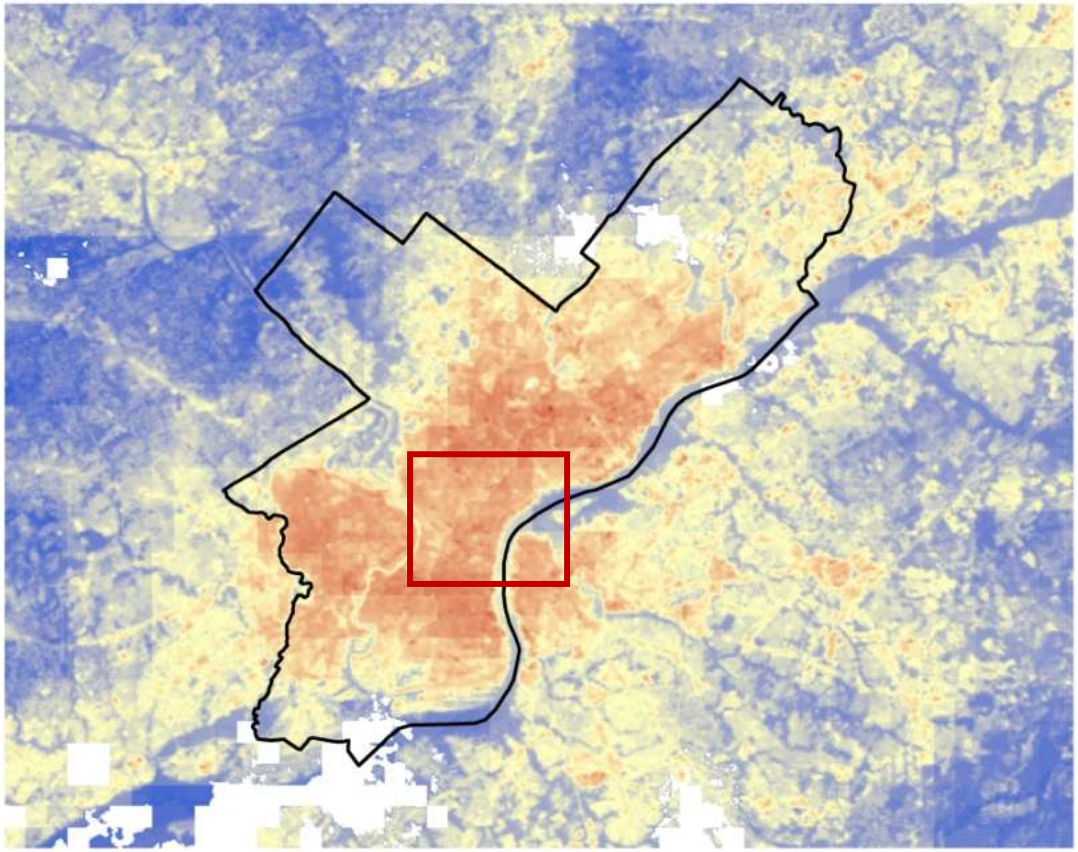
Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[381] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Central Planning District.

---

[380] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.

[381] "Heat Island Effect". US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[382] As the map shows, the Central is located in an area which experiences higher heat island effects along with the surrounding districts.



---

[382] "Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002". URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[383]

Winter flooding includes 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

---

[383] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

bridges and dams. All forms of flooding can damage infrastructure.[384] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

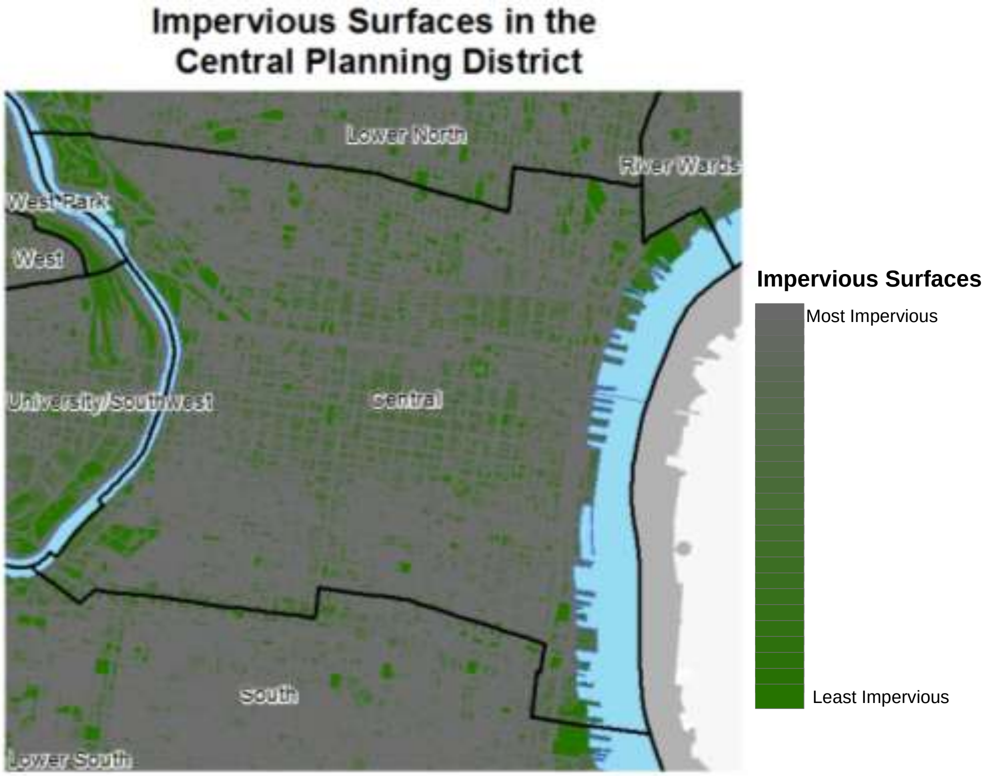
A small portion of the Central Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner’s insurance policy and must be purchased separately. Within the Central Planning District there are 2,015 of policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

---

[384] “Standard Operating Guide”. Commonwealth of Pennsylvania’s All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Flash flooding is a concern for some areas of the Central Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Central Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.


Impervious Surfaces in the Central Planning District

Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[385]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the Central Planning District

---

[385] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[386] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

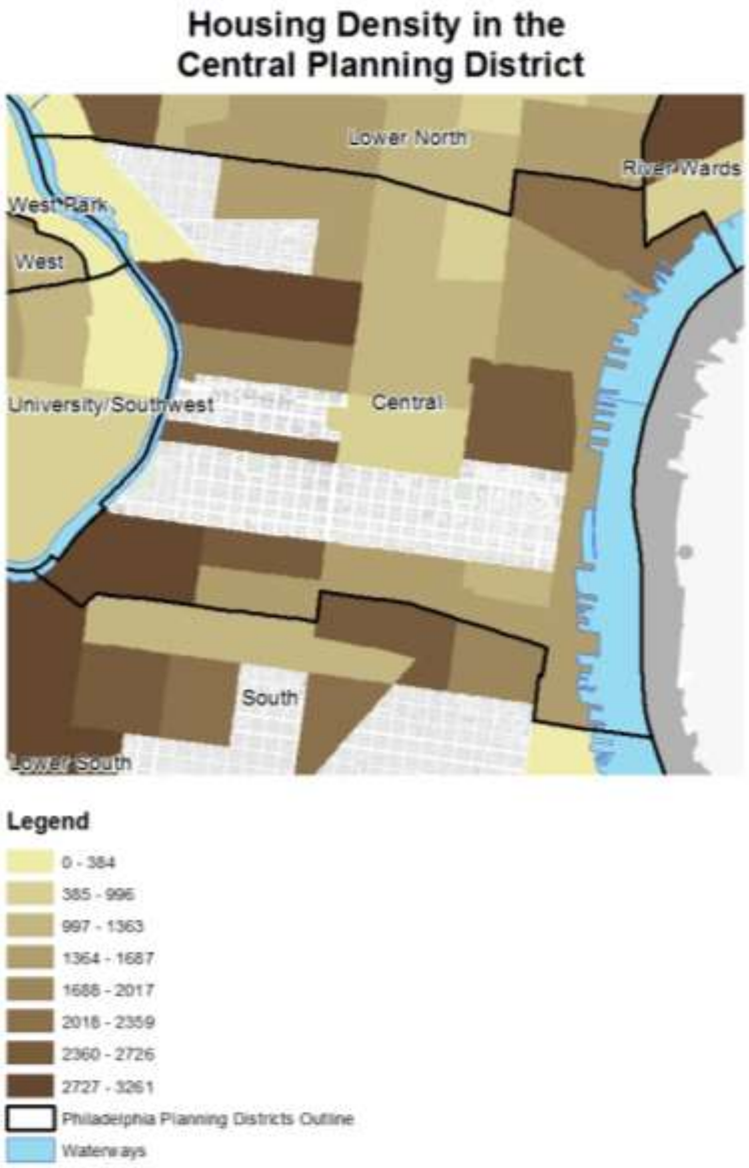
Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[387] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The Central Planning District has comparatively fewer vacant properties than many other parts of Philadelphia.

Vacancy in the Central Planning District

---

[386] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.
[387] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the Central Planning District's housing density. Data was unavailable for those portions of the map left uncolored. As the map shows, the Central Planning District has pockets of densely built homes throughout the district. These areas increase the risk of fire spread.

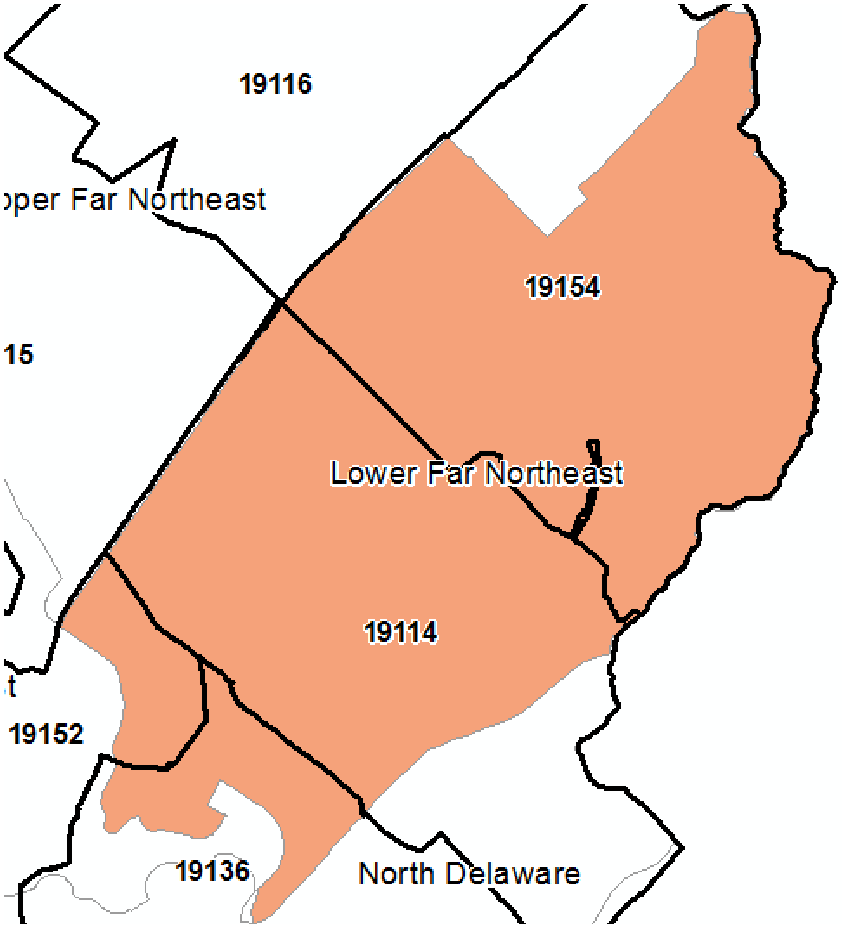


21.1.3 __Lower Far Northeast__

21.1.3.1 Geography and Hydrology

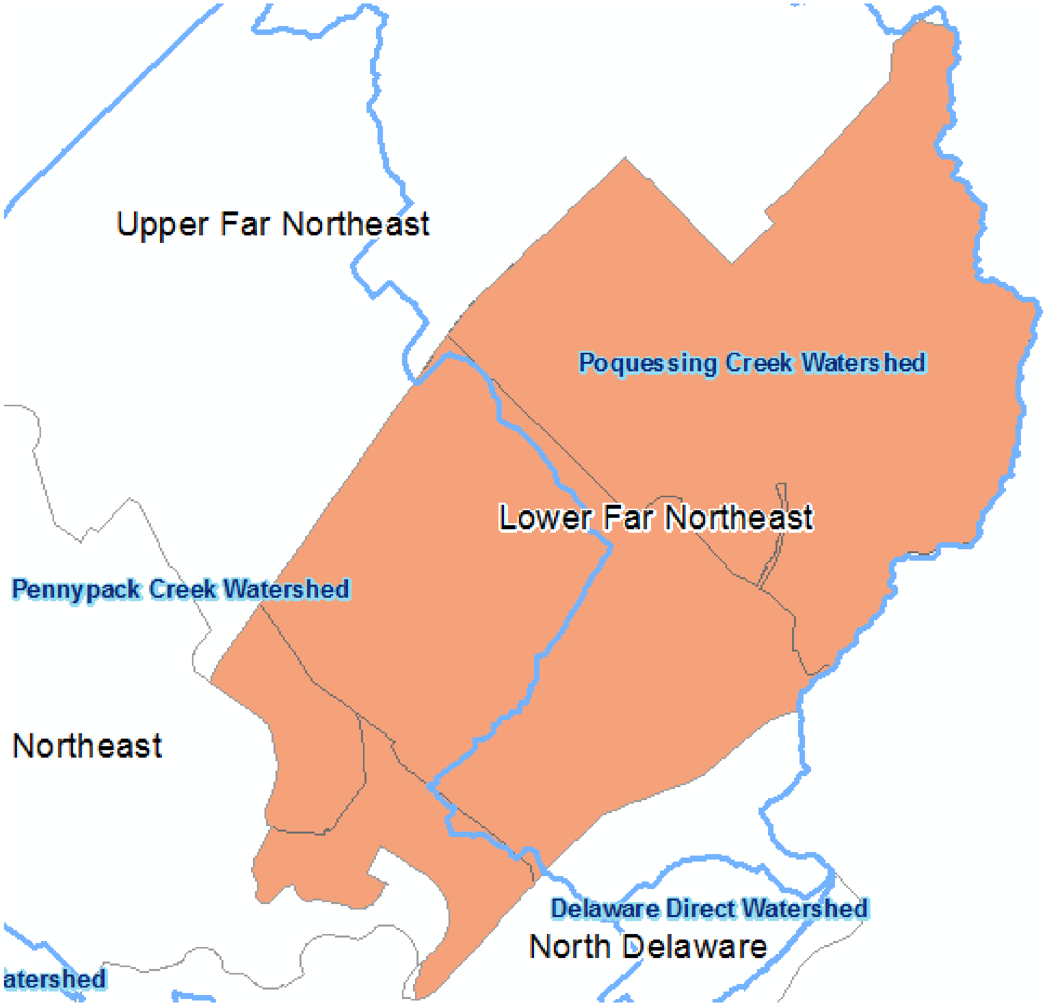
The Lower Far Northeast Planning District contains addresses in the zip codes 19154, 19114, 19136, and 19152.

Zip codes in the Lower Far Northeast Planning District



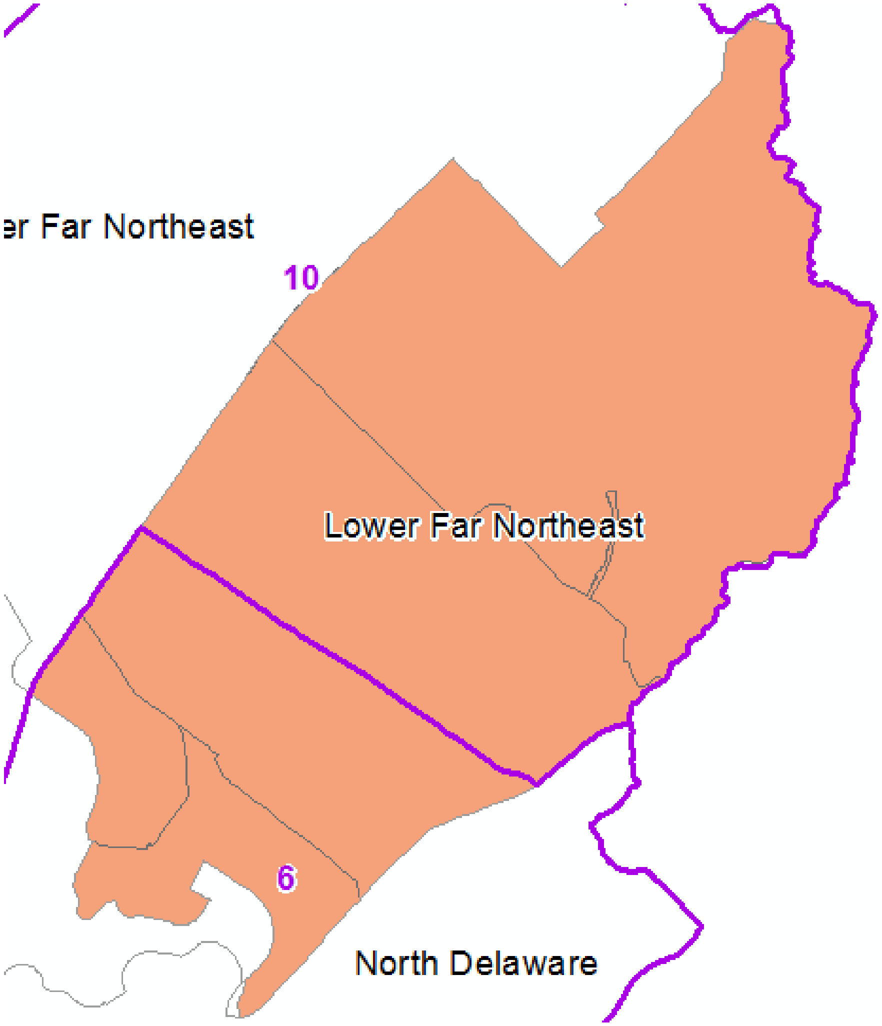
The Lower Far Northeast planning district falls partially in the Delaware Direct, Pennypack Creek, and Poquessing Creek Watersheds.

Watersheds in the Lower Far Northeast Planning District



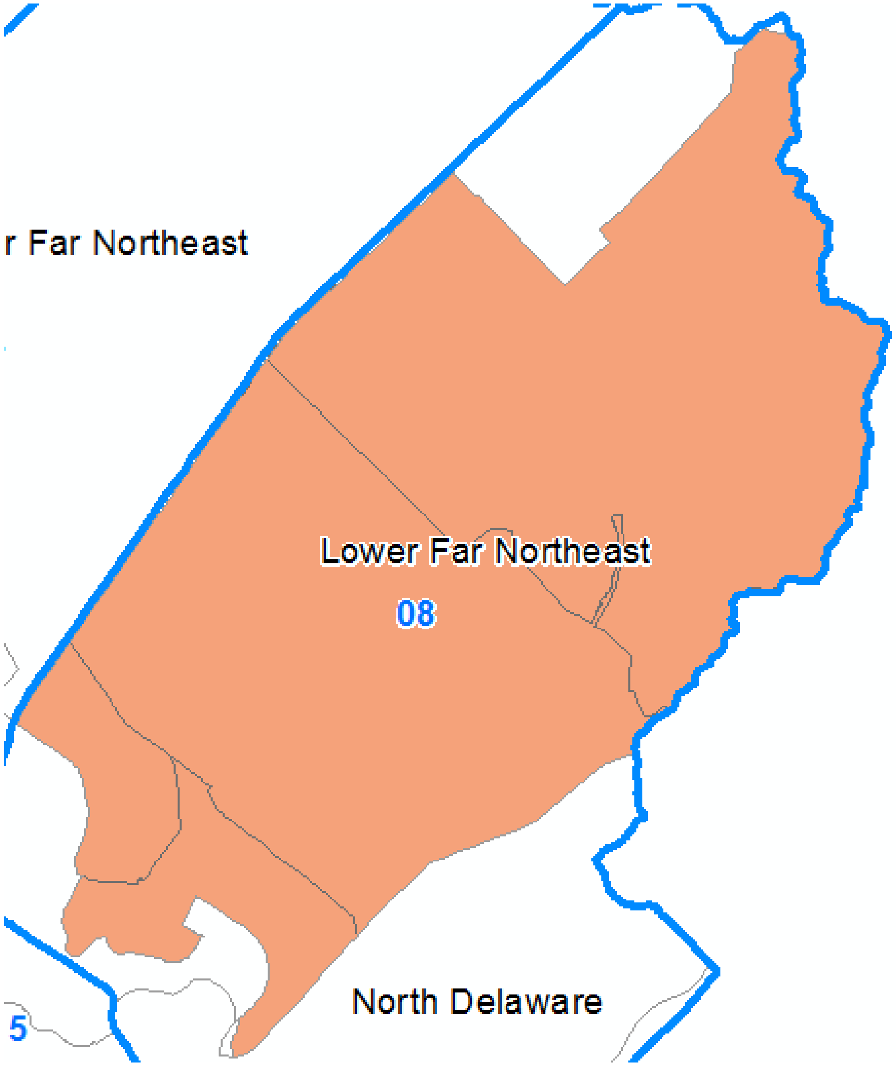
The Lower Far Northeast Planning District resides within the 10th and 6th Council Districts of Philadelphia.

Council Districts in Lower Far Northeast Planning District



The Lower Far Northeast Planning District falls with the 8th Police District.

Police Districts in the Lower Far Northeast Planning District



21.1.3.2 Social Characteristics

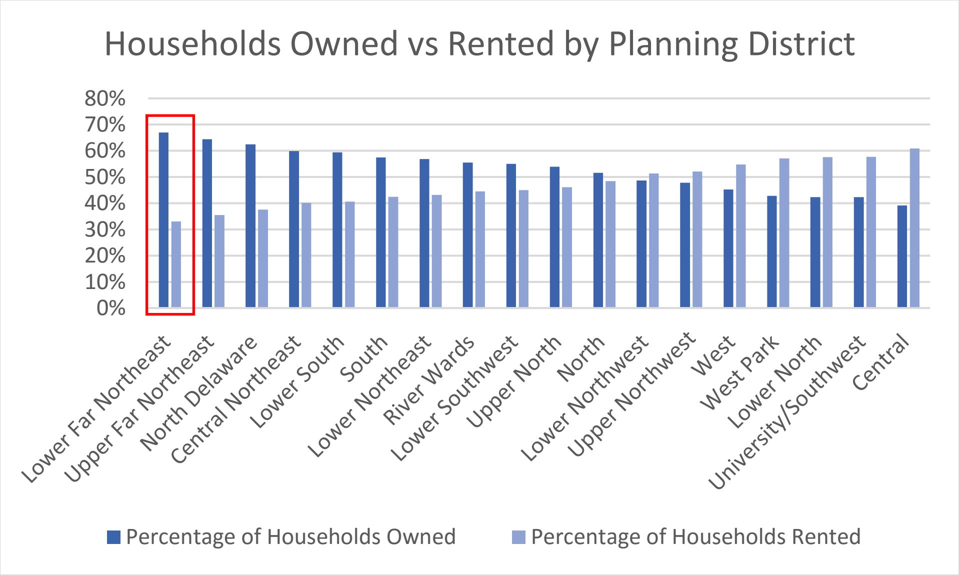
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

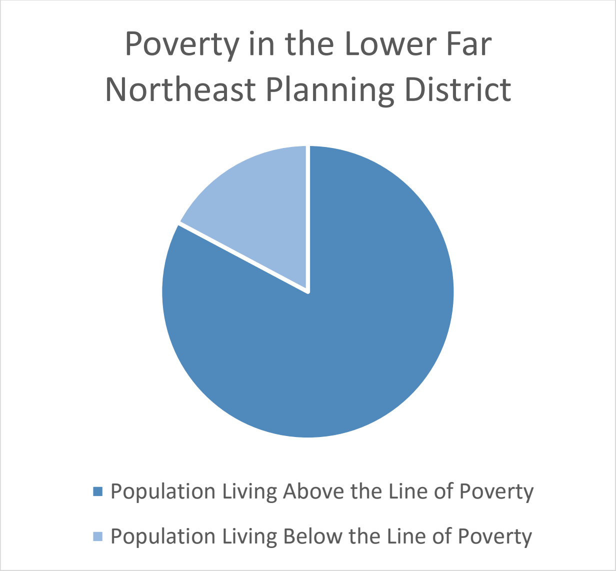
Population, Gender and Age Characteristics of the Lower Far Northeast Planning District	
Population	134,127
- Male population	66,575
- Female population	67,552
Median Age	39.6
- Age dependency ratio (the percentage of the population under 15 and over 64)	60.3%
- Population under 15	33.5%
- Population over 64	26.9%

21.1.3.3 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Lower Far Northeast Planning District	
Number of households	49,694
- Households owned	33,270
- Households rented	16,424
No vehicle access	6,254
Population below the federal line of poverty	12.6%





21.1.3.4 Disability

Of those individuals residing within the Lower Far Northeast Planning District, 15.2 percent reported having a disability. Disabilities reported by individuals in the Lower Far Northeast Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	4.9%
Vision difficulty	5.2%
Cognitive difficulty	6.0%
Ambulatory Difficulty	5.8%
Self-care Difficulty	5.8%
Independent Living Difficulty	5.7%

21.1.3.5 Lower Far Northeast Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Lower Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[388] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A “structurally deficient bridge” typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[389] [390] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the right shows those bridges deemed structurally deficient in the Lower Far Northeast Planning District.[391]

---

[388] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[389] 2010 Status of the Nation’s Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[390] Ibid.

[391] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

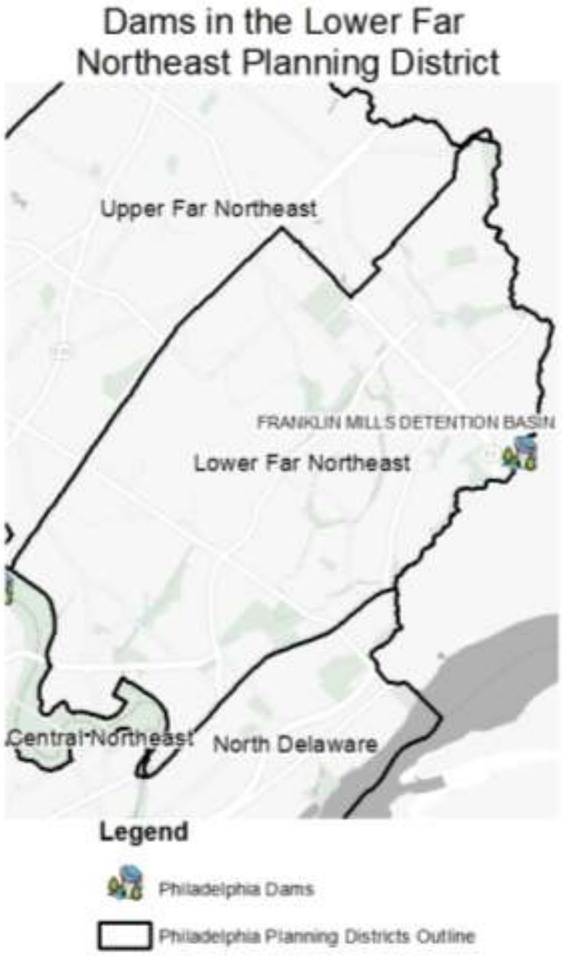
Structurally Deficient Bridges in the Lower Far Northeast Planning District

Name	Location	Year Built
Poquessing Creek	Red Lion Rd and PA 13	1845
Poquessing Creek	Century Lane and State Rd 132	1853
Woodhaven Rd	Millbrook Rd	1964
Wooden Bridge Run	Holme Avenue near Longford Rd	1921
Wooden Bridge Run	Willits Rd near Ashton Rd	1953

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. The table below shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.

Dam Name	Waterway	High Hazard?	Permitted Owner
Franklin Mills Detention Basin	Poquessing Creek	Yes	Franklin Mills Associates Limited Partnership

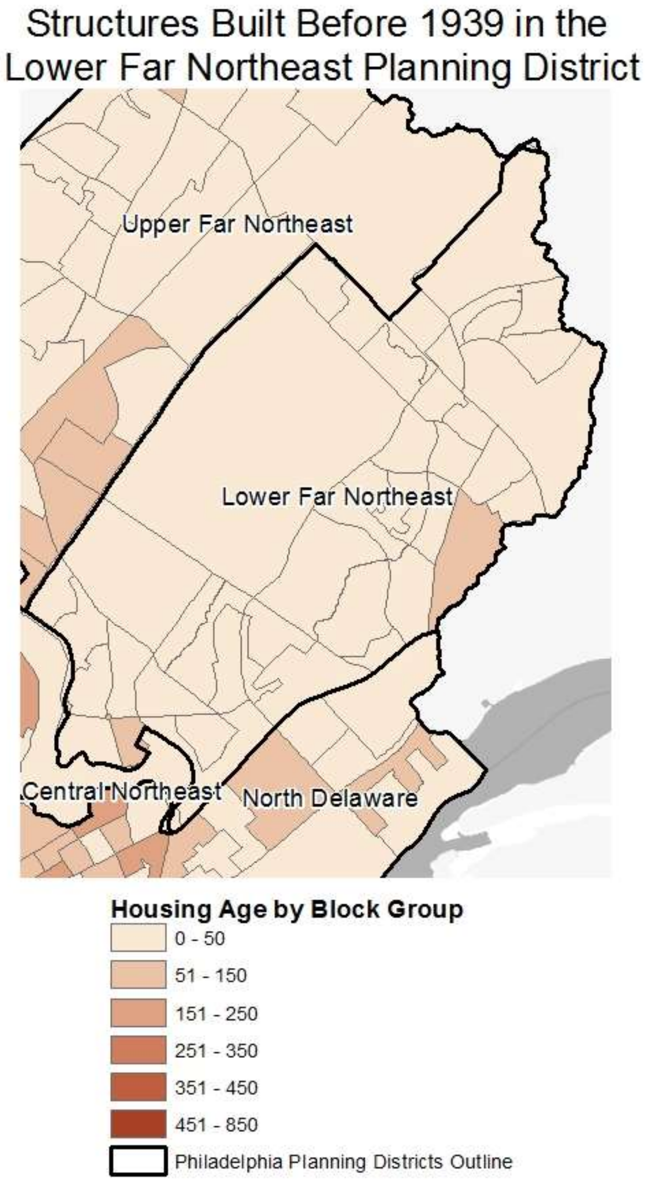


Building Collapse

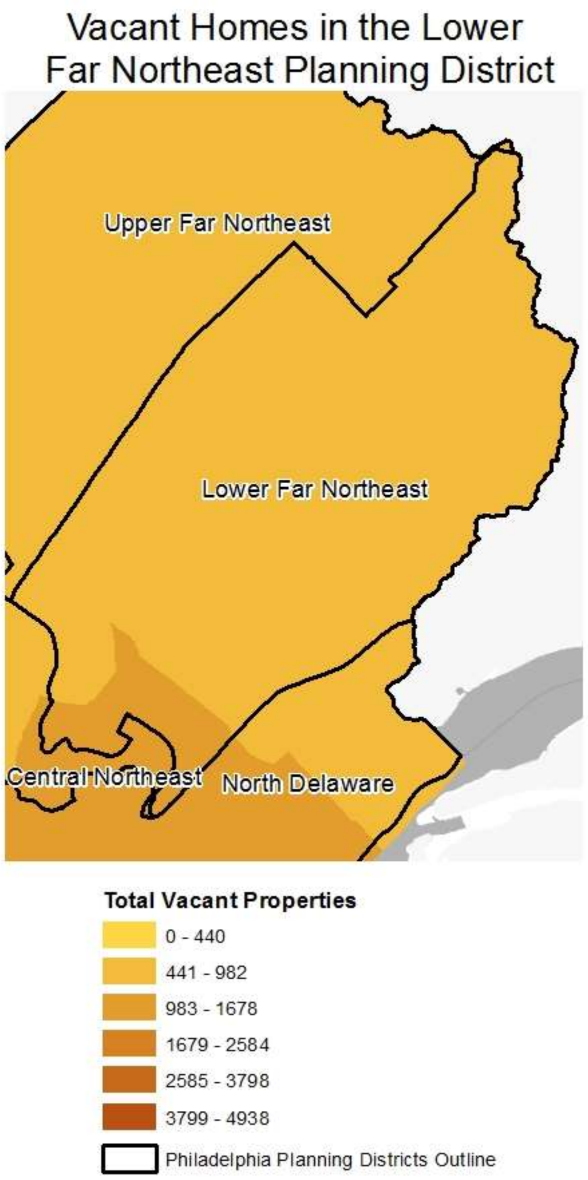
Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the Lower Far Northeast Planning District built before 1939.

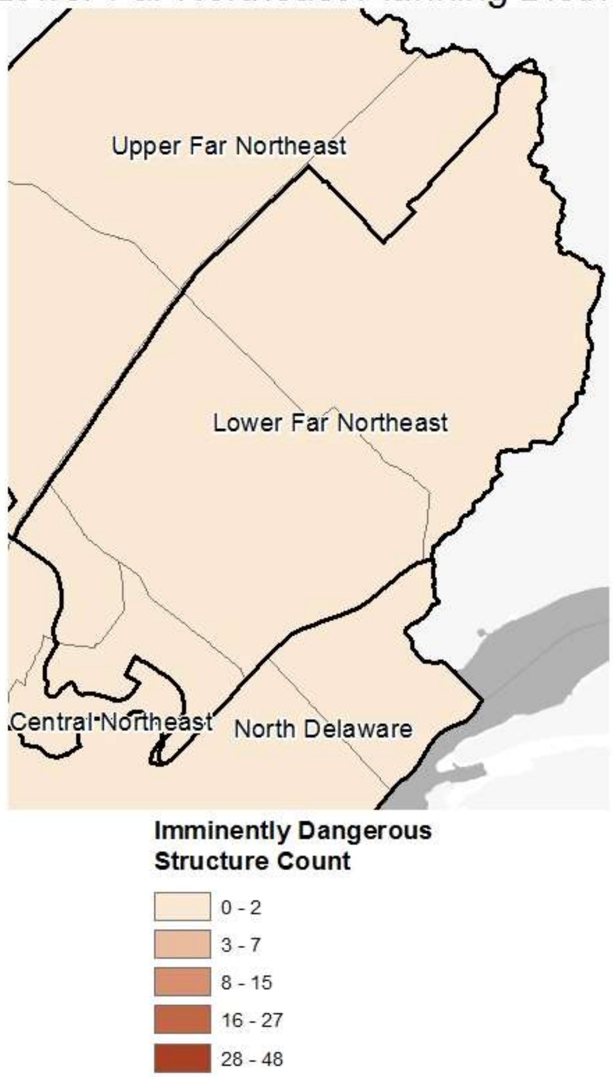


Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the Lower Far Northeast Planning District.



Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the Lower Far Northeast Planning District.

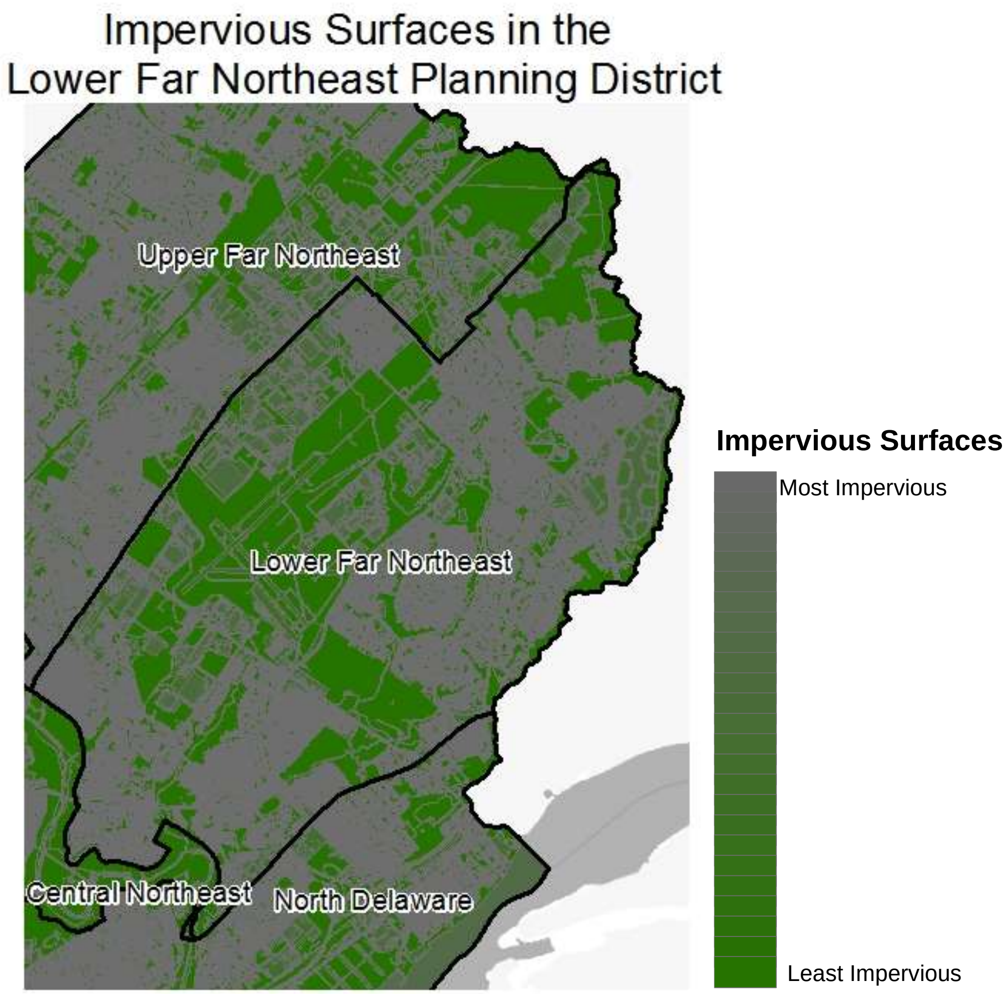
Imminently Dangerous Structures in the Lower Far Northeast Planning District



Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[392] For more information on extreme heat and its impacts, please see [Extreme Heat](#) under the [Risk Assessment](#) section of the 2017 Hazard Mitigation Plan.

Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[393] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right

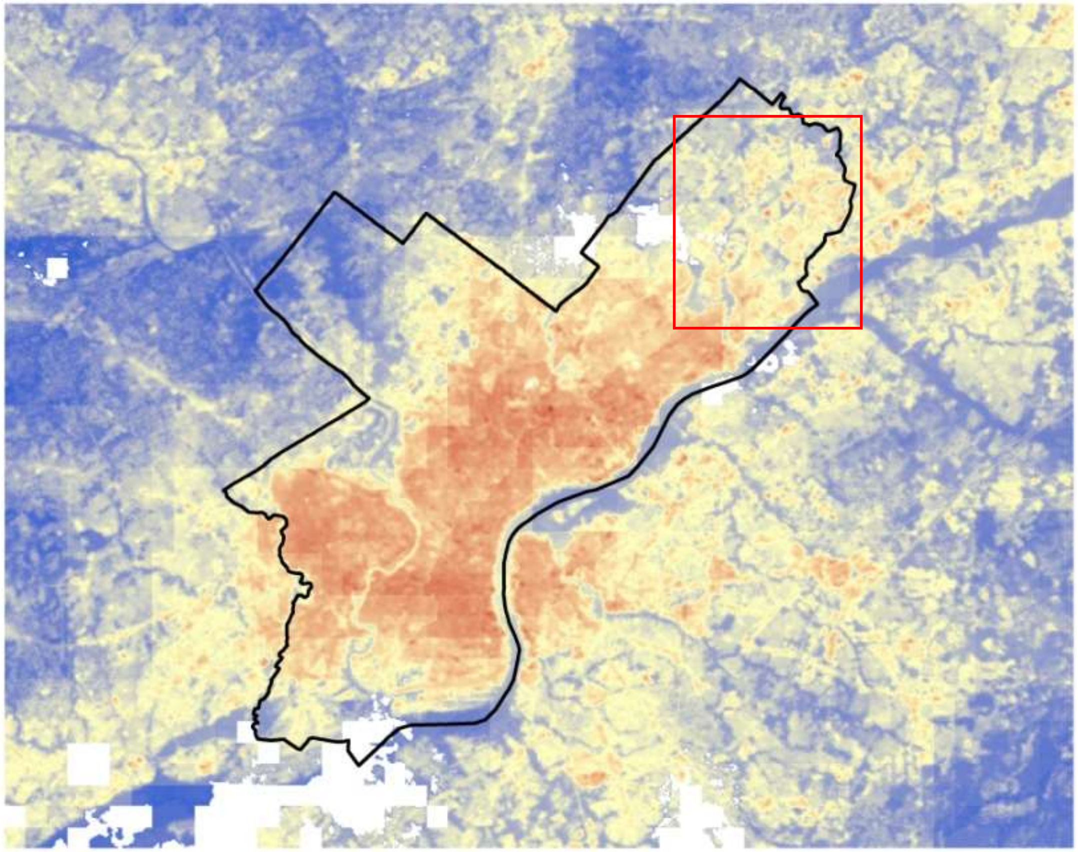


---

[392] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[393] "Heat Island Effect". US EPA. Retrieved March 3, 2016.

displays impervious surfaces in the Lower Far Northeast Planning District.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[394] As the map shows, the Lower Far Northeast is not located in the areas which experience the highest heat island effects, but the Lower Far Northeast still feels some of the effects of such an event more than the surrounding counties.



---

[394] “Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002”. URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[395]

Winter flooding includes 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. All forms of flooding can damage infrastructure.[396] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

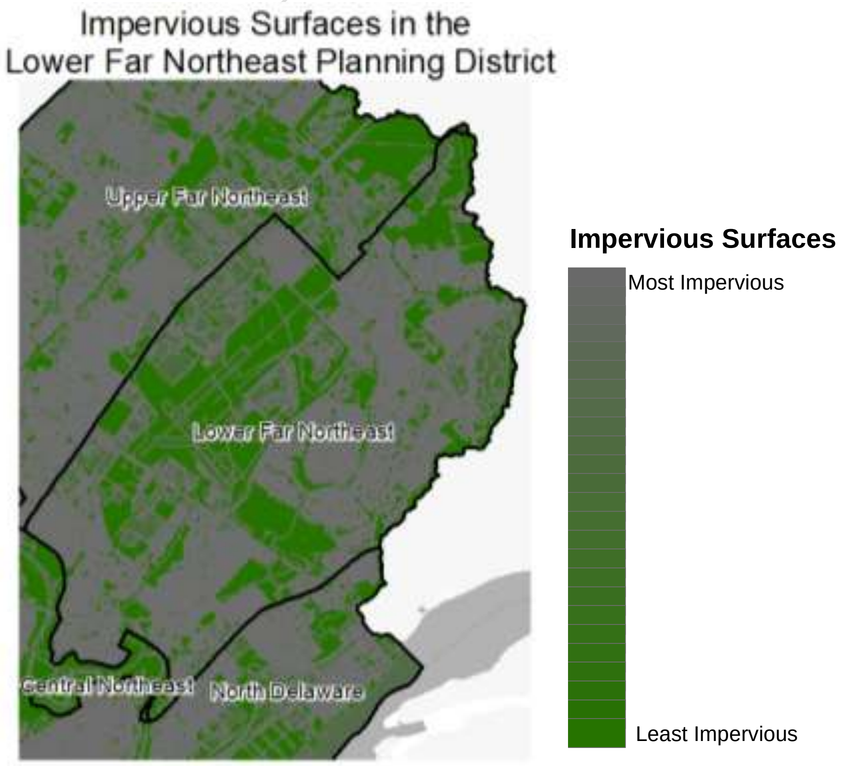
---

[395] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.
[396] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

A small portion of the Lower Far Northeast Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the Lower Far Northeast Planning District there are 50 NFIP policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

Flash flooding is a concern for some areas of the Lower Far Northeast Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Lower Far Northeast Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[397]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

---

[397] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

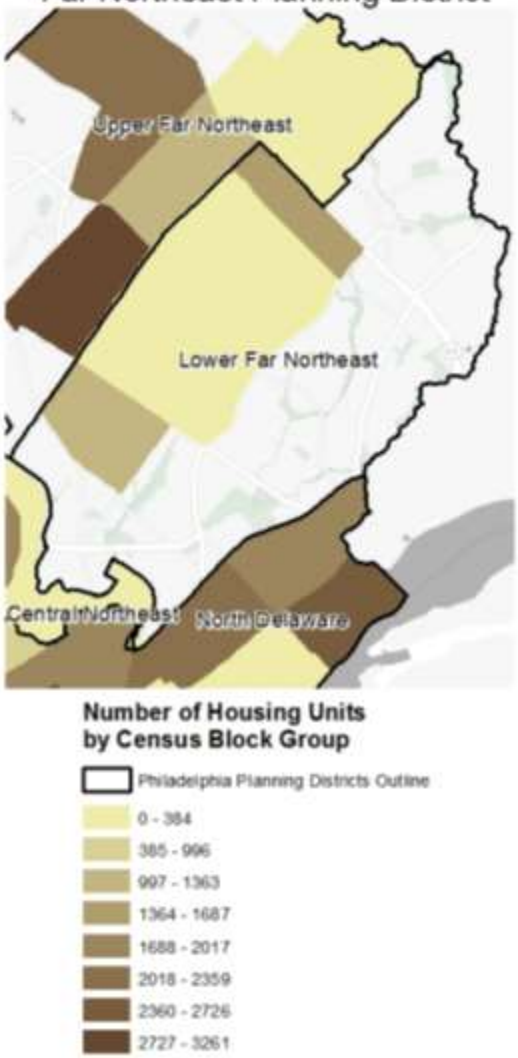
Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[398] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[399] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The Lower Far Northeast Planning District has comparatively fewer vacant properties than many other parts of Philadelphia, and therefore has a slightly lower risk for urban conflagration.

---

[398] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.
[399] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the Lower Far Northeast Planning District's housing density. Data was unavailable for those portions of the map left uncolored.



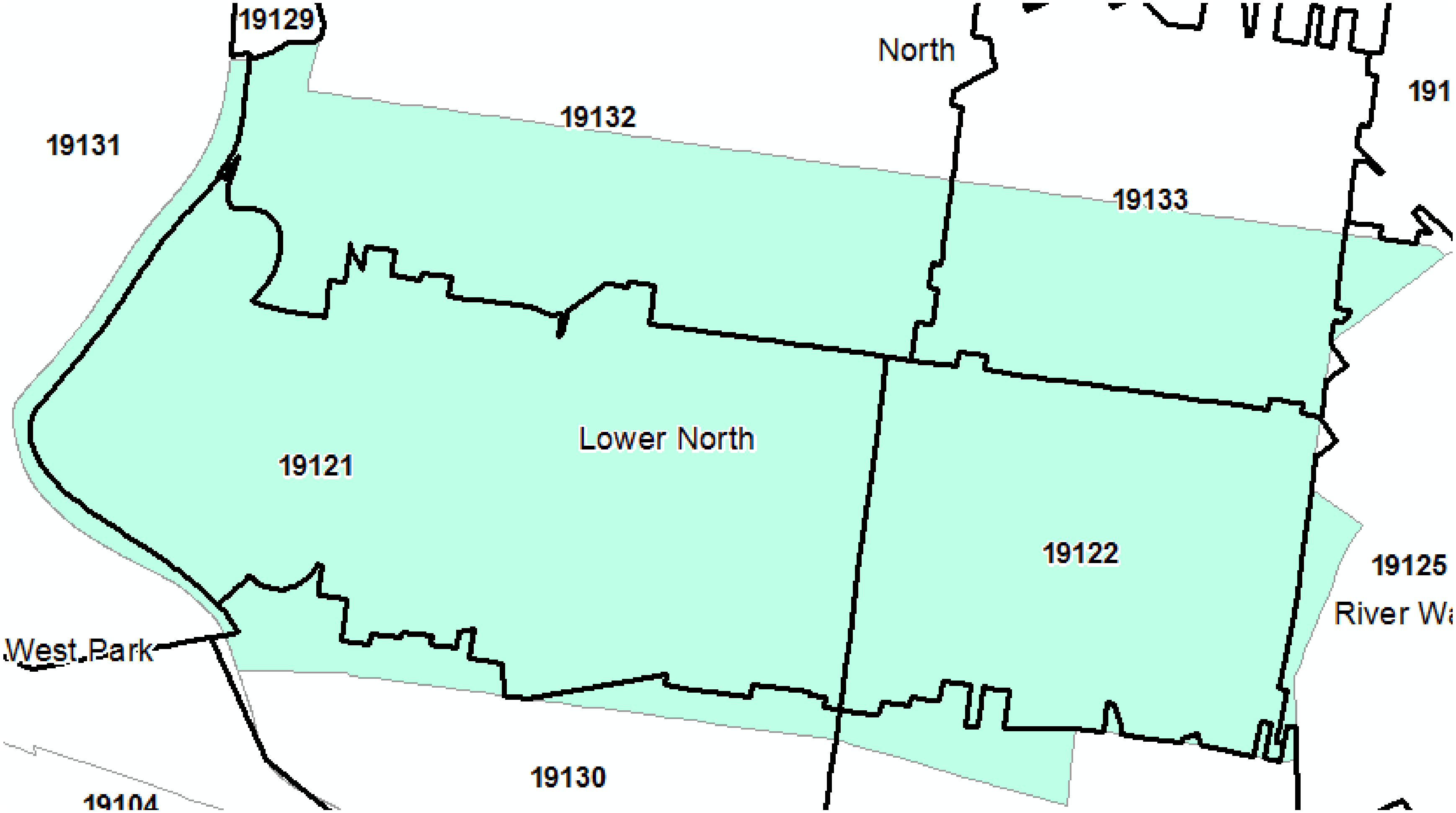
Vacancy Rates in the Lower Far Northeast Planning District

21.1.4 Lower North Planning District

21.1.4.1 Geography and Hydrology

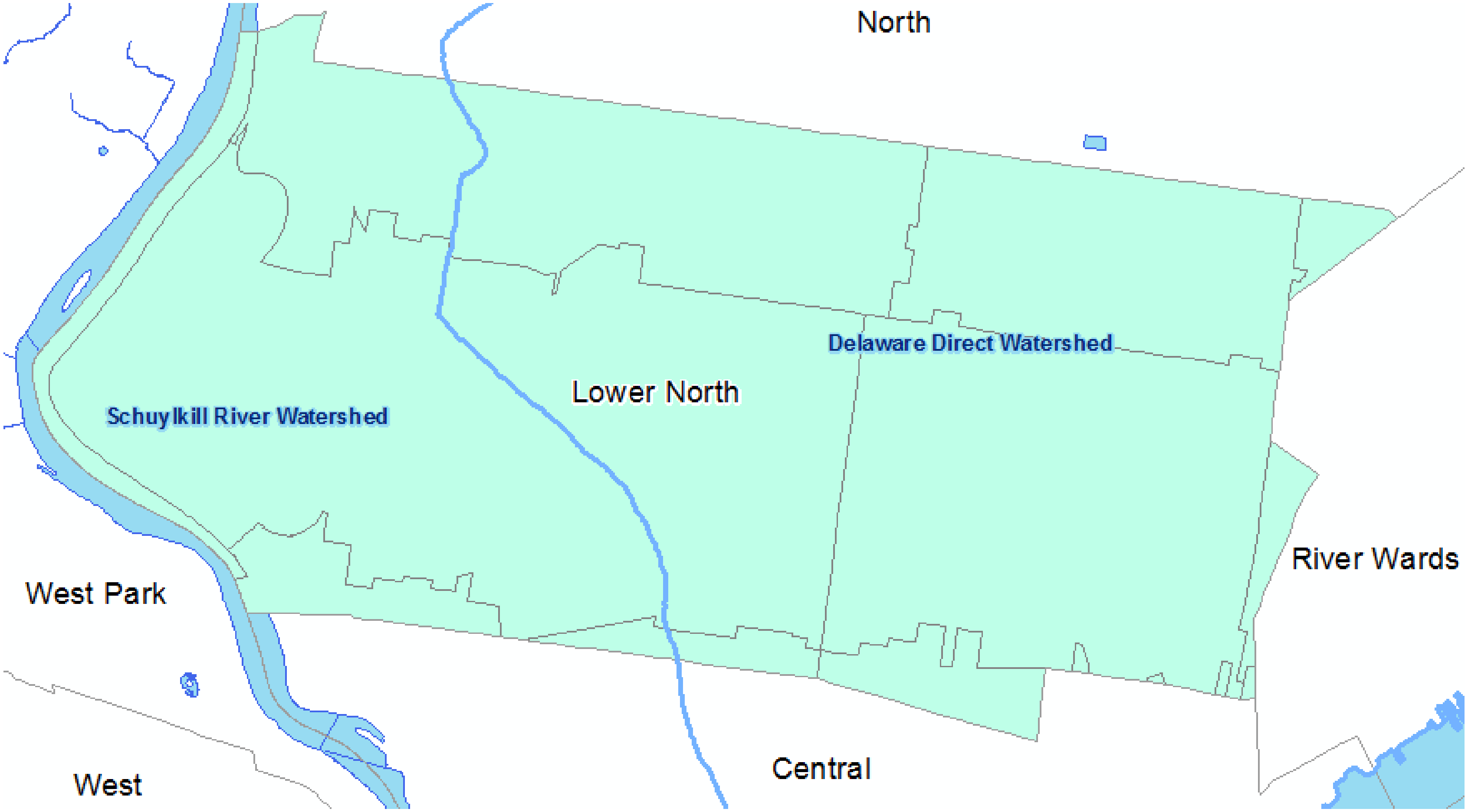
The Lower North Planning District contains addresses in the zip codes 19121, 19122, 19133, 19132, 19125, 19134, and 19130.

Zip codes in the Lower North Planning District



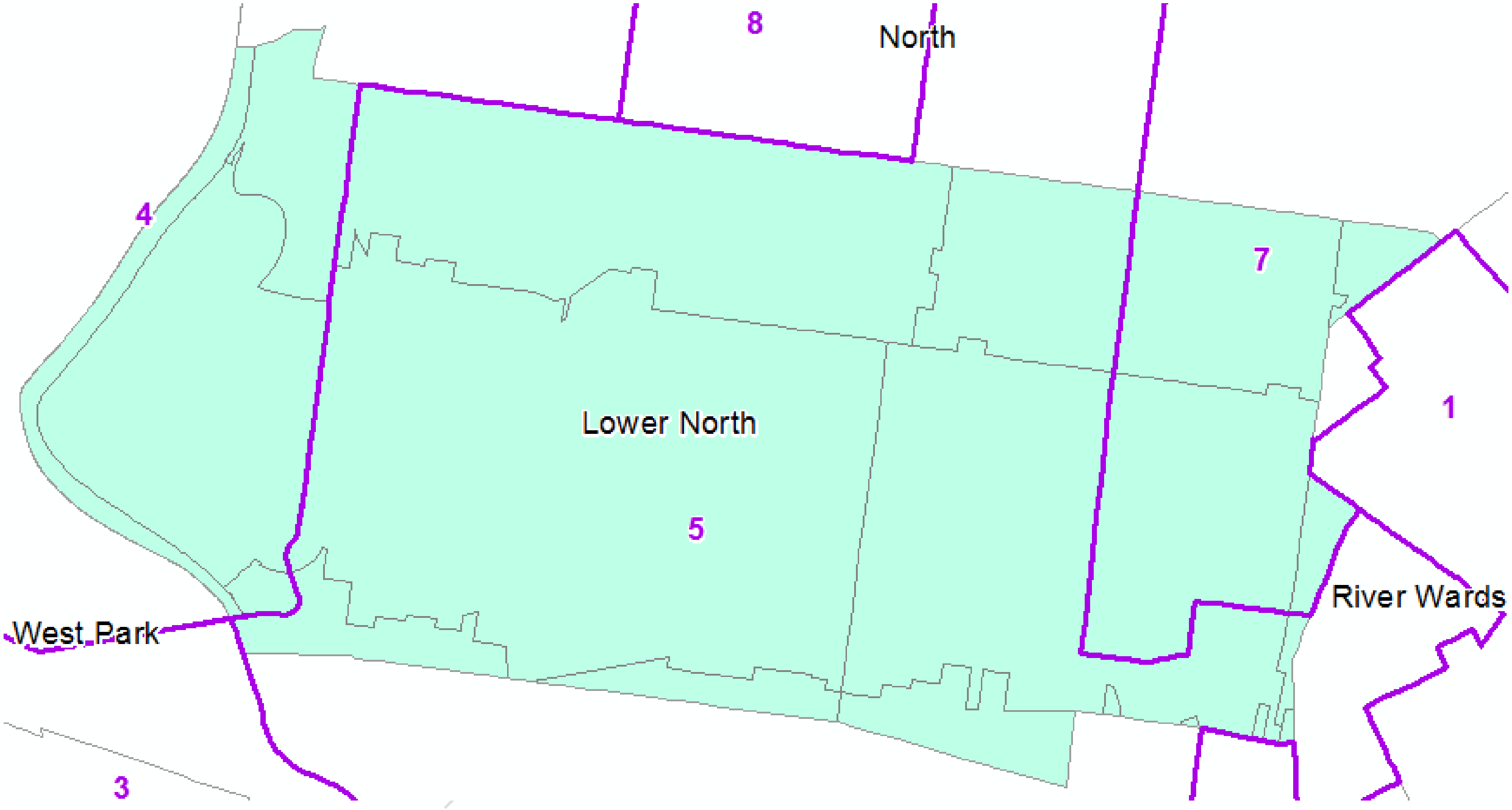
The Lower North planning district falls partially in the Delaware Direct and Schuylkill Watersheds.

Watersheds in the Lower North Planning District



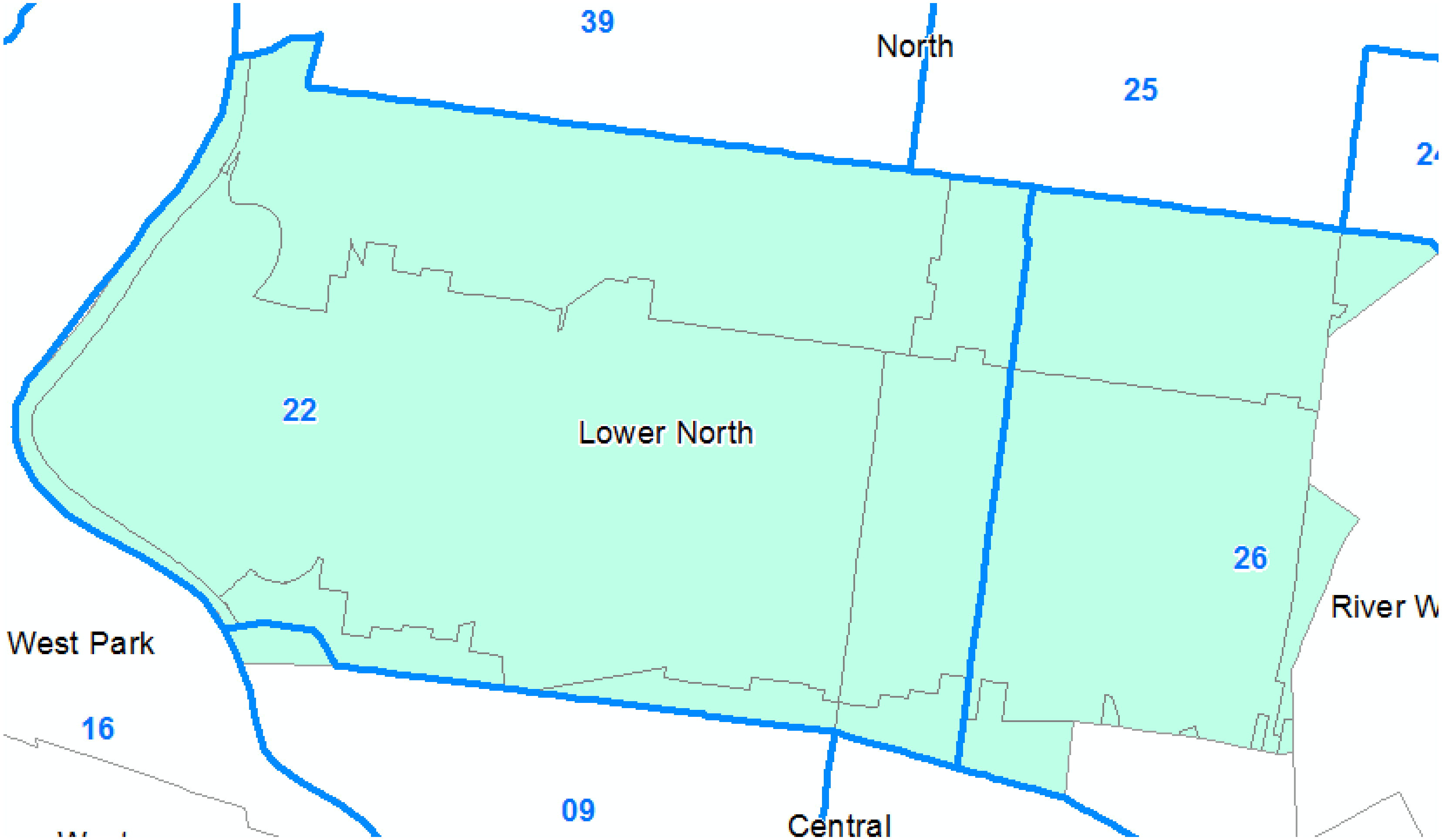
The Lower North Planning District resides within the 4th, 5th, and 7th Council Districts of Philadelphia.

Council Districts in Lower North Planning District



The Lower North Planning District falls within the 22nd and 26th Police Districts.

Police Districts in the Lower North Planning District



21.1.4.2 Current and Future Land Use

The Lower North Planning District has low growth forecasts.[400] The current residential neighborhoods and commercial corridors function well and land uses in this area should continue as is.[401] The future growth map takes into consideration recreation centers, shopping centers, and historic districts, as well as the weak demand for market-rate housing in large sections of the district.[402] [403]

---

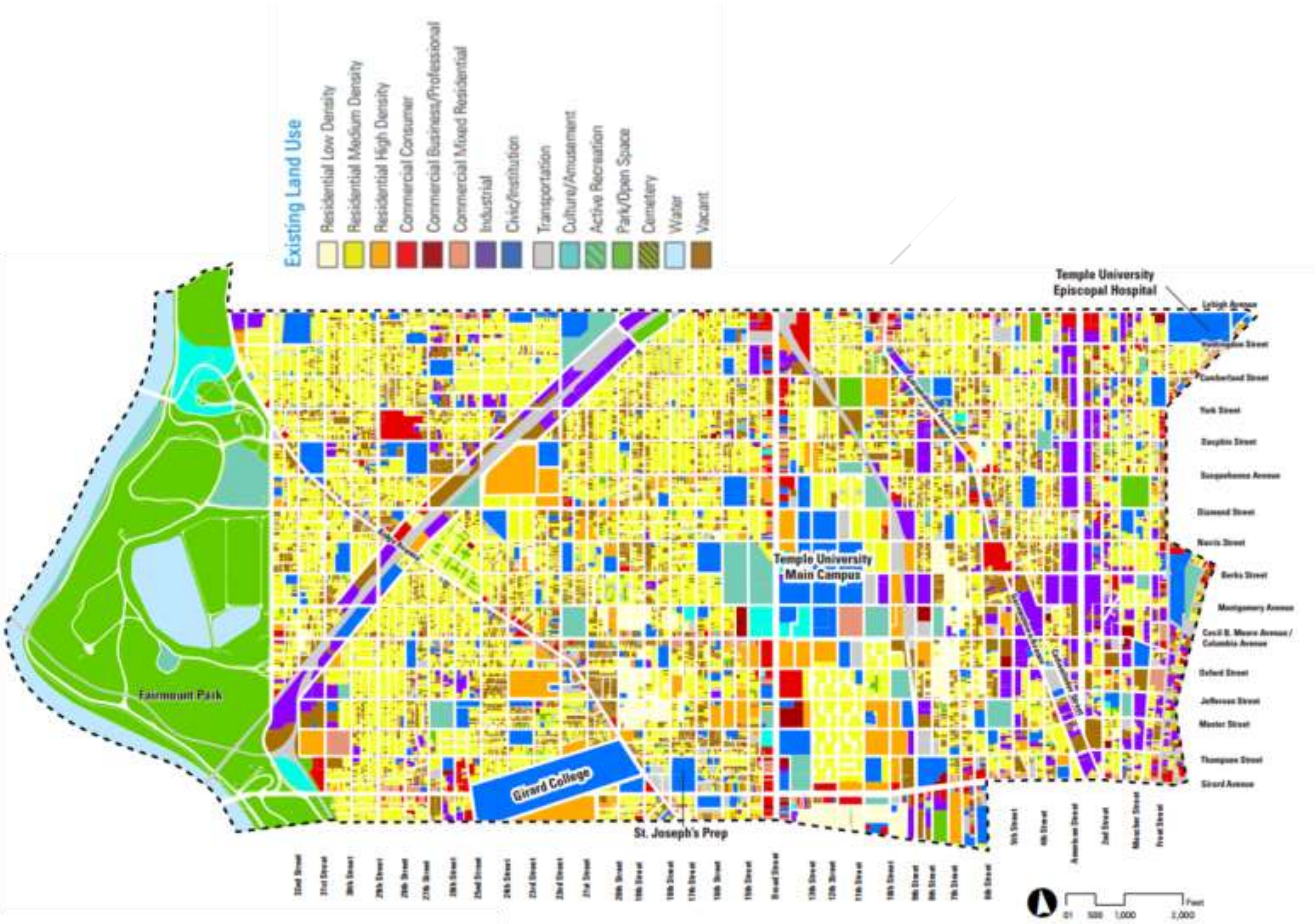
[400] City of Philadelphia, Philadelphia 2035. Lower North District Plan. Retrieved November 20, 2015.

[401] Ibid.

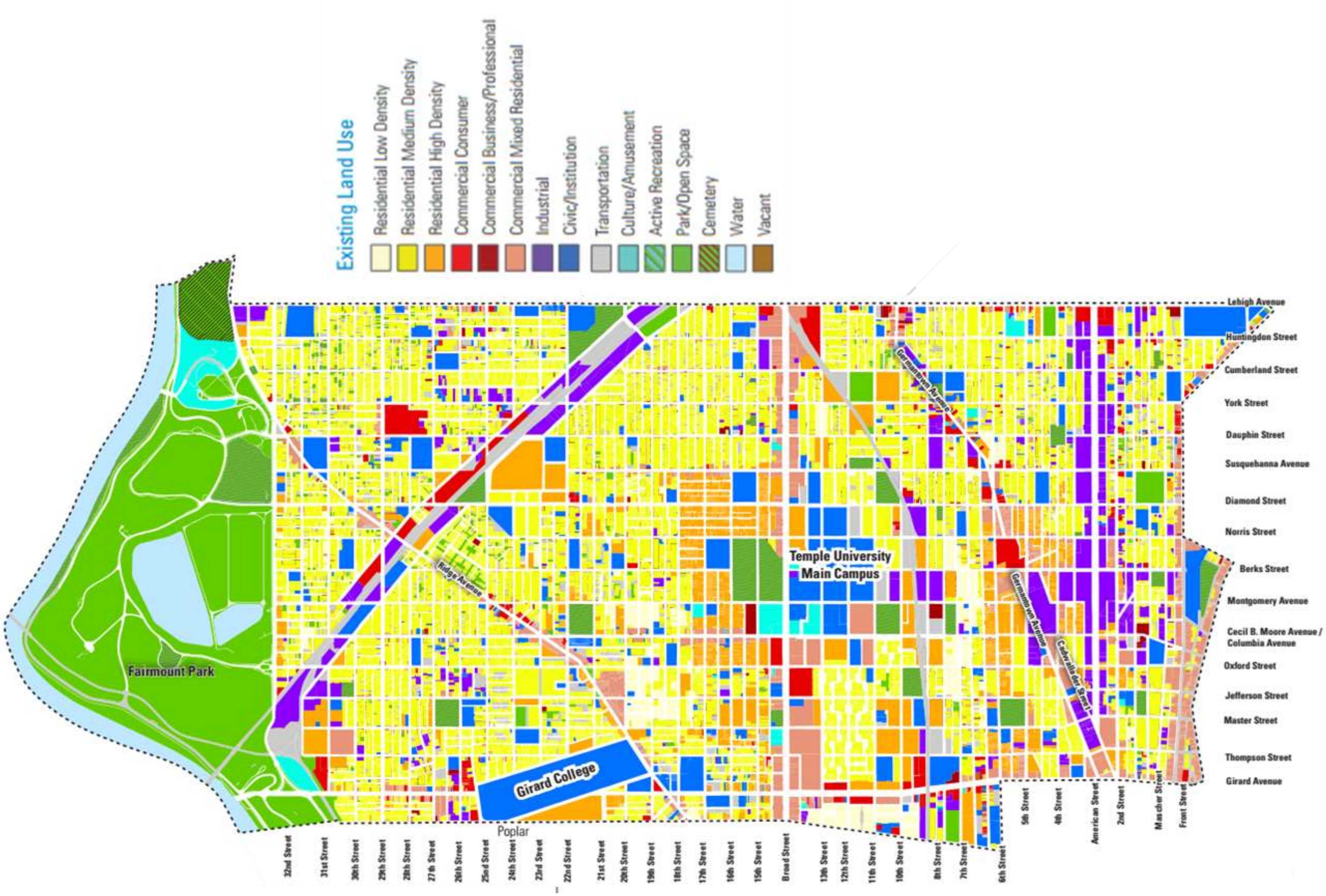
[402] Ibid.

[403] All graphics, charts, and recommendations come from the City of Philadelphia: Philadelphia 2035 Lower North District Plan. Retrieved November 20, 2015.

Philadelphia Lower North Planning District Existing Land Use



Philadelphia Lower North Planning District Future Land Use



21.1.4.3 Social Characteristics

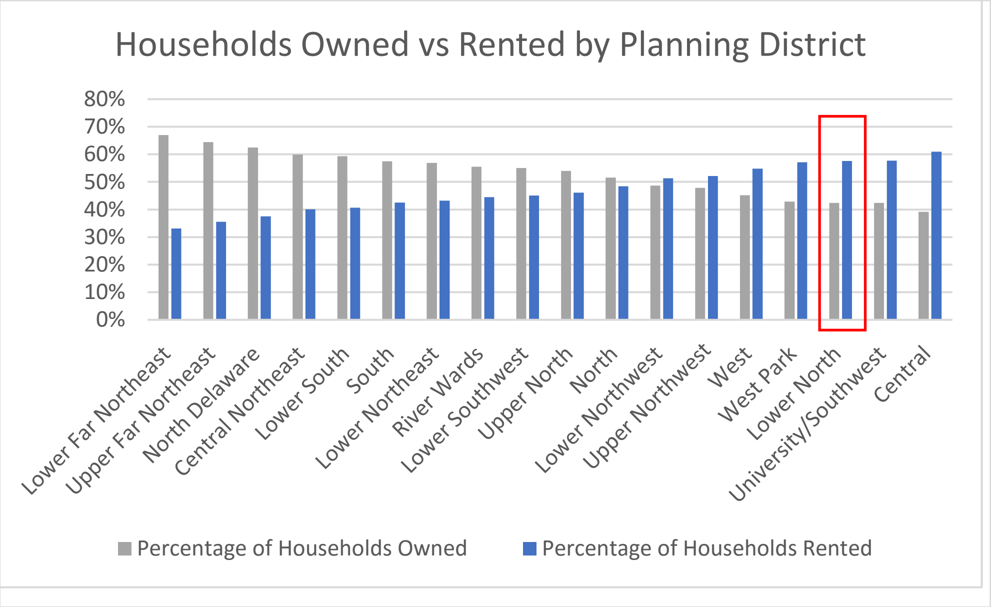
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

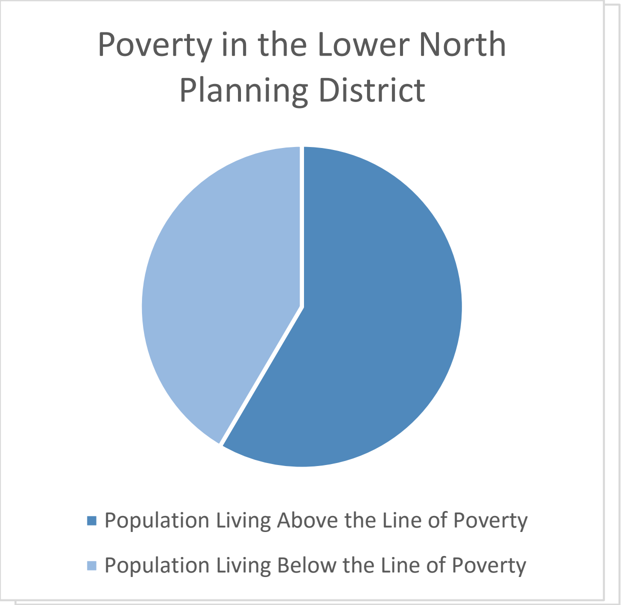
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	142,066
▪ Male population	65,897
▪ Female population	76,169
Median Age	29.8
Age dependency ratio (the percentage of the population under 15 and over 64)	48.5%
Population under 15	33.8%
Population over 64	14.7%

21.1.4.4 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	52,529
▪ Households owned	22,253
▪ Households rented	30,276
No vehicle access	25,205
Population below the federal line of poverty	40.8%





21.1.4.5 *Disability*

Of those individuals residing within the Lower North Planning District, 17.4 percent reported having a disability. Disabilities reported by individuals in the Lower North Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Vision difficulty	8.6%
Cognitive difficulty	9.4%
Ambulatory Difficulty	9.4%
Self-care Difficulty	9.2%
Independent Living Difficulty	9.8%

21.1.4.6 *Lower North Hazards*

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

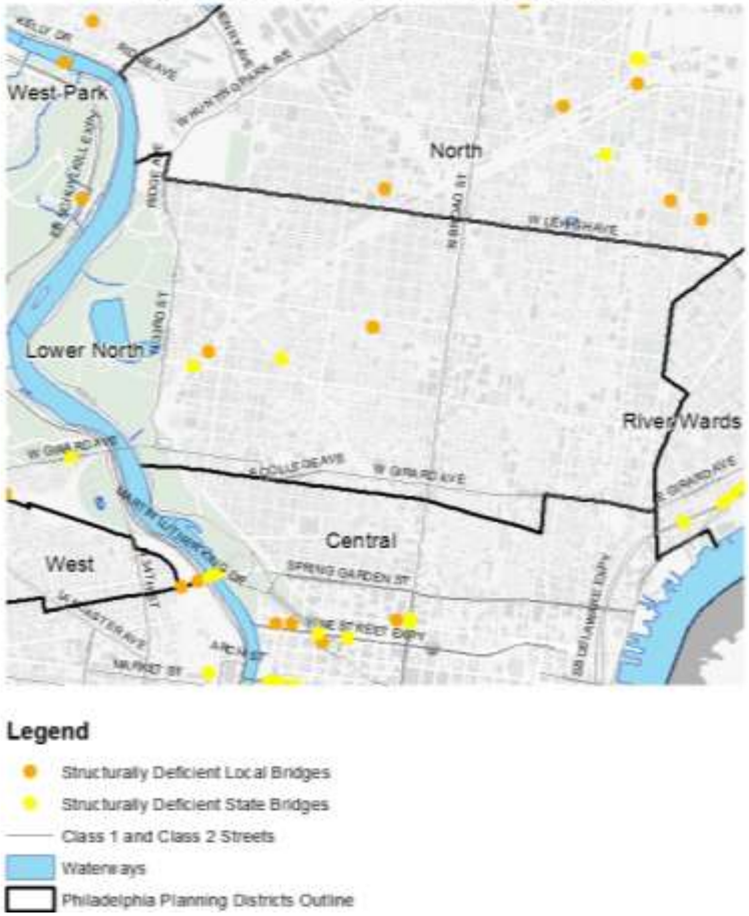
Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[404] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[405] [406] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the Lower North Planning District.[407]

Structurally Deficient Bridges in the Lower North Planning District



---

[404] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[405] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[406] Ibid.

[407] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the Lower North Planning District		
Name	**Location**	**Year Built**
Amtrak and Conrail	Montgomery Ave	1913
Amtrak	Margie St at 19th St	1919
Amtrak Main Line	Ridge Ave, .1 mile southeast of 29th St	1918
Amtrak	Cecil B. Moore Ave near 31st St	1909

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. The table below shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.

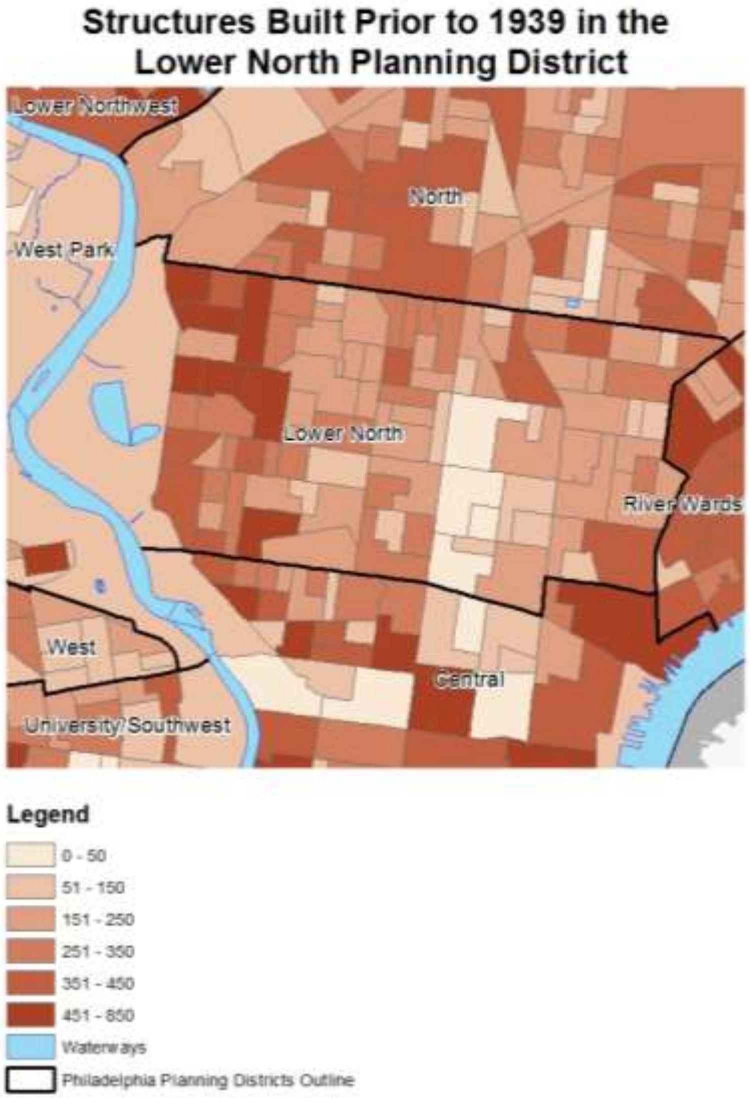
Dam Name	Waterway	High Hazard?	Permitted Owner
East Park Reservoir	Watershed: Schuylkill River	Yes	Philadelphia Water Department

Building Collapse

Buildings may collapse for a variety of reasons, including:

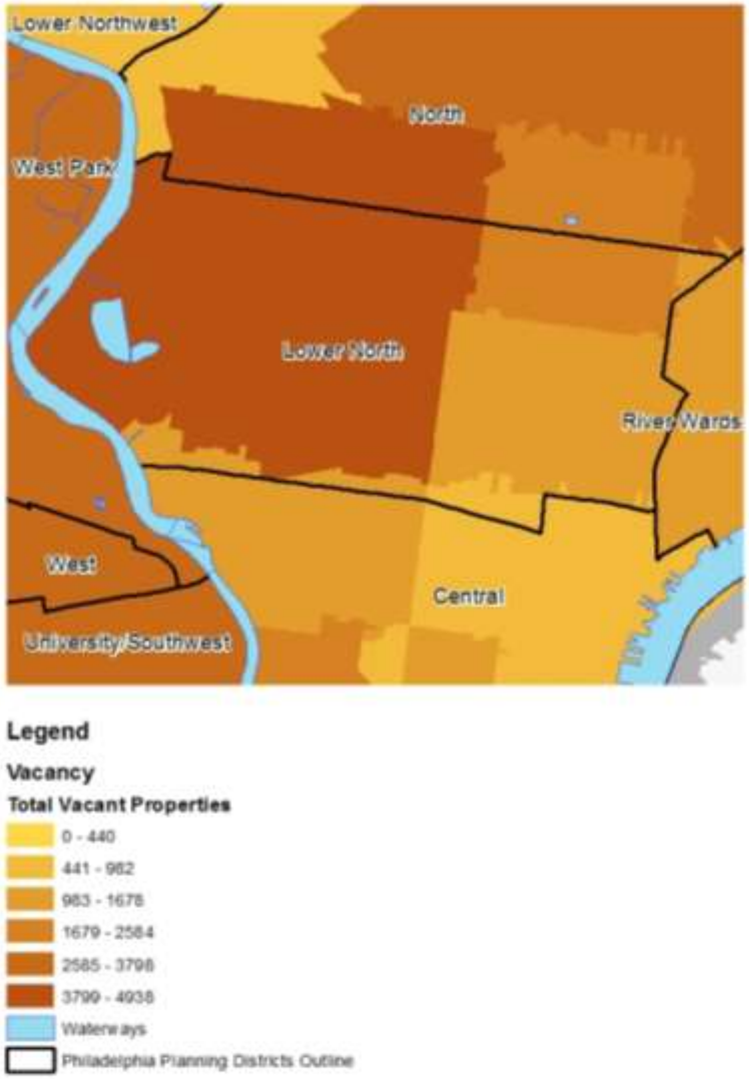
- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the Lower North Planning District built before 1939.



Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the Lower North Planning District. The Lower North Planning District has a high concentration of vacant properties across the western portion of the district.

Vacancy in the Lower North Planning District

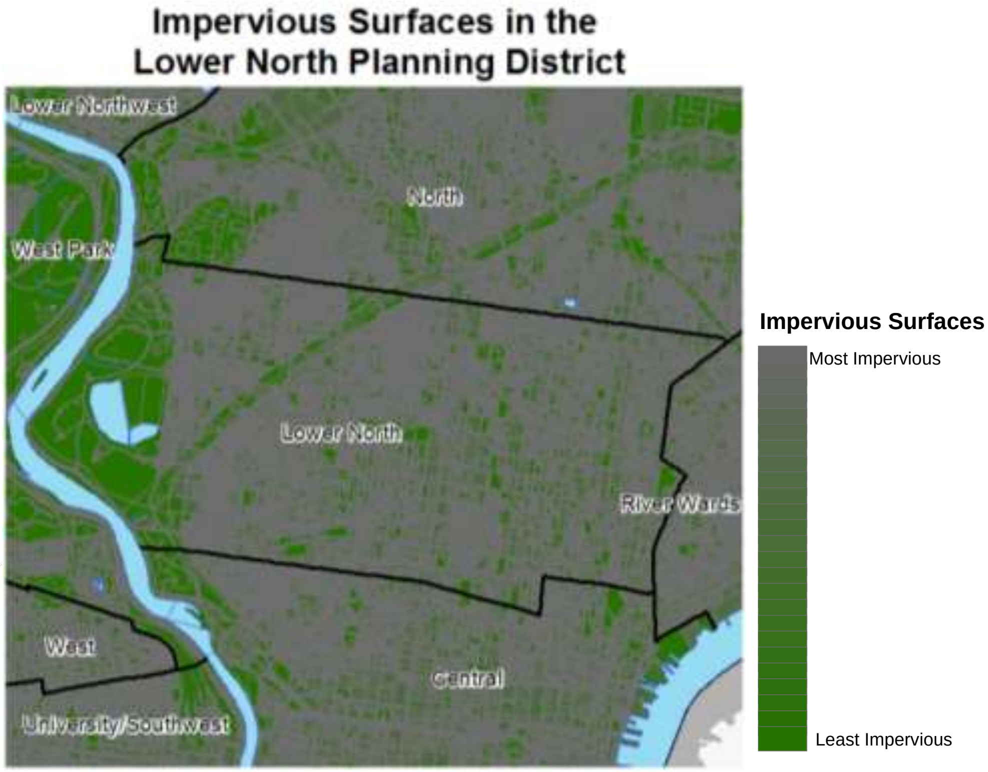


Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map to the right shows the location of imminently dangerous structures in the Lower North Planning District. The highest concentration of imminently dangerous structures in the Lower North Planning District exists in the western portion of the district.

Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[408] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

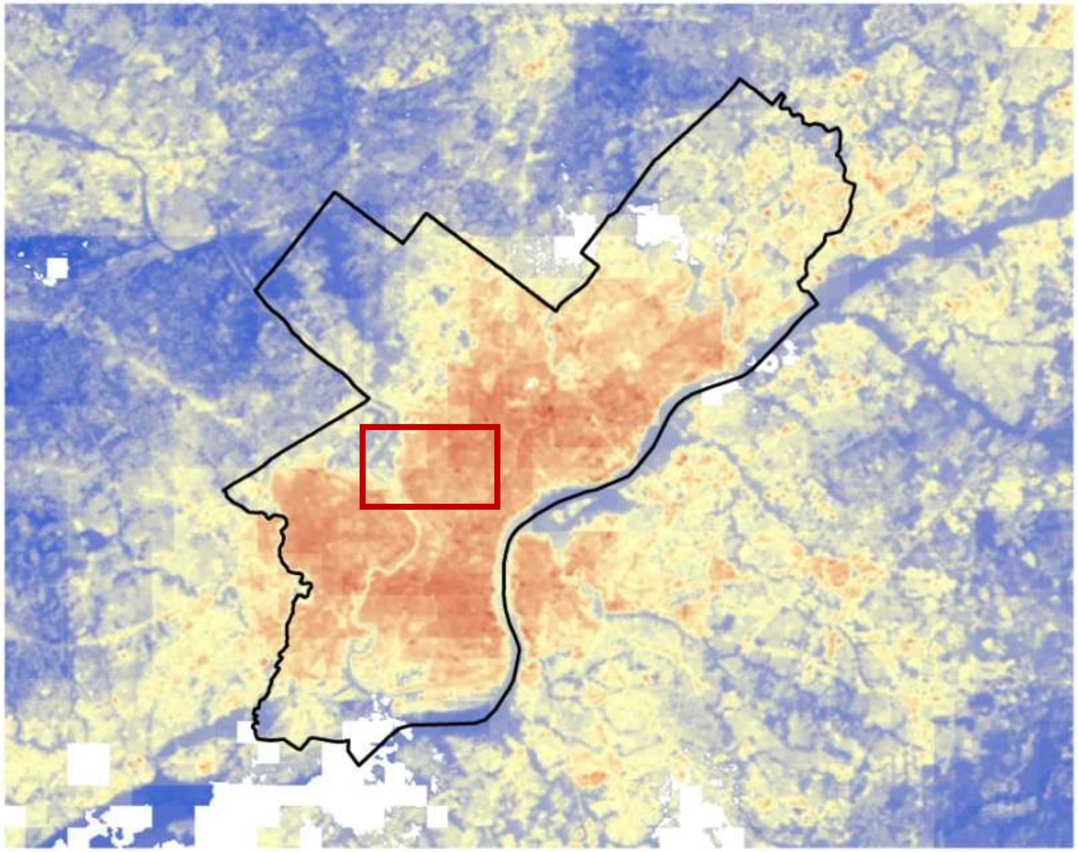
Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[409] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Lower North Planning District.



---

[408] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[409] "Heat Island Effect". US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[410] As the map shows, the Lower North is located in an area which experience higher heat island effects, and feels some of the effects of such an event more than the bordering counties.



---

[410] “Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002”. URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[411]

Winter flooding includes 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. All forms of

---

[411] “Standard Operating Guide”. Commonwealth of Pennsylvania’s All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

flooding can damage infrastructure.[412] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

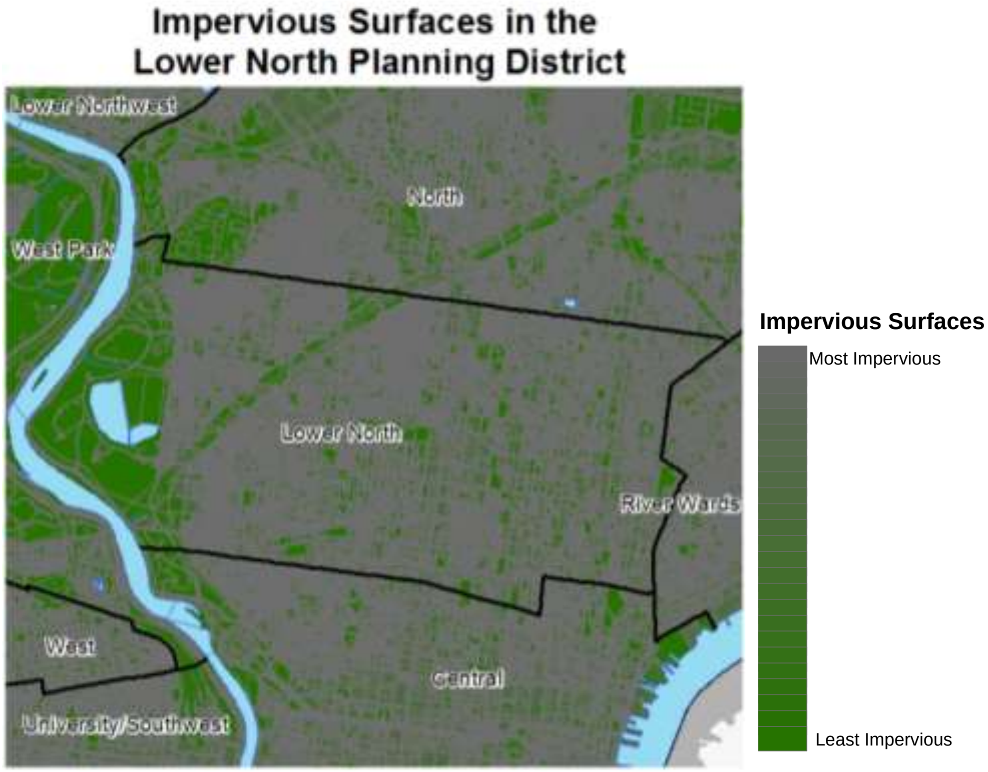
A small portion of the Lower North Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the Lower North Planning District there are 12 National Flood Insurance Program (NFIP) policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

---

[412] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Flash flooding is a concern for some areas of the Lower North Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Lower North Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[413]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

---

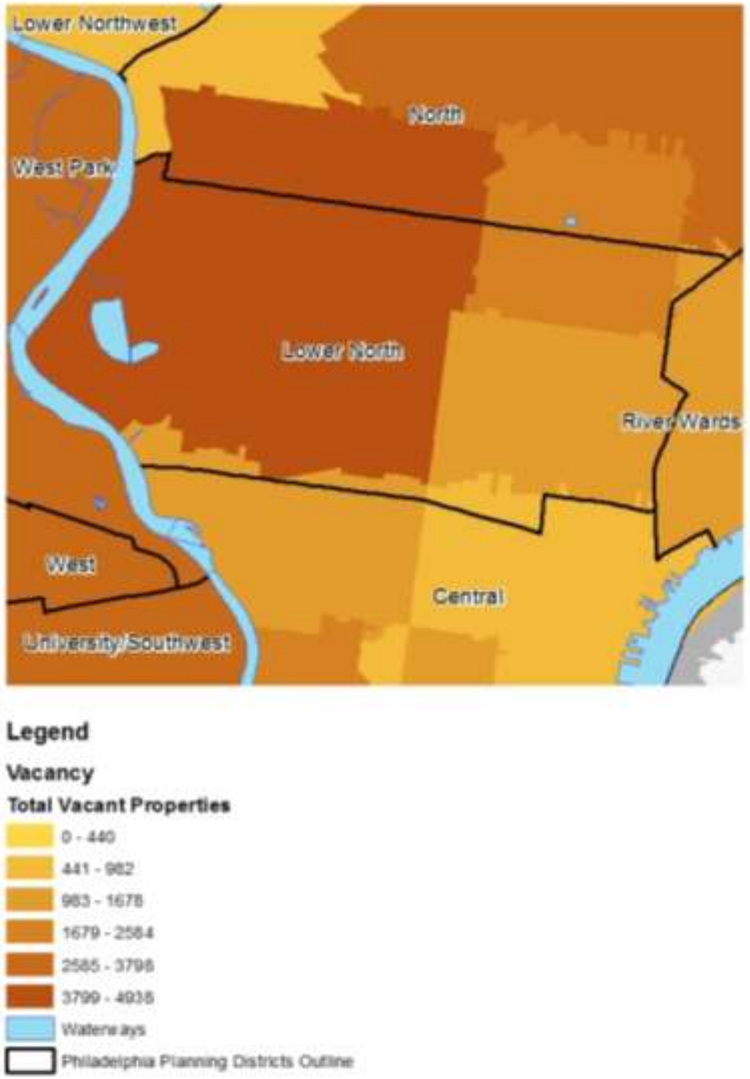
[413] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[414] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[415] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The Lower North Planning District has a high concentration of vacant properties across the western portion of the district.

Vacancy in the Lower North Planning District



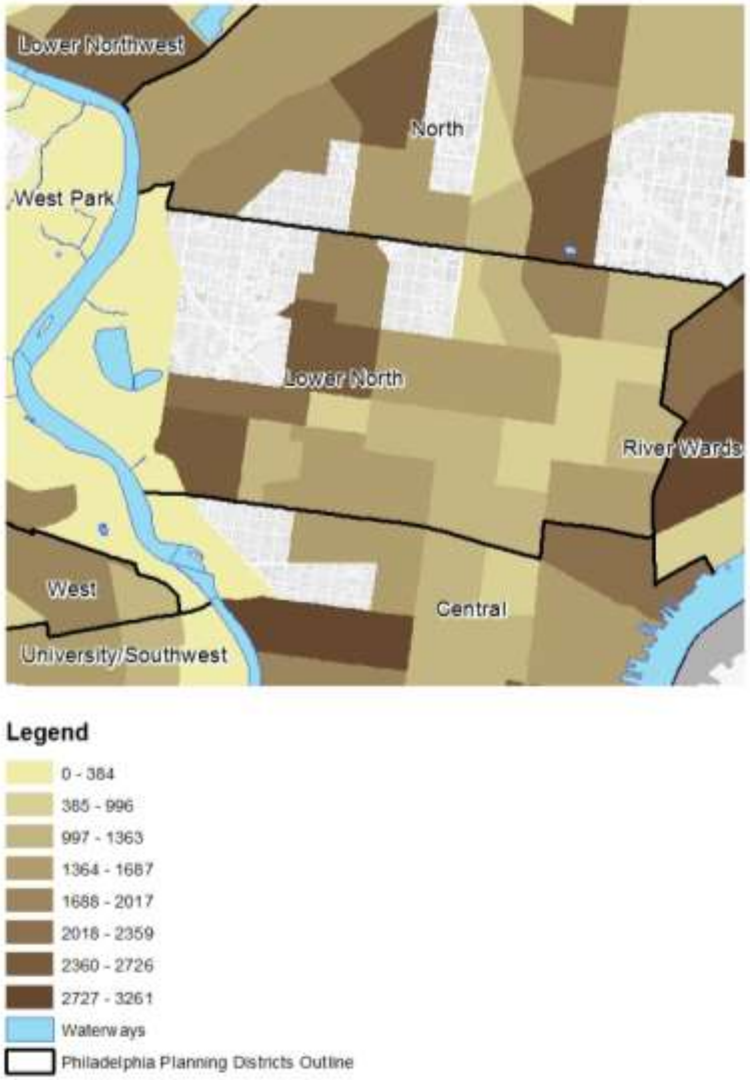
---

[414] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.

[415] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the Lower North Planning District's housing density. Data was unavailable for those portions of the map left uncolored.

Rail Lines in the Lower North Planning District

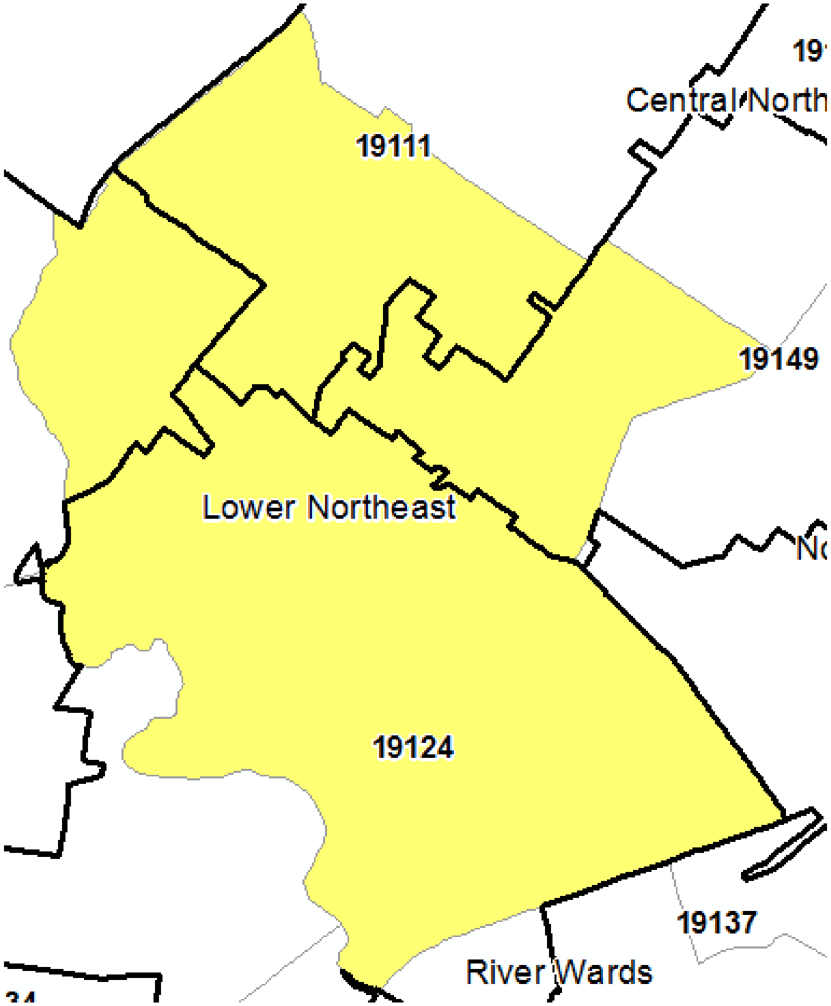


21.1.5 Lower Northeast Planning District

21.1.5.1 Geography and Hydrology

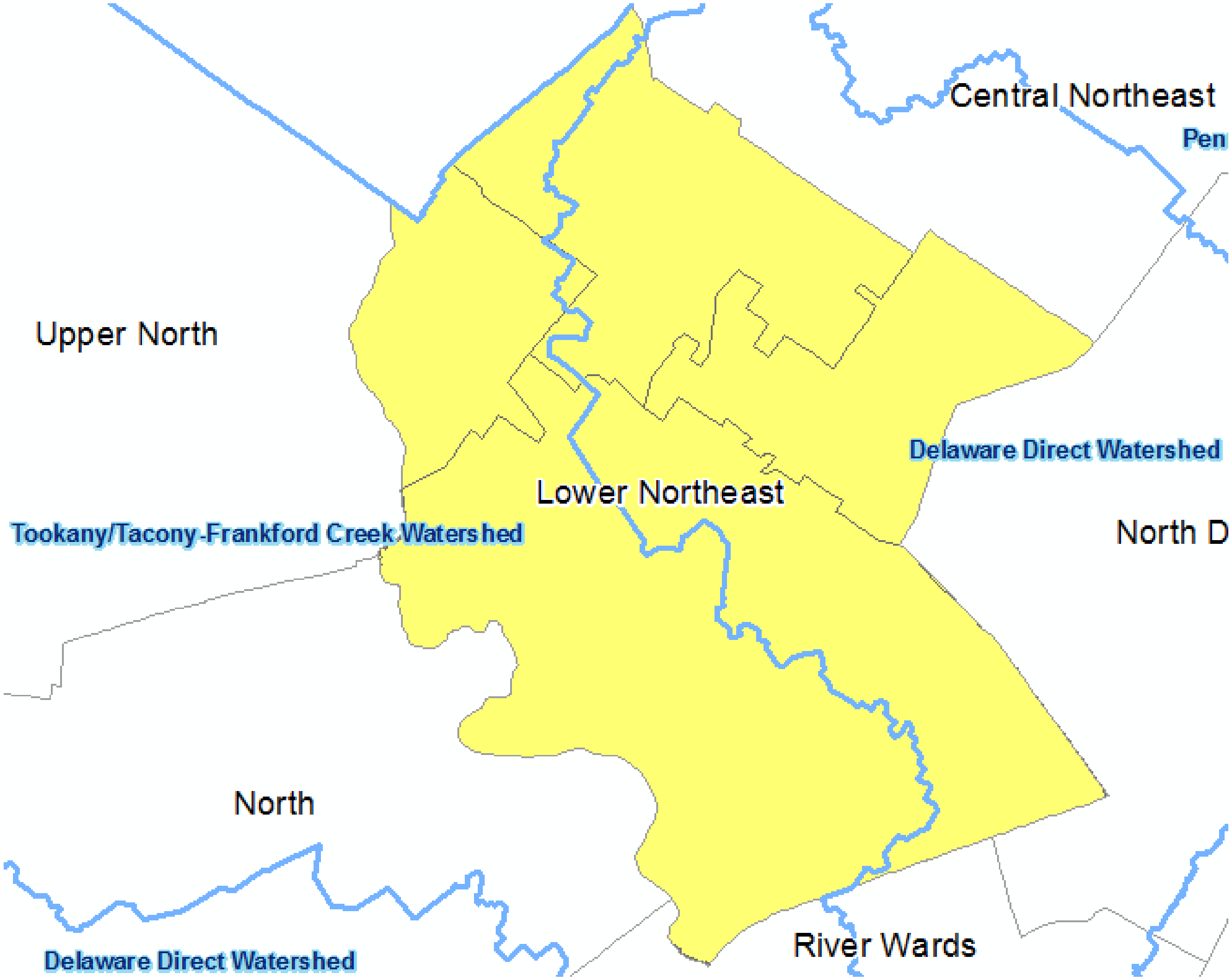
The Lower Northeast Planning District contains addresses in the zip codes 19111, 19124, 19120, and 19149.

Zip codes in the Lower Northeast Planning District



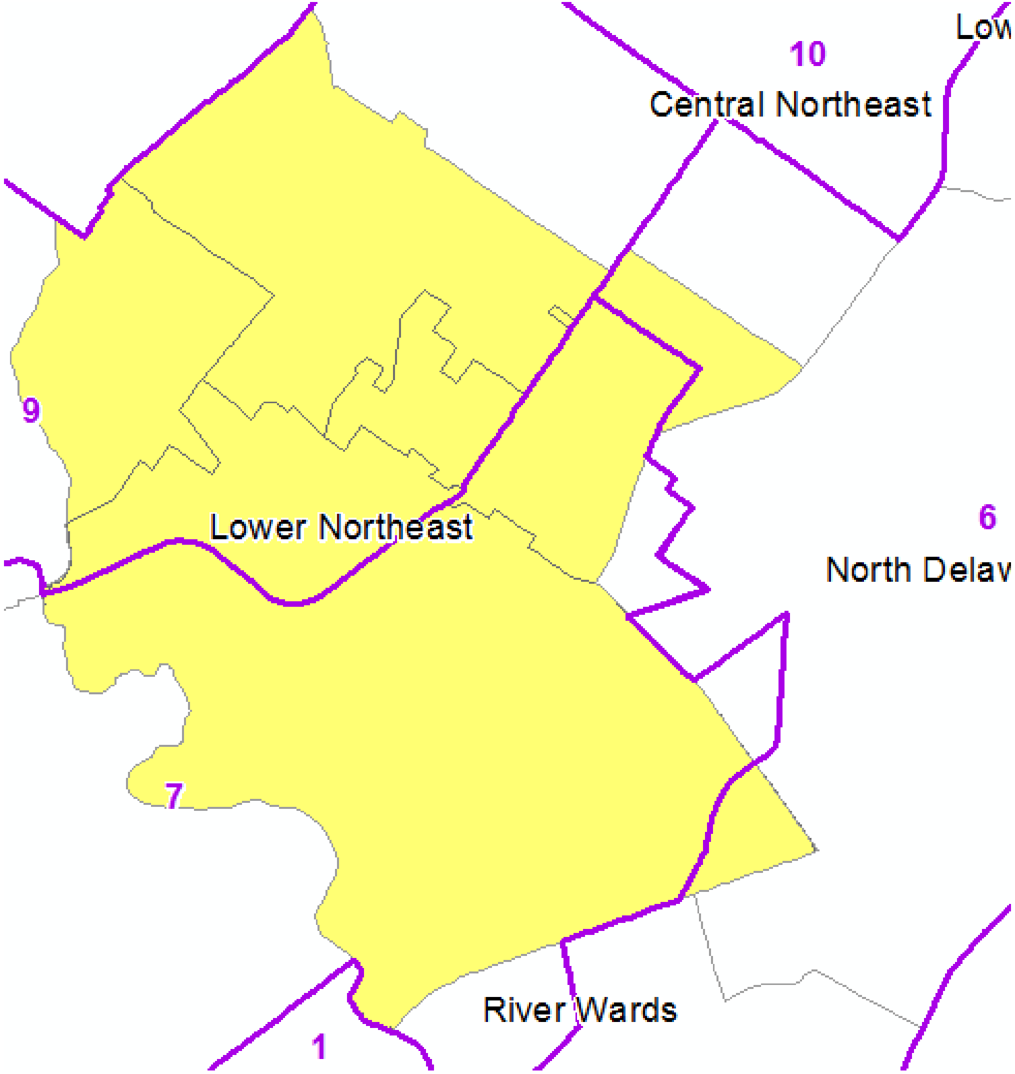
The Lower Northeast planning district falls partially in the Delaware Direct, and Tookany/Tacony-Frankford Watersheds.

Watersheds in the Lower Northeast Planning District



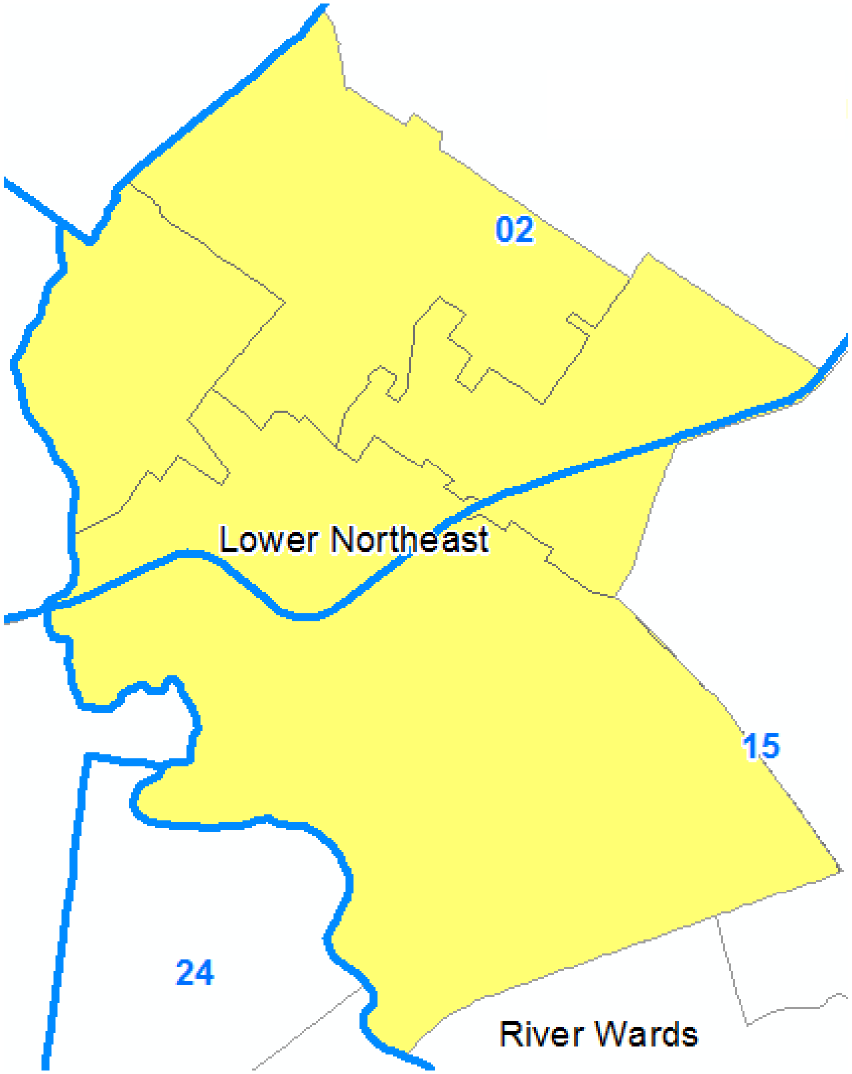
The Lower Northeast Planning District resides within the 7th, 9th, and 6th Council Districts of Philadelphia.

Council Districts in Lower Northeast Planning District



The Lower Northeast Planning District falls mostly within the 15th and 2nd Police Districts.

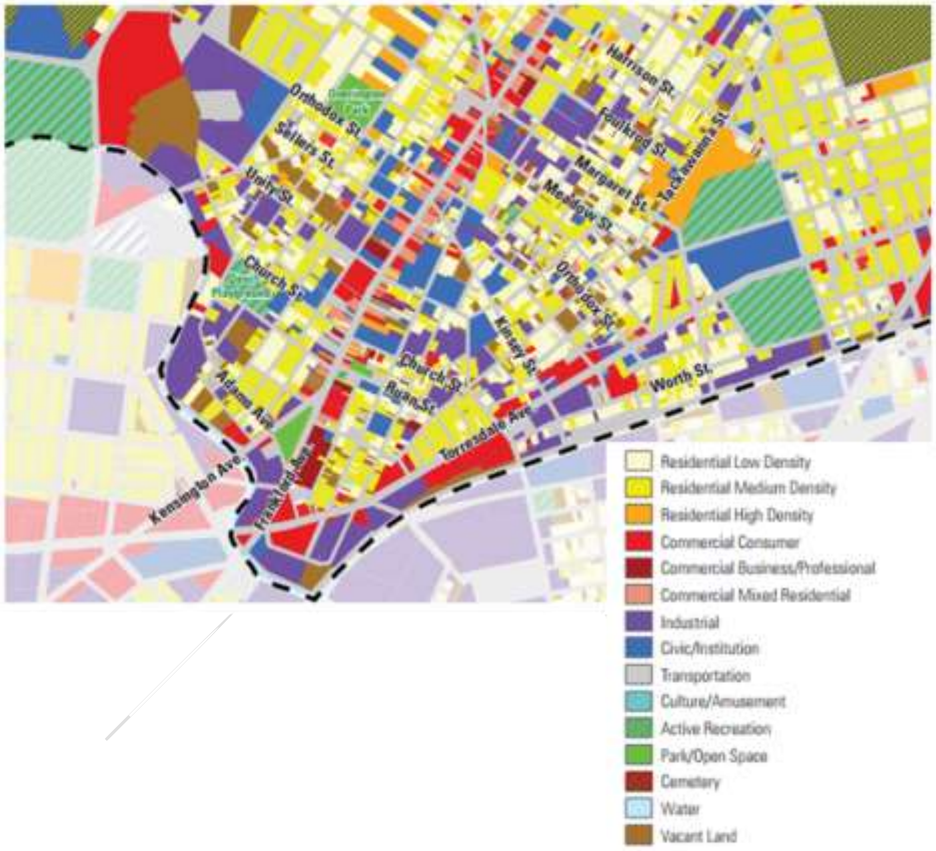
Police Districts in the Lower Northeast Planning District



21.1.5.2 *Current and Future Land Use*

The Lower Northeast is the third fastest growing district in the city. Its stable and affordable housing stock has made the district attractive to young families and immigrant populations.[416] Housing options range from detached houses to apartments above stores on walkable commercial corridors. [417] [418]

Philadelphia Lower Northeast Planning District Existing Land Use



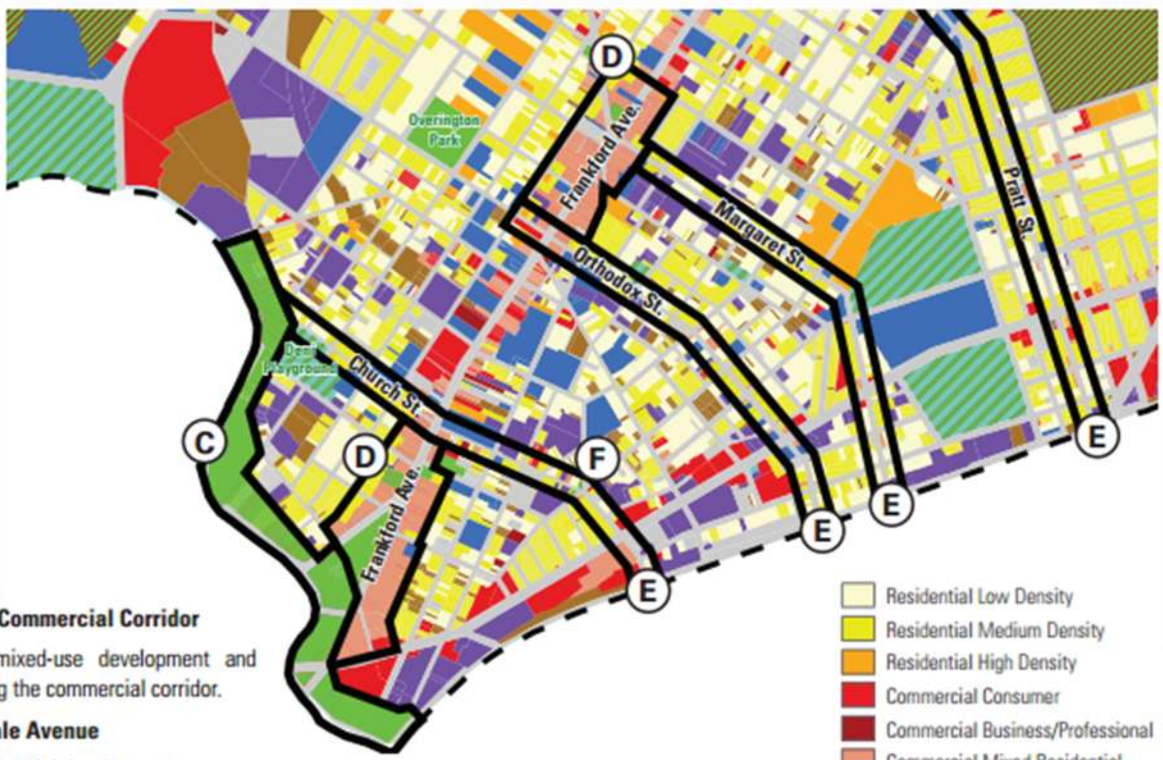
---

[416] City of Philadelphia, Philadelphia 2035. Lower Northeast District Plan. Retrieved November 20, 2015.

[417] Ibid.

[418] All graphics, charts, and recommendations come from the City of Philadelphia: Philadelphia 2035 Lower Northeast District Plan. Retrieved November 20, 2015.

Philadelphia Lower Northeast Planning District Future Land Use



A. Castor Avenue Commercial Corridor

Reflect proposed mixed-use development and redevelopment along the commercial corridor.

B. 5000 Summerdale Avenue

Reflect proposed industrial development.

C. Frankford Creek

The land adjacent to the Frankford Creek is shown as park/open space. It could also include residential reuse of existing industrial buildings.

D. Frankford Avenue Commercial Corridor

The future land uses along the corridor illustrate the consolidation of commercial uses into three nodes centered around the El stations. Land uses around the Frankford Transportation Center (FTC) are revised to reflect the proposed uses in the focus area.

E. Vacant Land in East Frankford

A reduction in the amount of vacant land in East Frankford is illustrated by increased residential uses on the following streets: Church, Margaret, Orthodox, and Pratt.

F. Church Street

Revised land uses show pocket parks at the intersection of Church, Tackawanna, and Waln Streets.

- ⬜ Residential Low Density
- 🟨 Residential Medium Density
- 🟧 Residential High Density
- 🟥 Commercial Consumer
- 🟥 Commercial Business/Professional
- 🟧 Commercial Mixed Residential
- 🟪 Industrial
- 🟦 Civic/Institution
- ⬜ Transportation
- 🟦 Culture/Amusement
- ▨ Active Recreation
- 🟩 Park/Open Space
- ▨ Cemetery
- 🟦 Water
- 🟫 Vacant Land
- ☐ Land Use Change

21.1.5.3 Social Characteristics

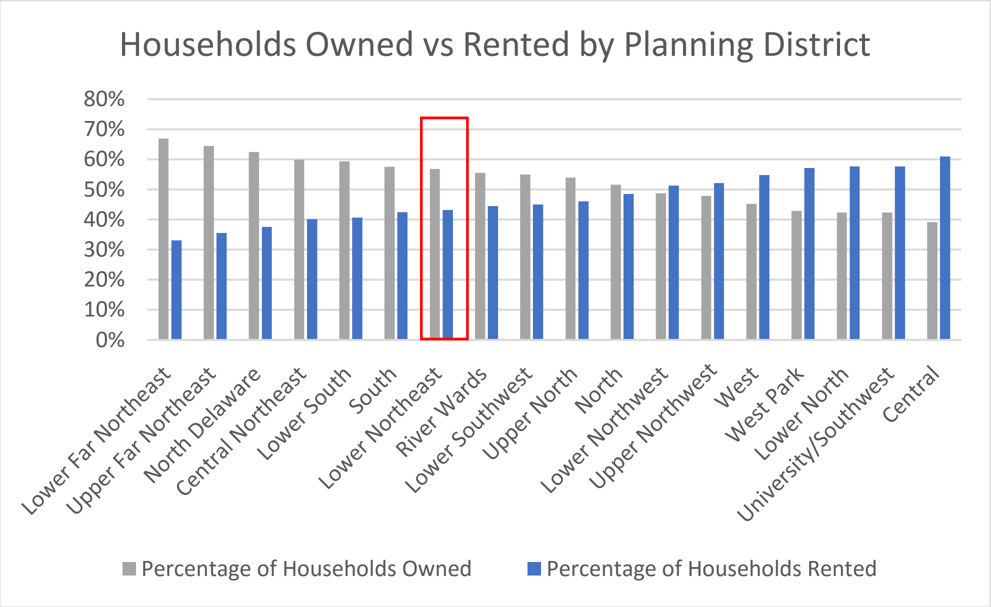
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

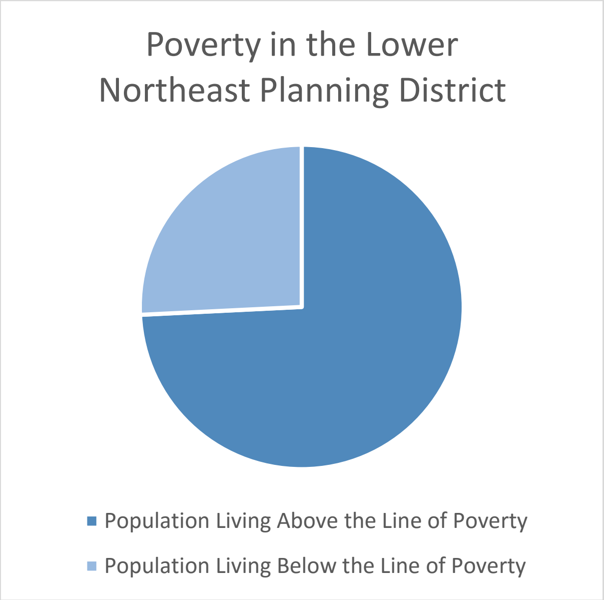
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	266,472
▪ Male population	125,899
▪ Female population	140,573
Median Age	31.5
Age dependency ratio (the percentage of the population under 15 and over 64)	59.2%
Population under 15	45.1%
Population over 64	14.2%

21.1.5.4 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	87,211
▪ Households owned	49,565
▪ Households rented	37,646
No vehicle access	21,210
Population below the federal line of poverty	25.8%





21.1.5.5 Disability

Of those individuals residing within the Lower Northeast Planning District, 16.4 percent reported having a disability. Disabilities reported by individuals in the Lower Northeast Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	8.5%
Vision difficulty	8.7%
Cognitive difficulty	9.8%
Ambulatory Difficulty	9.5 %
Self-care Difficulty	9.5%
Independent Living Difficulty	9.8%

21.1.5.6 Lower Northeast Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

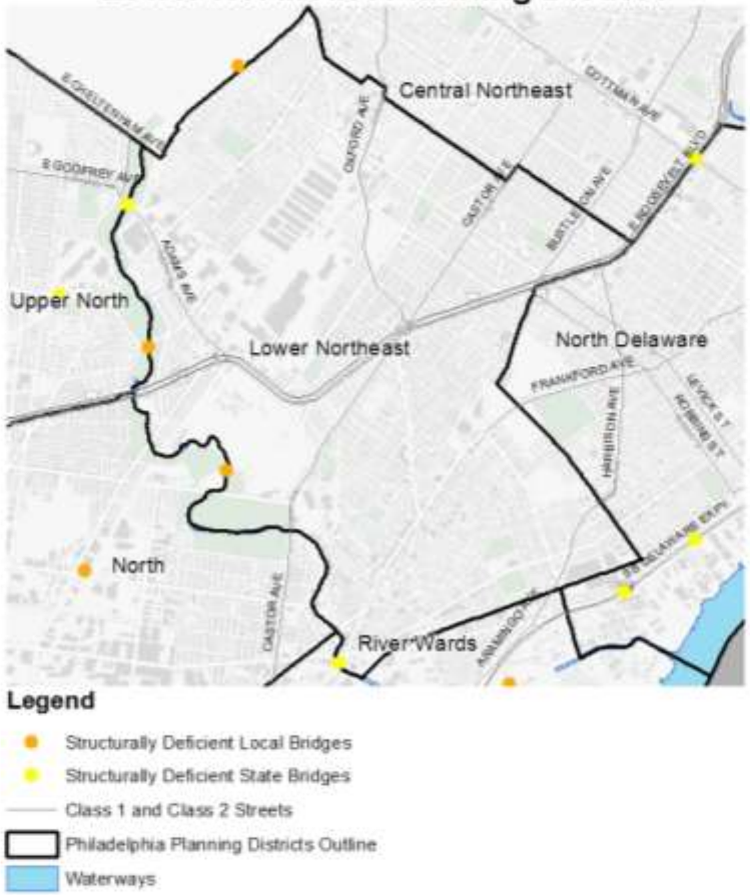
Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[419] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[420] [421] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the Lower Northeast Planning District.[422]

Structurally Deficient Bridges in the Lower Northeast Planning District



---

[419] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[420] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[421] Ibid.

[422] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the Lower Northeast Planning District		
Name	**Location**	**Year Built**
Tacony Creek	Tacony Creek and Fisher’s Lane	1801
Tacony Creek	Tacony Creek and Tabor Road	1957
Tacony Creek	Tacony Creek and Adam’s Avenue	1901
Frankford Creek	Frankford Avenue near Hunting Park Avenue	1903

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. The table below shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.

Dams in the Lower Northeast Planning District

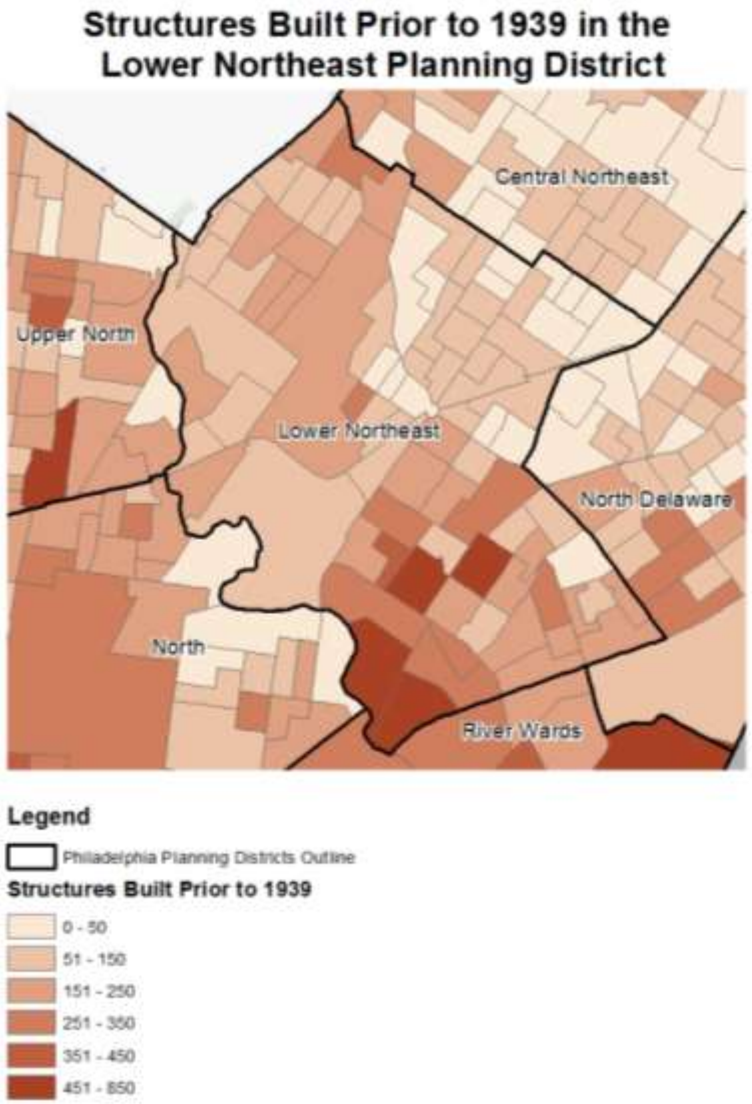
Dam Name	Waterway	High Hazard?	Permitted Owner
Tacony Creek Park	Tacony Creek	No	City of Philadelphia
Debris Dam	Tacony Creek	No	City of Philadelphia

Building Collapse

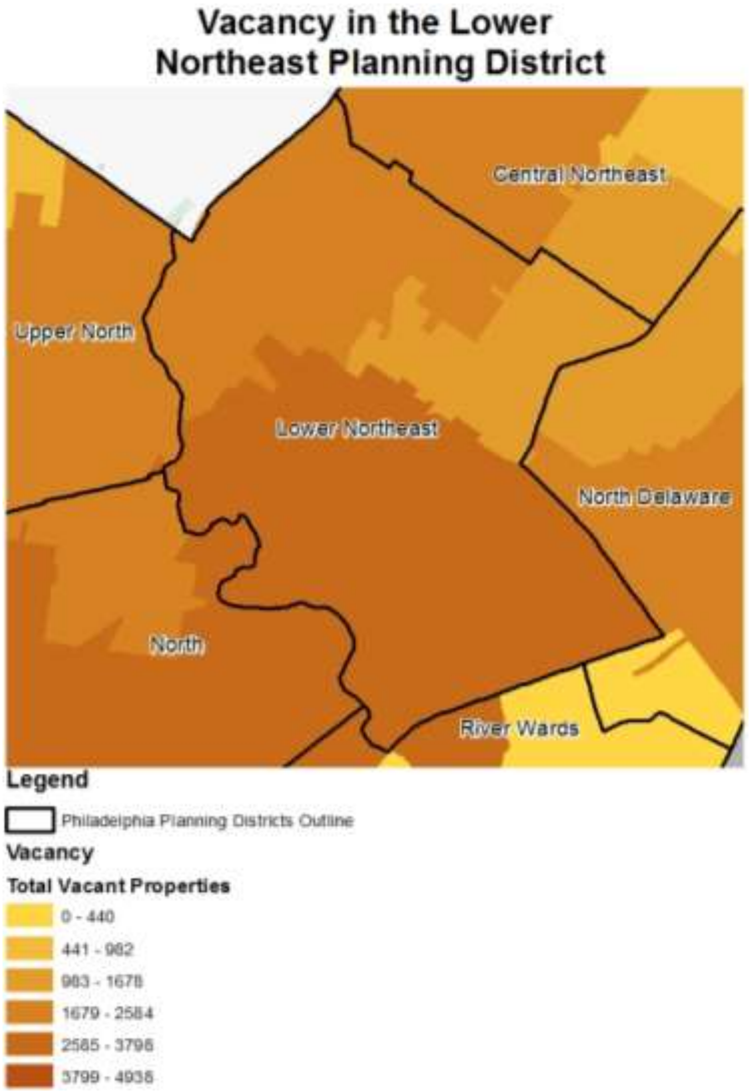
Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

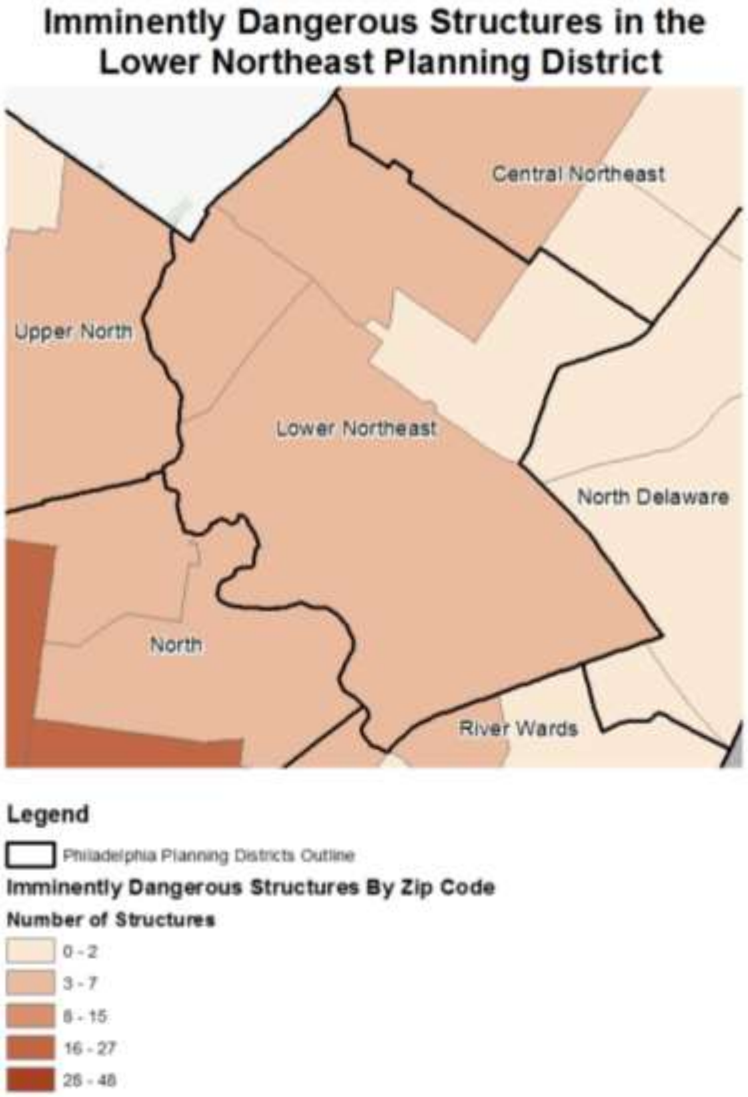
Building age increases the risk of collapse. The map to the right shows the number of properties built in the Lower Northeast Planning District built before 1939.



Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the Lower Northeast Planning District.



Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the Lower Northeast Planning District.

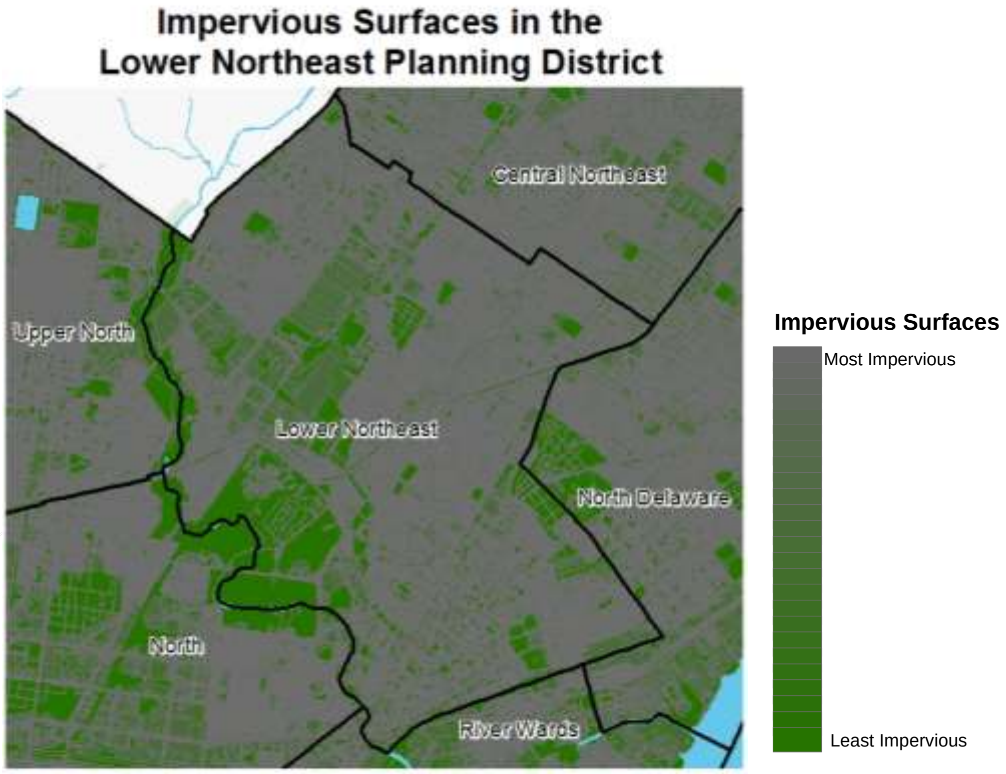


Imminently Dangerous Structures in the Lower Northeast Planning District

Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[423] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

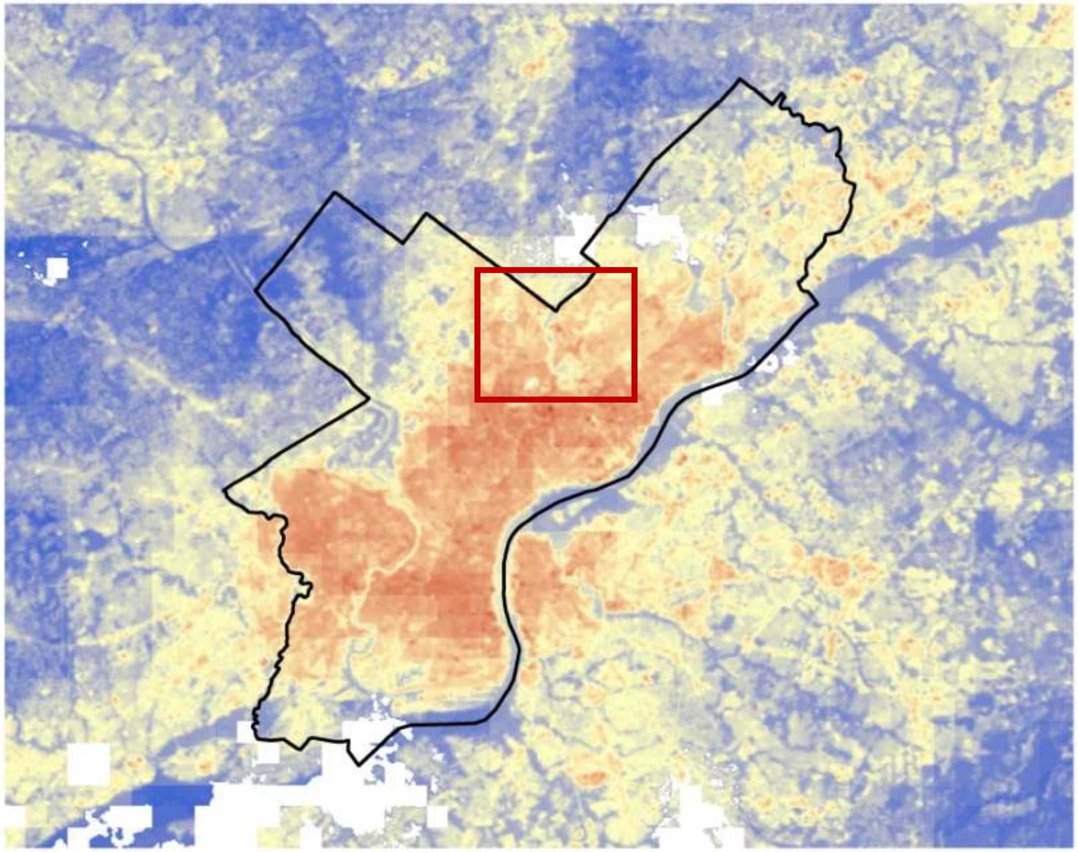
Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[424] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Lower Northeast Planning District.



---

[423] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[424] “Heat Island Effect”. US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[425] As the map shows, the Lower Northeast is located in an area which experience higher heat island effects, and feels some of the effects of such an event more than the bordering counties.

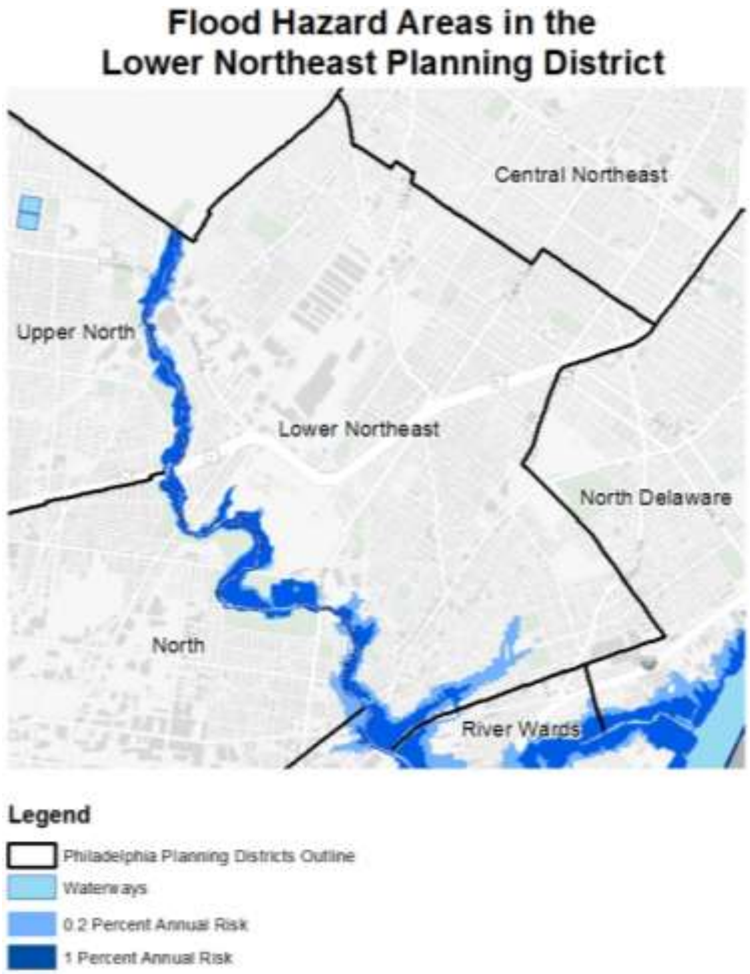


---

[425] “Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002”. URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.



The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[426]

Winter flooding includes 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. All forms of flooding can damage

---

[426] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

infrastructure.[427] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

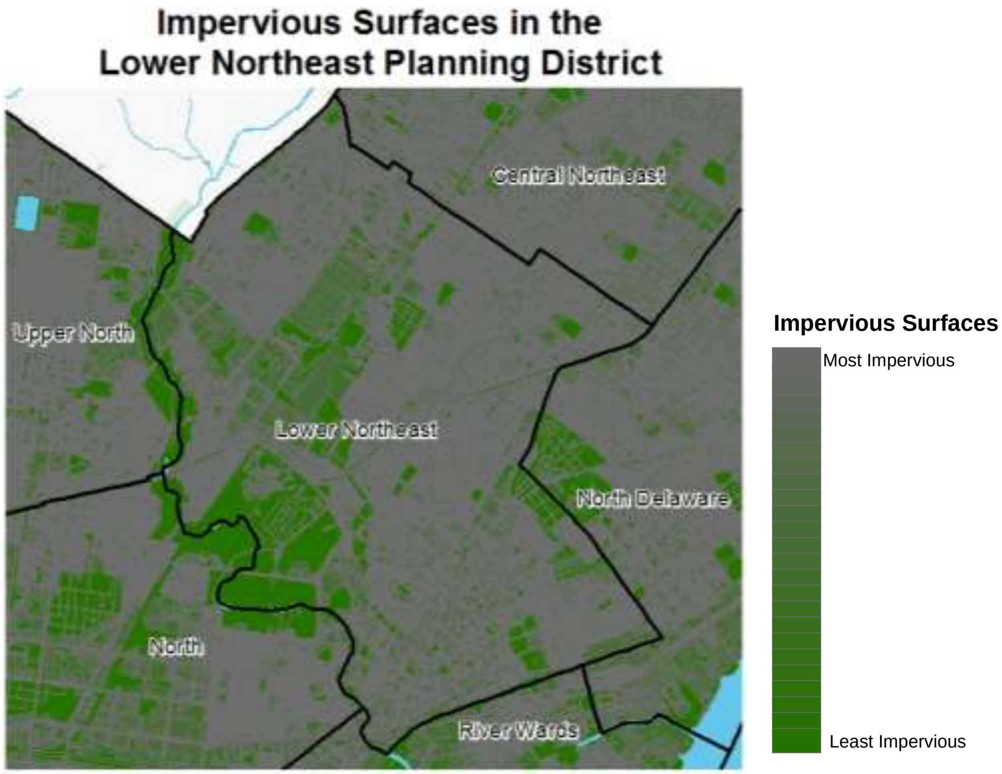
A small portion of the Lower Northeast Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the Lower Northeast Planning District there are 58 National Flood Insurance Program (NFIP) policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

---

[427] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Flash flooding is a concern for some areas of the Lower Northeast Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Lower Northeast Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Impervious Surfaces in the Lower Northeast Planning District

Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[428]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the Lower Northeast Planning District

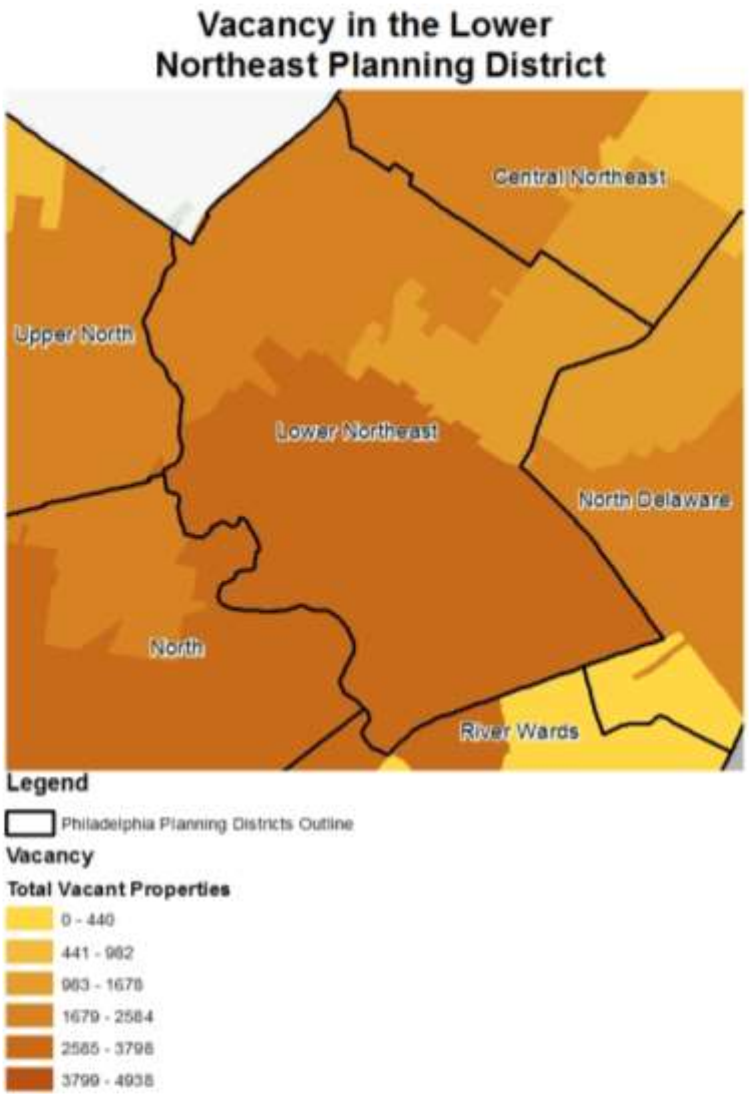
---

[428] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[429] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

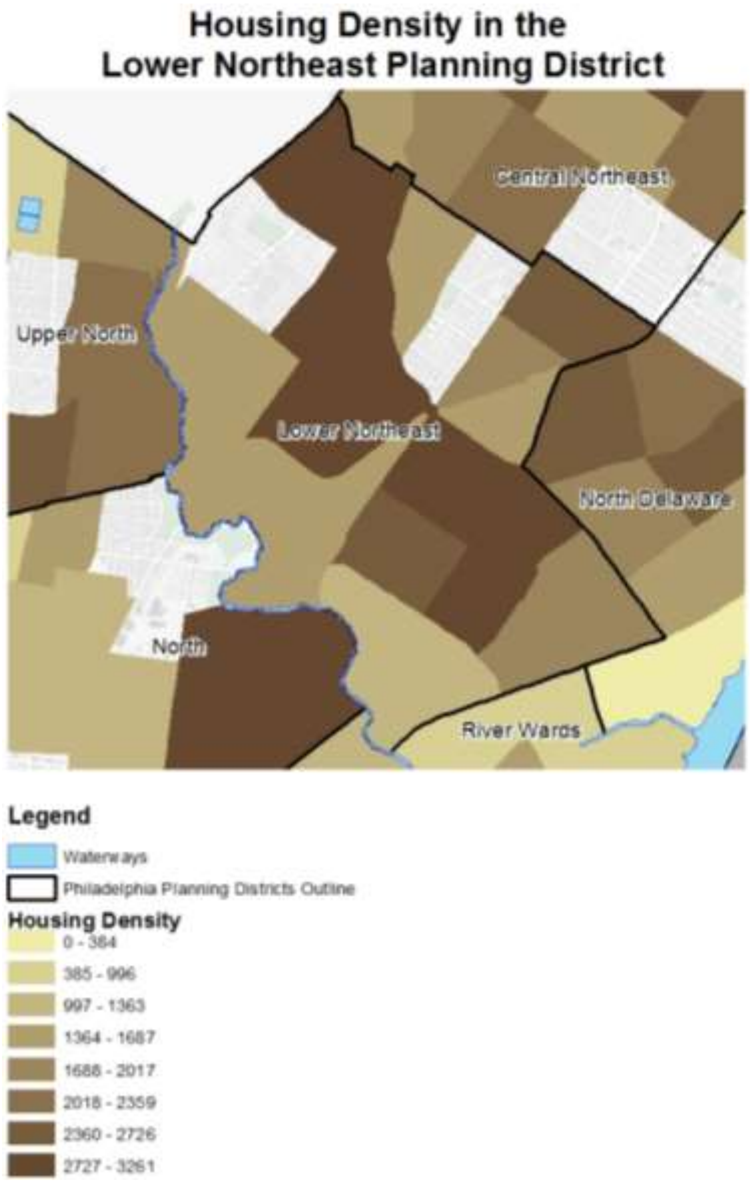
Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[430] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The Lower Northeast Planning District has comparatively fewer vacant properties than many other parts of Philadelphia, and therefore has a slightly lower risk for urban conflagration.



---

[429] William Michael Kramer. "Disaster Planning and Control". Fire Engineering. Retrieved January 11, 2016.
[430] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the Lower Northeast Planning District's housing density. Data was unavailable for those portions of the map left uncolored.

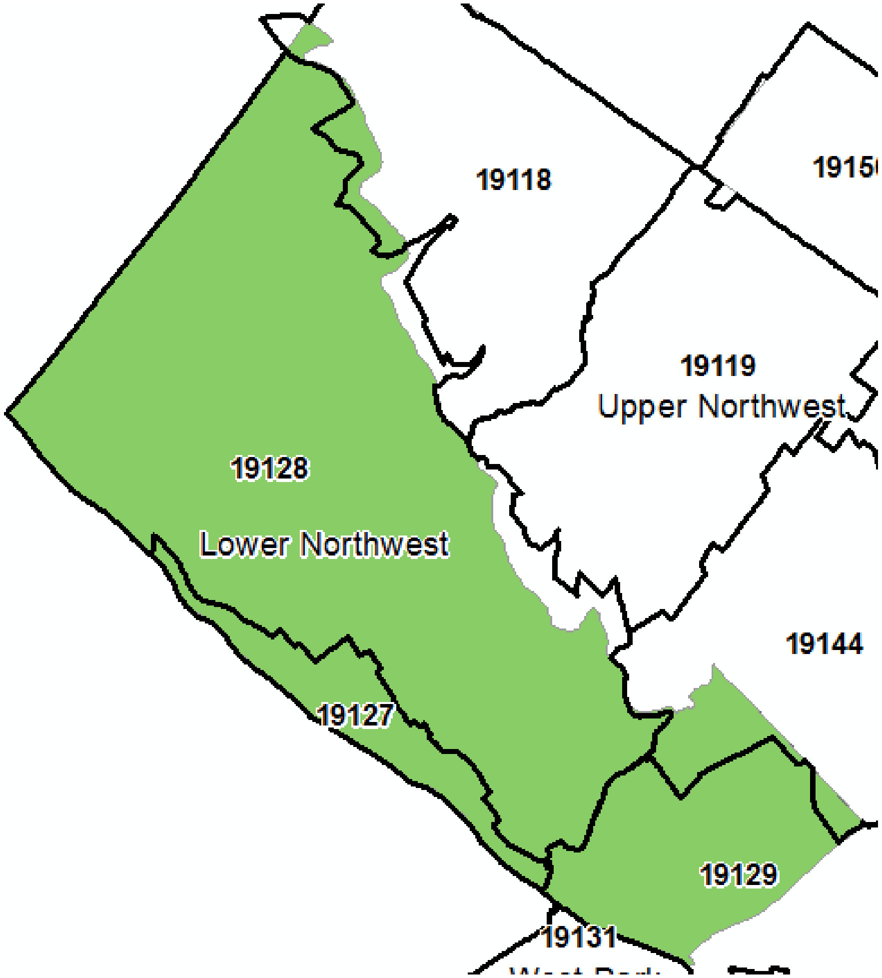


21.1.6 <u>Lower Northwest Planning District</u>

21.1.6.1 Geography and Hydrology

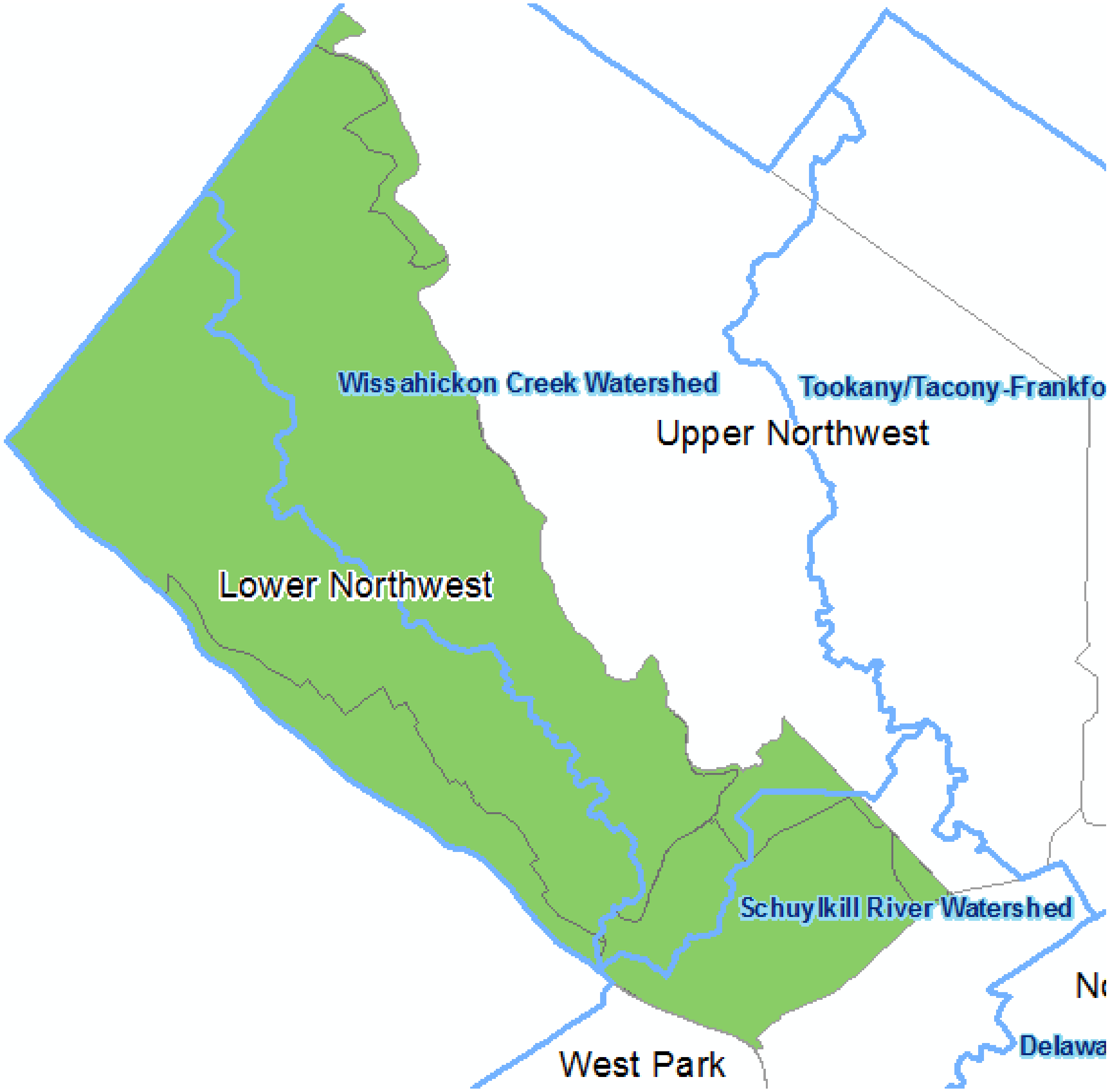
The Lower Northwest Planning District contains addresses in the zip codes 19118, 19127, 19128, 19129, and 19144.

Zip codes in the Lower Northwest Planning District



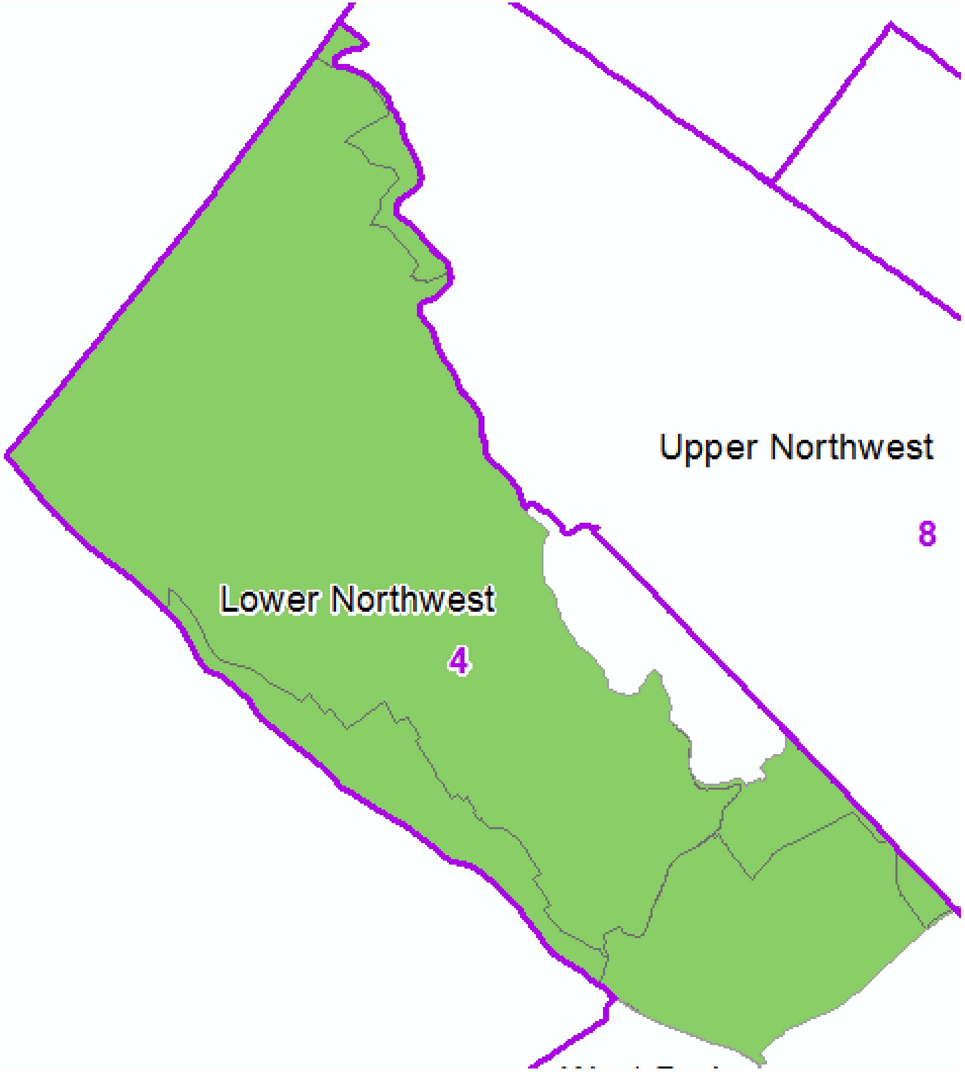
The Lower Northwest planning district falls partially in the Wissahickon Creek and Schuylkill River Watersheds.

Watersheds in the Lower Northwest Planning District



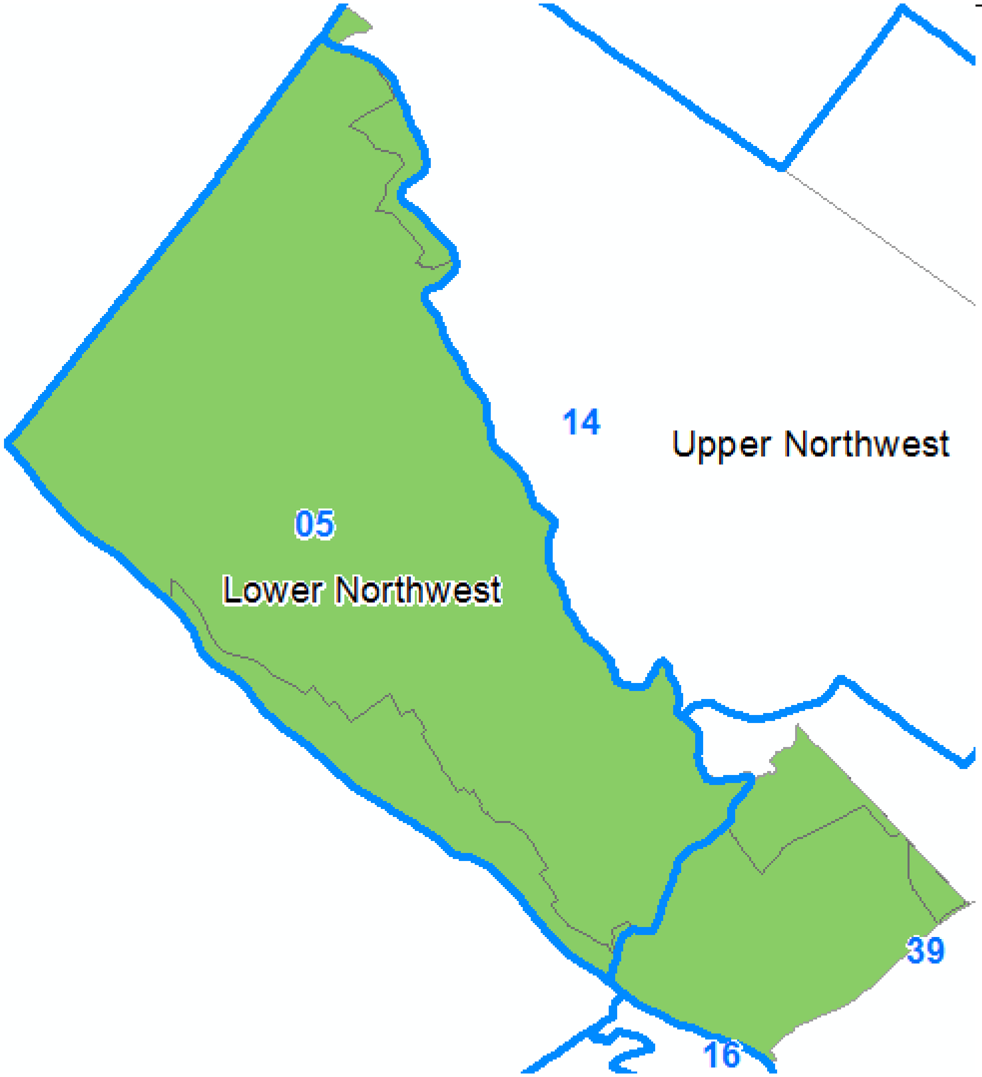
The Lower Northwest Planning District resides within the 4th Council District of Philadelphia.

Council Districts in Lower Northwest Planning District



The Lower Northwest Planning District falls mostly within the 5th Police District, and also crosses into 39th Police District.

Police Districts in the Lower Northwest Planning District



21.1.6.2 Current and Future Land Use

The Lower Northwest District will see continued residential growth over the next ten years.[431] The proposed land use map identifies areas for new residential and commercial growth and development. Future land use is based on the premise of directing residential development away from “car-centric, single-family neighborhoods and toward transit nodes and commercial corridors”.[432] [433]

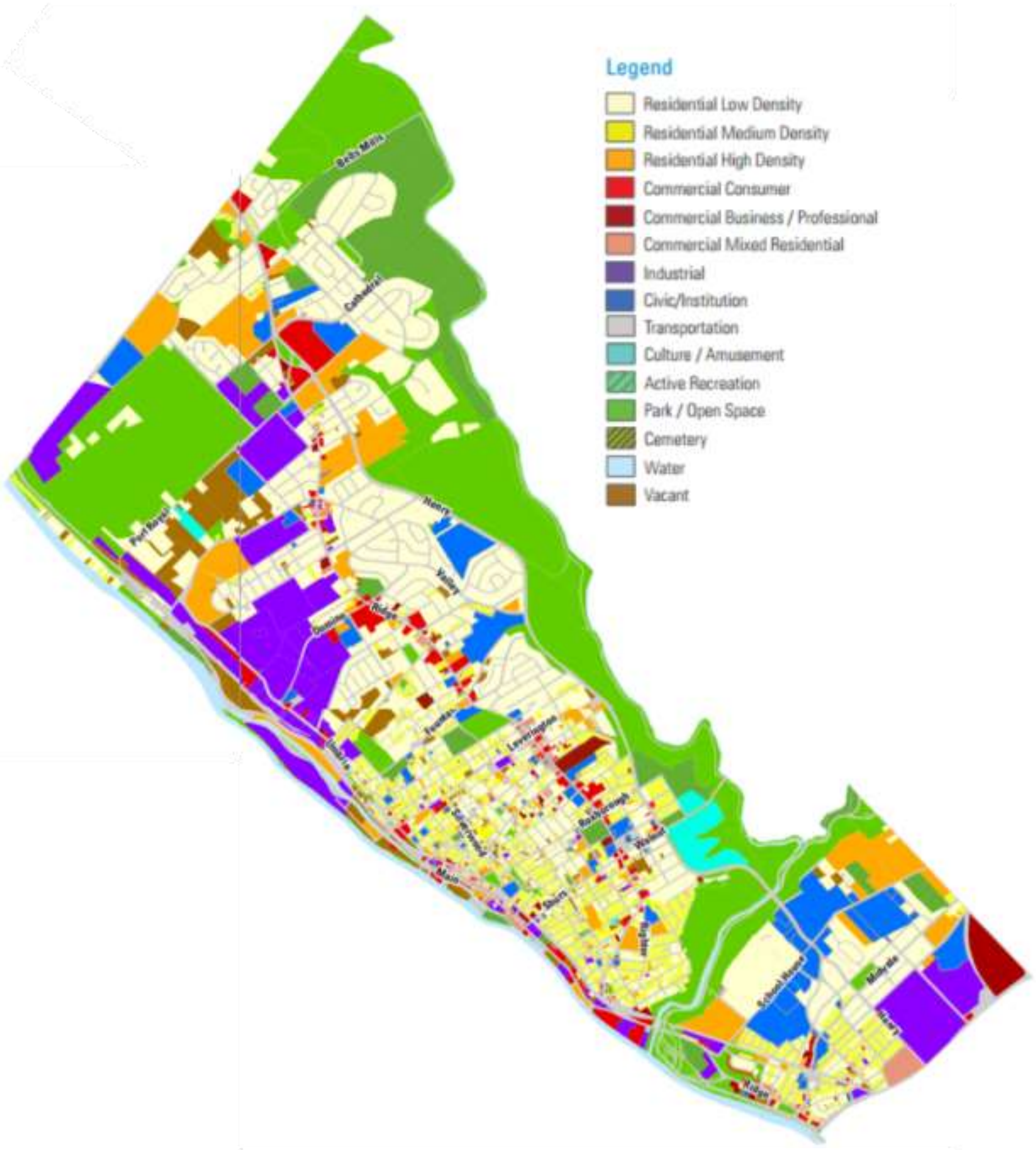
---

[431] City of Philadelphia, Philadelphia 2035. Lower South District Plan. Retrieved November 20, 2015.

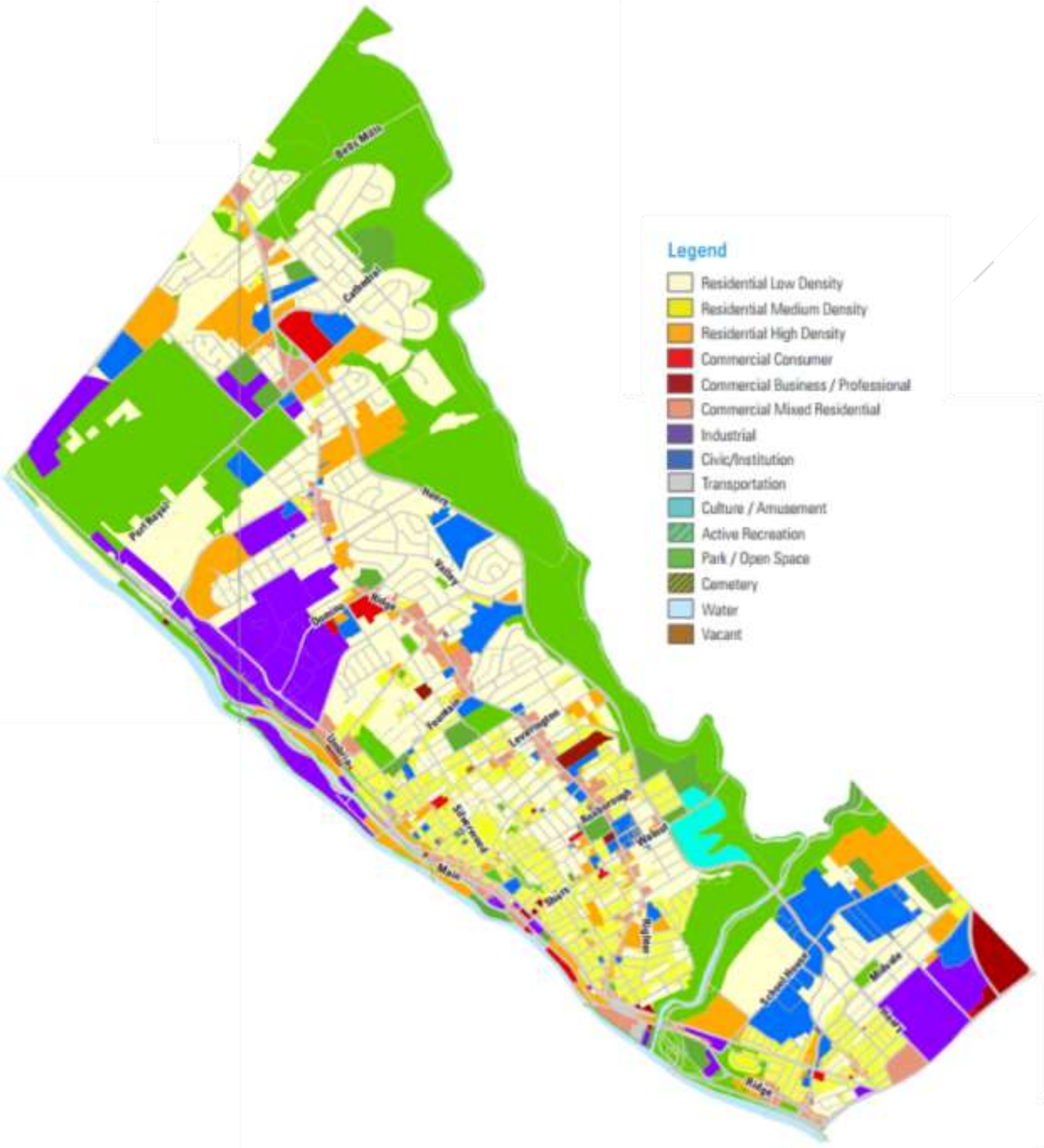
[432] Ibid.

[433] All graphics, charts, and recommendations come from the City of Philadelphia: Philadelphia 2035 Lower South District Plan. Retrieved November 20, 2015.

Philadelphia Lower Northwest Planning District Existing Land Use



Philadelphia Lower Northwest Planning District Future Land Use



21.1.6.3 Social Characteristics

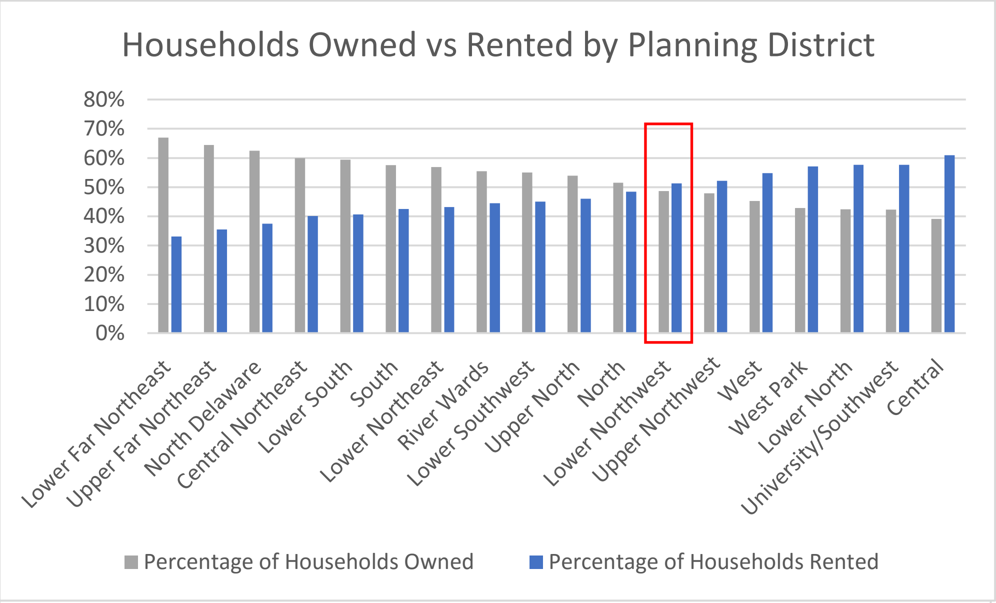
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

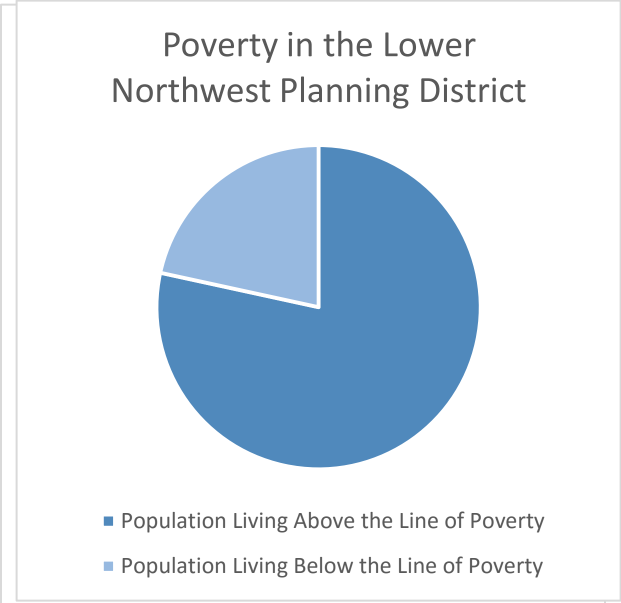
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	178,618
▪ Male population	82,891
▪ Female population	95,727
Median Age	35.4
Age dependency ratio (the percentage of the population under 15 and over 64)	47.0%
Population under 15	25.5%
Population over 64	21.5%

21.1.6.4 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants’ belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district’s population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	39,273
▪ Households owned	19,118
▪ Households rented	20,155
No vehicle access	10,160
Population below the federal line of poverty	21.6%





21.1.6.5 Disability

Of those individuals residing within the Lower Northwest Planning District, 11.3 percent reported having a disability. Disabilities reported by individuals in the Lower Northwest Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	11.6%
Vision difficulty	11.6%
Cognitive difficulty	11.8%
Ambulatory Difficulty	11.8%
Self-care Difficulty	11.9%
Independent Living Difficulty	12.2%

21.1.6.6 *Lower Northwest Hazards*

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

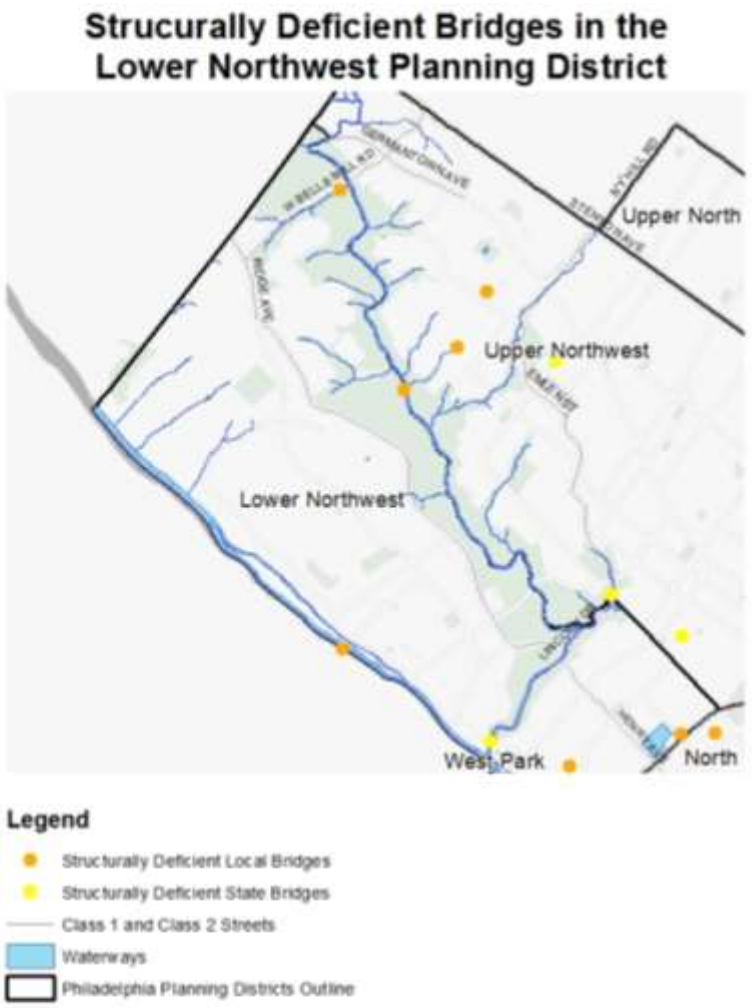
Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[434] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[435] [436] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the Lower Northwest Planning District.[437]



---

[434] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[435] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

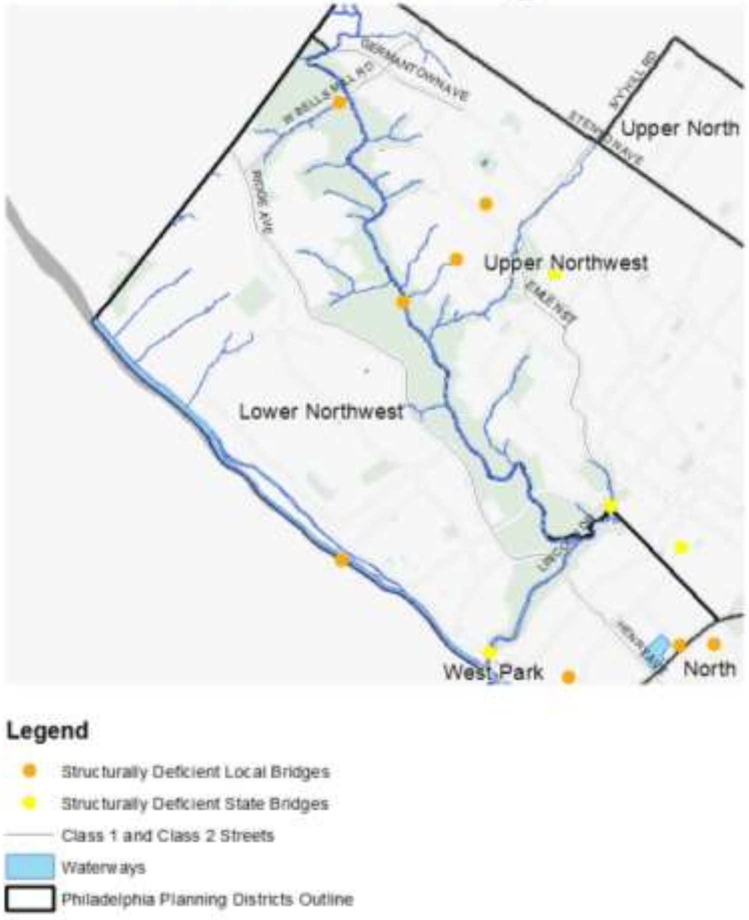
[436] Ibid.

[437] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the Lower Northwest Planning District		
Name	**Location**	**Year Built**
Belmont Ave	Schuylkill River	1928
Wissahickon Creek	Bell’s Mill Rd	1820
SEPTA (Norristown Bridge)	Calumet St, west of Cresson St	1993
Falls Bridge	Schuylkill River	1986
Valley Green Rd	Wissahickon Creek	1915
Ridge Ave	Wissahickon Creek at Gustine Lake	1888

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see [Dam Failure]() under the [Risk Assessment]() section of the 2017 Hazard Mitigation Plan. The table on the following page shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.



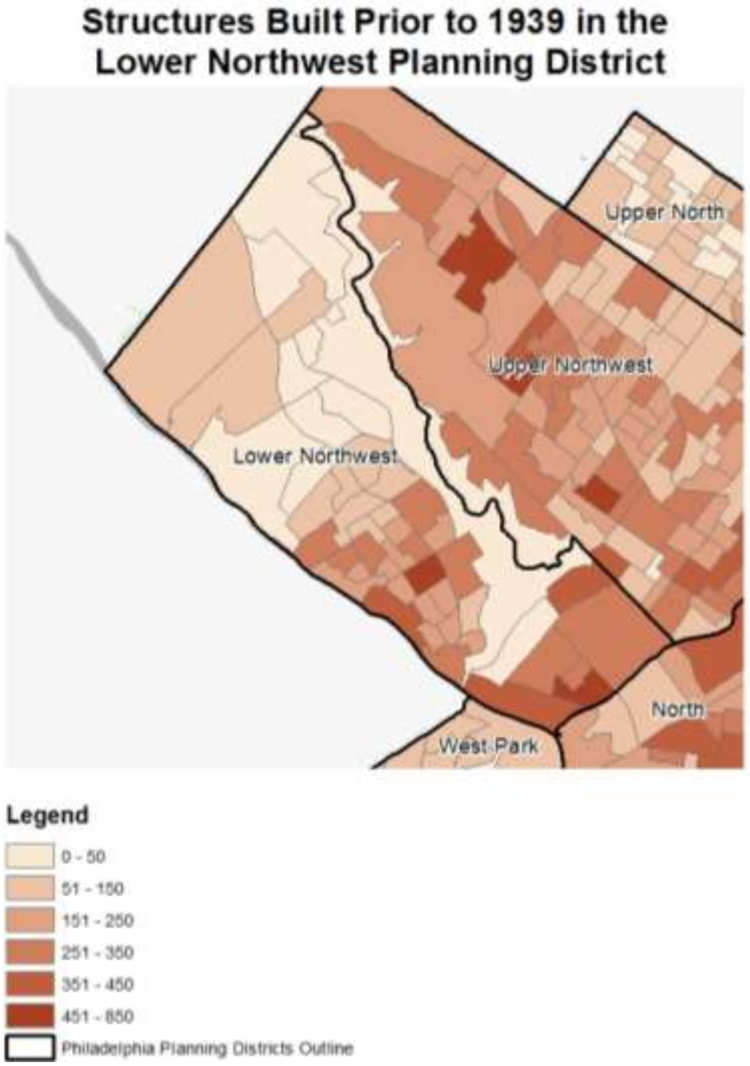
Strucurally Deficient Bridges in the Lower Northwest Planning District

Dam Name	Waterway	High Hazard?	Permitted Owner
Flat Rock	Schuylkill River	Yes	U.S. Department of Environmental Protection
Margaree	Wissahickon Creek	No	City of Philadelphia
Queen Lane Raw Water Basin	Watershed: Schuylkill River	Yes	Philadelphia Water Department
Robeson-Vandaren Mill Upper	Wissahickon Creek	No	City of Philadelphia
Grant Street	Wissahickon Creek	No	City of Philadelphia
Thomas Mill Road	Wissahickon Creek	No	City of Philadelphia
Livezey	Wissahickon Creek	No	City of Philadelphia

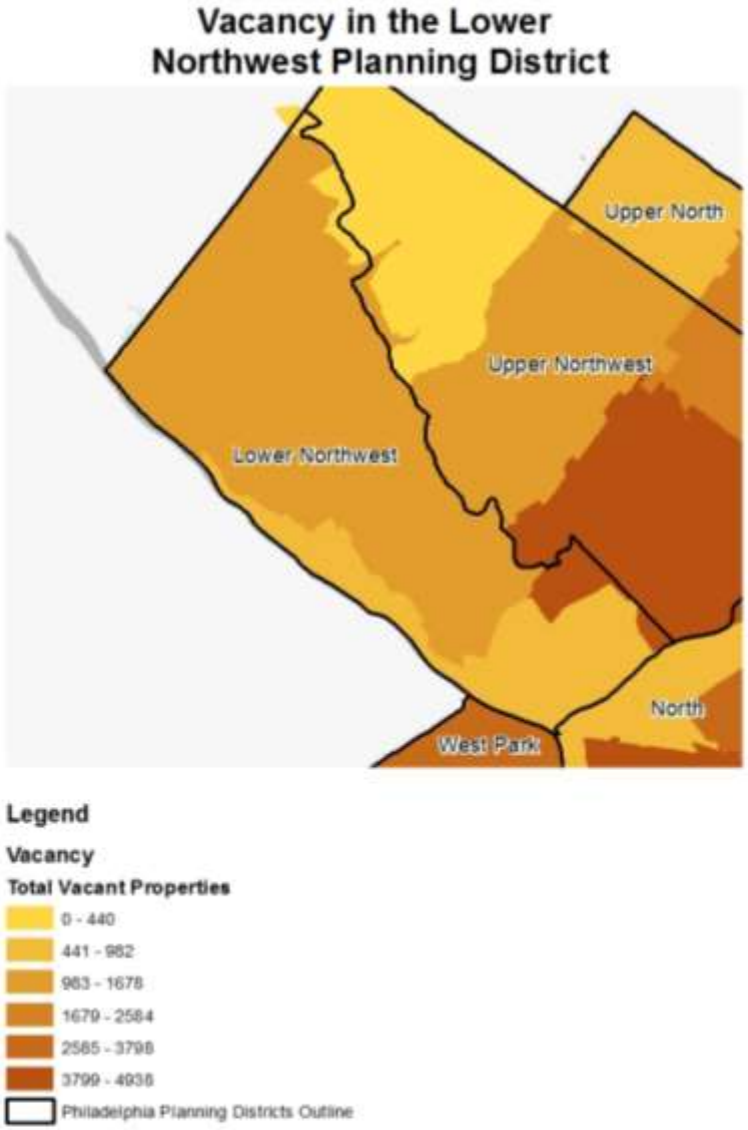
Building Collapse
Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

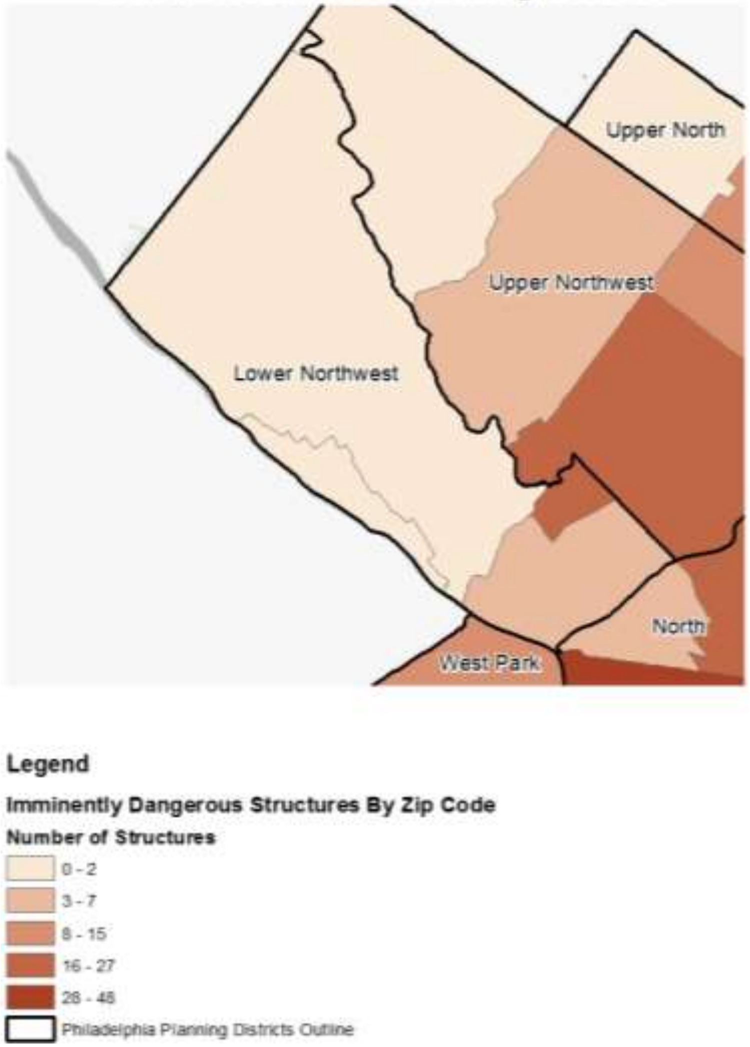
Building age increases the risk of collapse. The map to the right shows the number of properties built in the Lower Northwest Planning District built before 1939.



Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the Lower Northwest Planning District. The Lower Northwest Planning District has a lower portion of vacant properties throughout the majority of the planning district, with a small concentration of vacant properties in the southeastern portion of the district.



Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map to the right shows the location of imminently dangerous structures in the Lower Northwest Planning District.

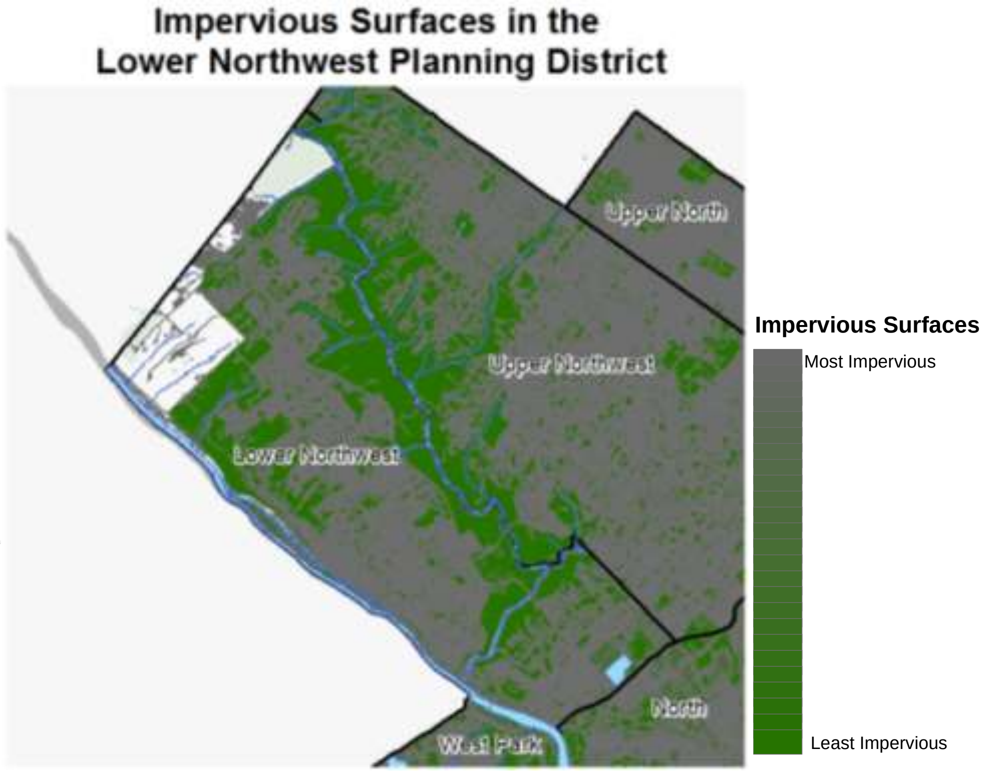


Imminently Dangerous in the Lower Northwest Planning District

Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[438] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

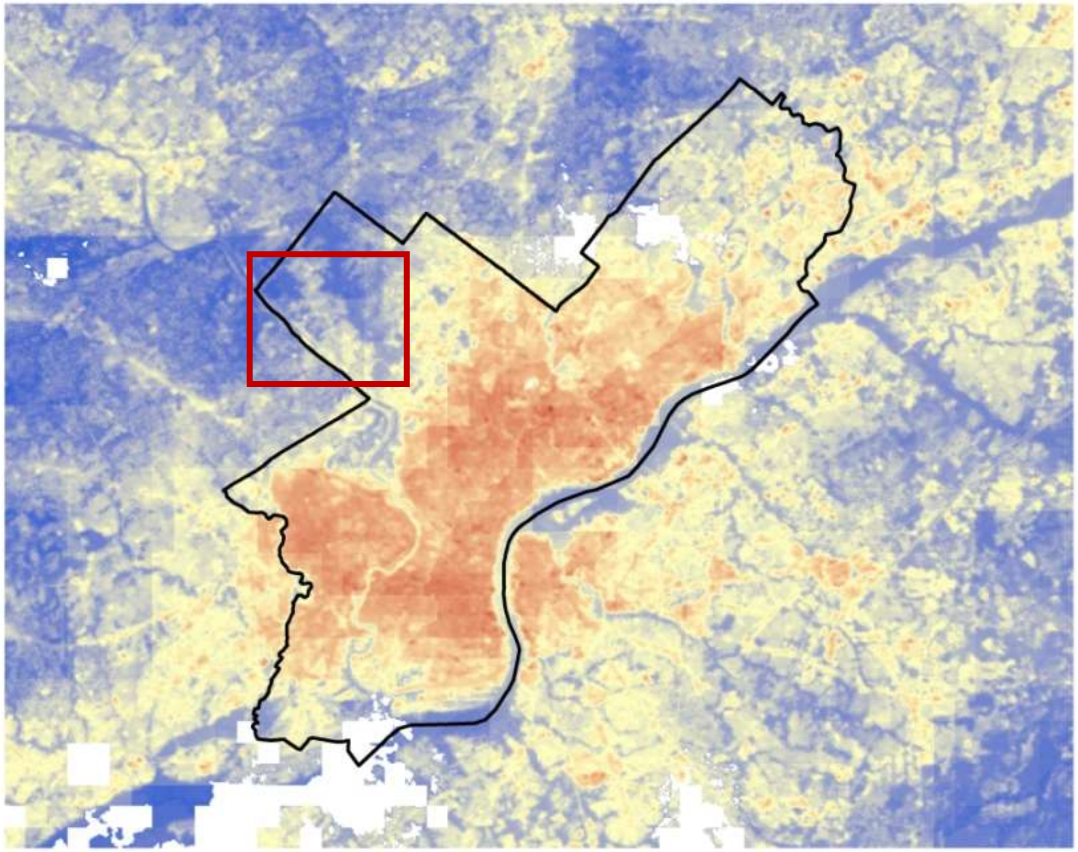
Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[439] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Lower Northwest Planning District.



---

[438] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[439] “Heat Island Effect”. US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[440] As the map shows, the Lower Northwest is located in an area which experience higher heat island effects, and feels some of the effects of such an event more than the bordering counties.



---

[440] "Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002". URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[441]

Winter flooding includes 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.

---

[441] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

All forms of flooding can damage infrastructure.[442] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

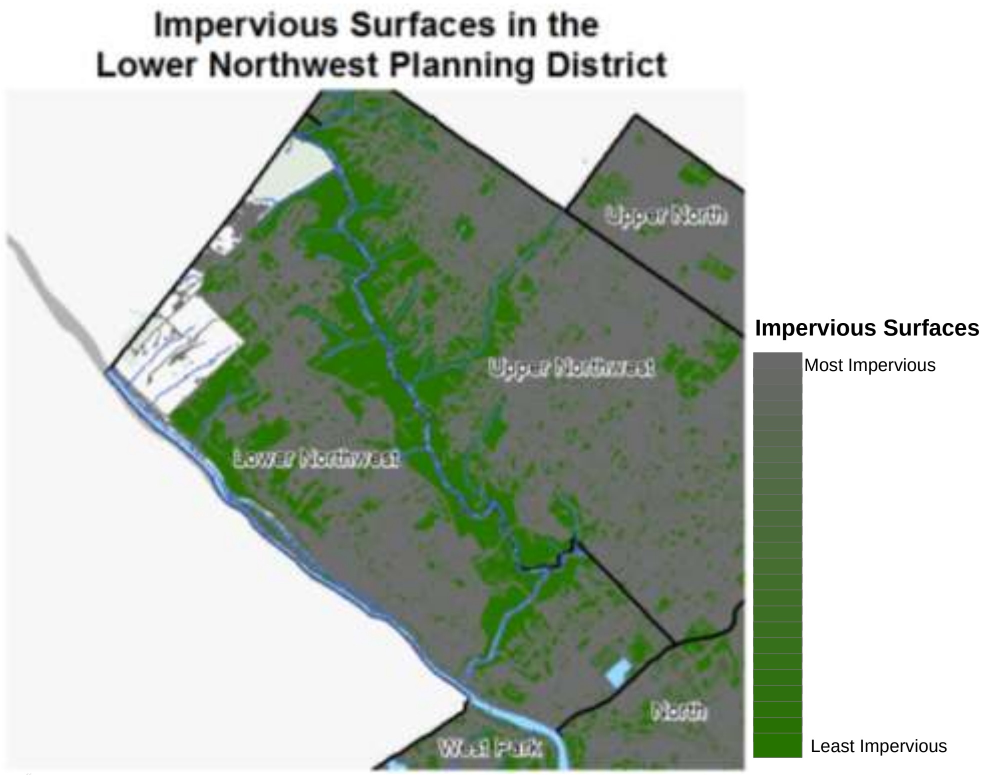
A small portion of the Lower Northwest Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the Lower Northwest Planning District there are 243 National Flood Insurance Program (NFIP) policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

---

[442] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Flash flooding is a concern for some areas of the Lower Northwest Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Lower Northwest Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Impervious Surfaces in the Lower Northwest Planning District

Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[443]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the Lower Northwest Planning District

---

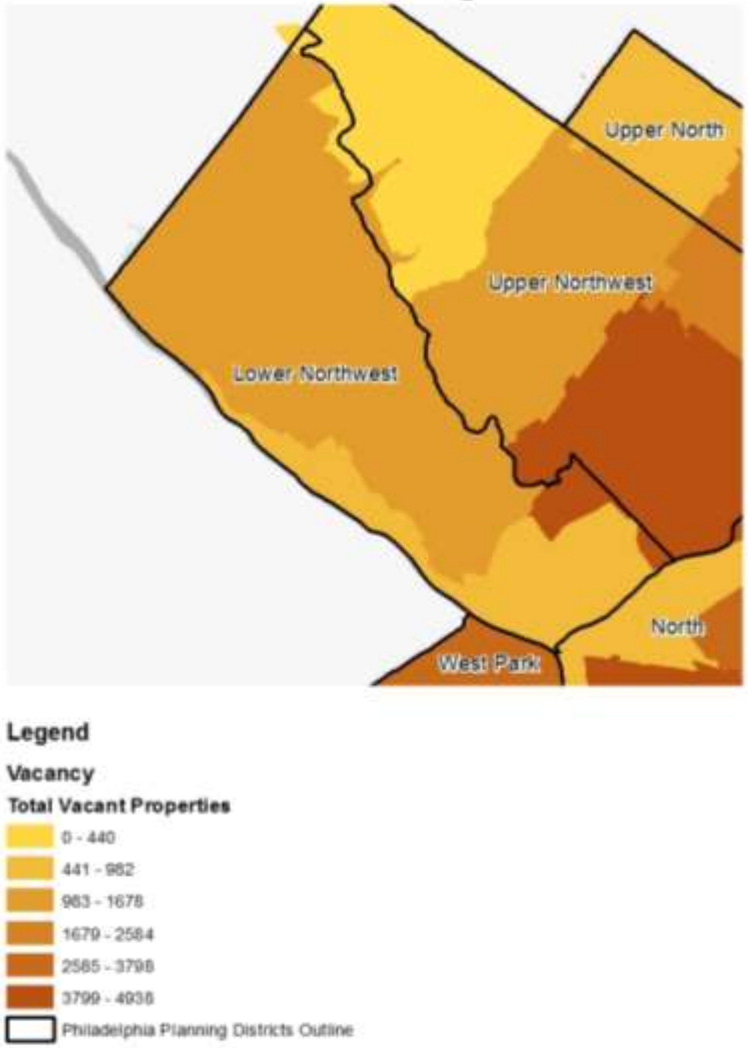
[443] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[444] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[445] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The Lower Northwest Planning District has comparatively fewer vacant properties than many other parts of Philadelphia, with a small concentration of vacant properties in the far south eastern portion of the planning district.

Vacancy in the Lower Northwest Planning District

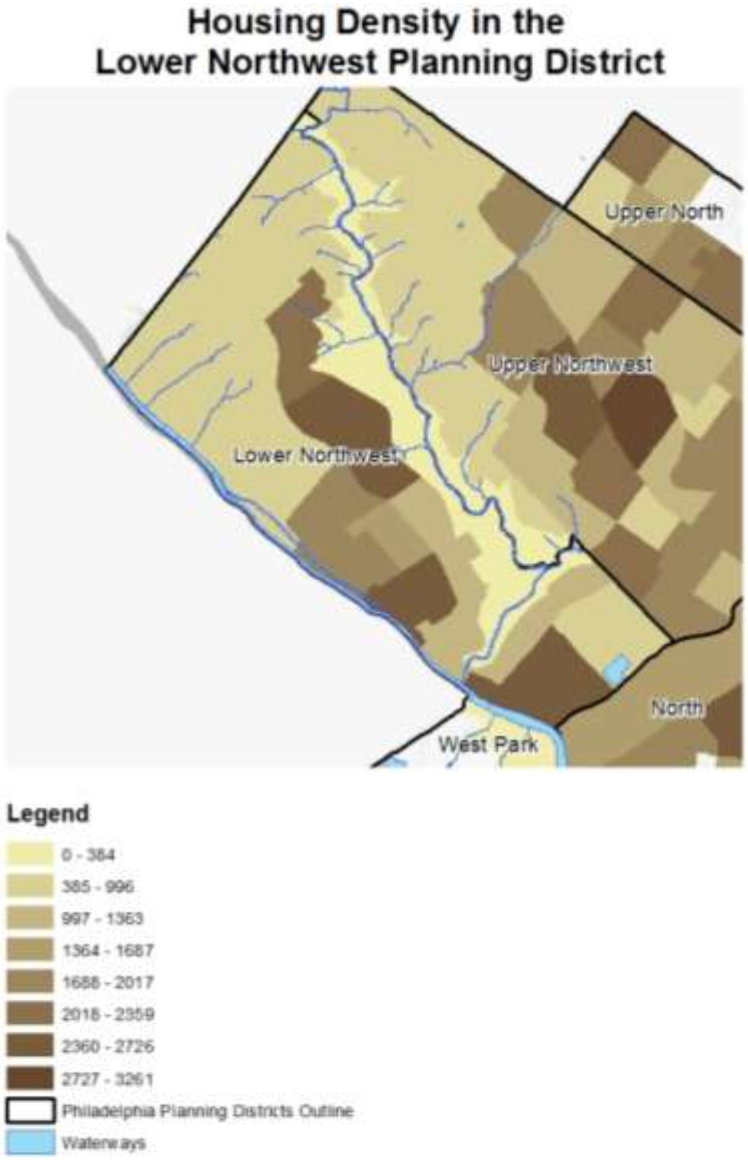


---

[444] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.

[445] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the Lower Northwest Planning District's housing density. Data was unavailable for those portions of the map left uncolored.

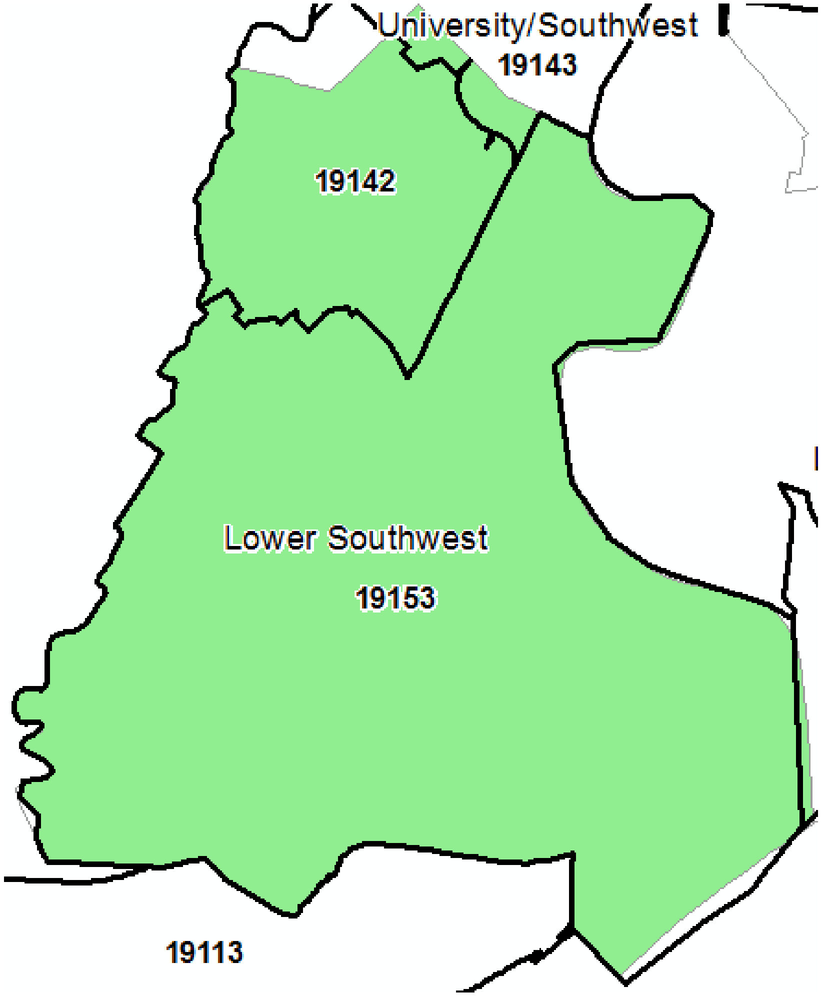


21.1.7 Lower Southwest

21.1.7.1 Geography and Hydrology

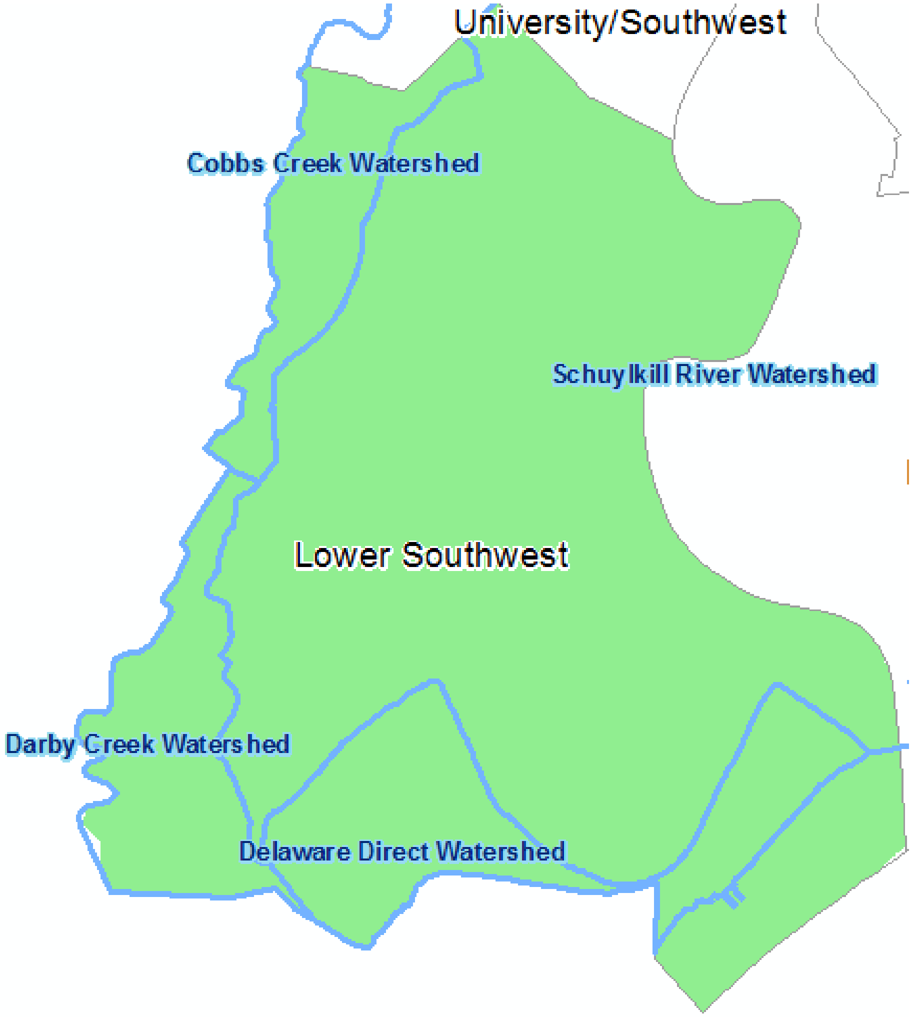
The Lower Southwest Planning District contains addresses in the zip codes 19142, 19153, and 19143.

Zip codes in the Lower Southwest Planning District



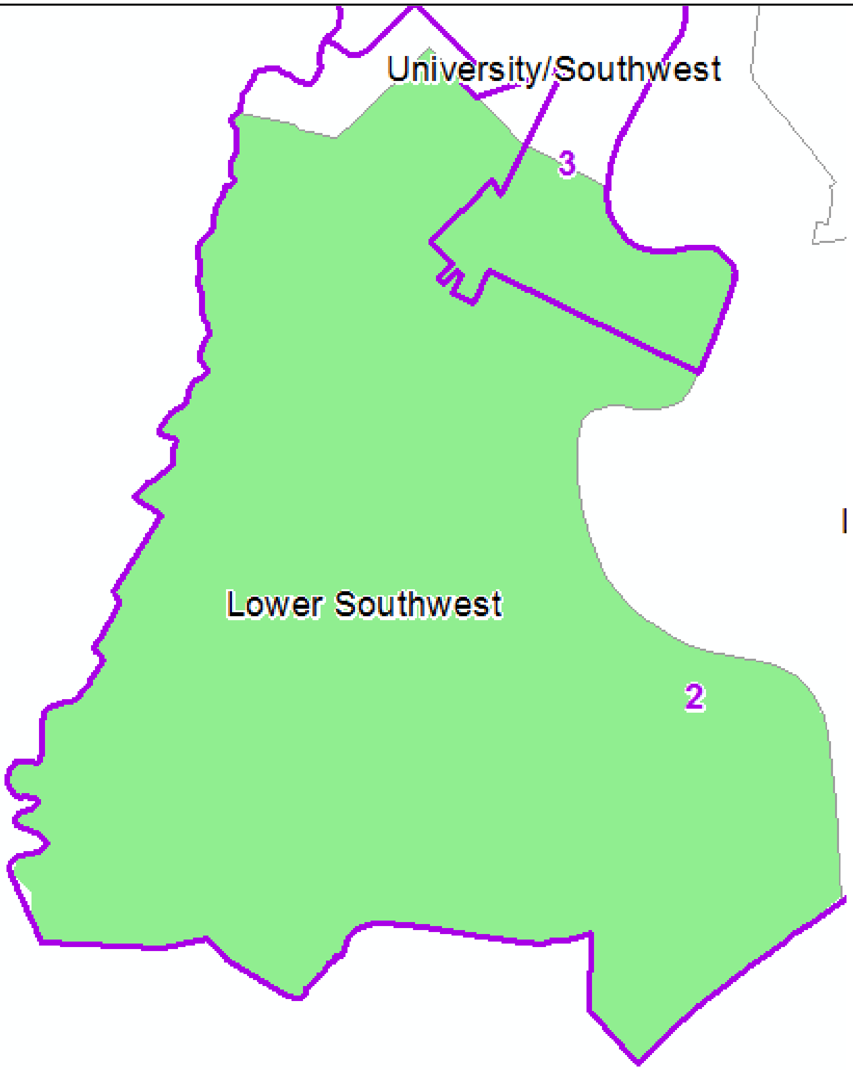
The Lower Southwest planning district falls partially in the Delaware Direct, Darby Creek, Cobbs Creek, and Schuylkill River Watersheds.

Watersheds in the Lower Southwest Planning District



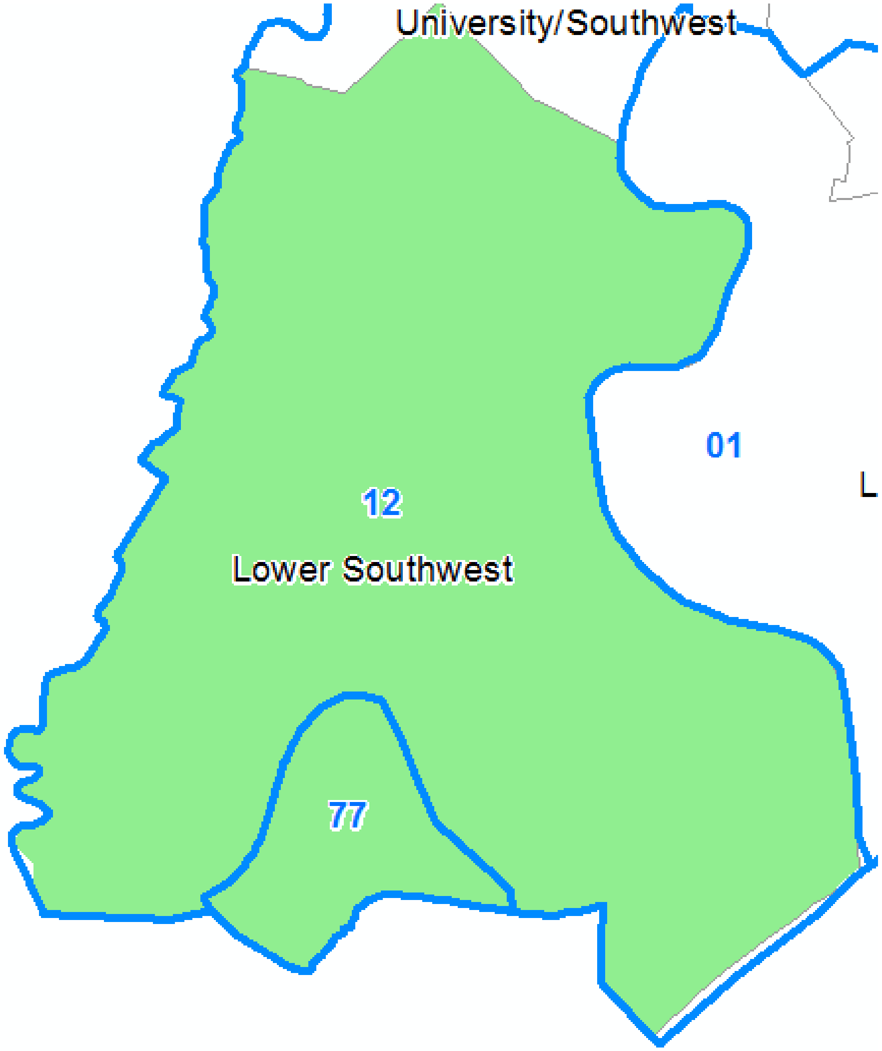
The Lower Southwest Planning District resides within the 2nd and 3rd Council Districts of Philadelphia.

Council Districts in Lower Southwest Planning District



The Lower Southwest Planning District falls mostly within the 12th and 77th Police Districts.

Police Districts in the Lower Southwest Planning District



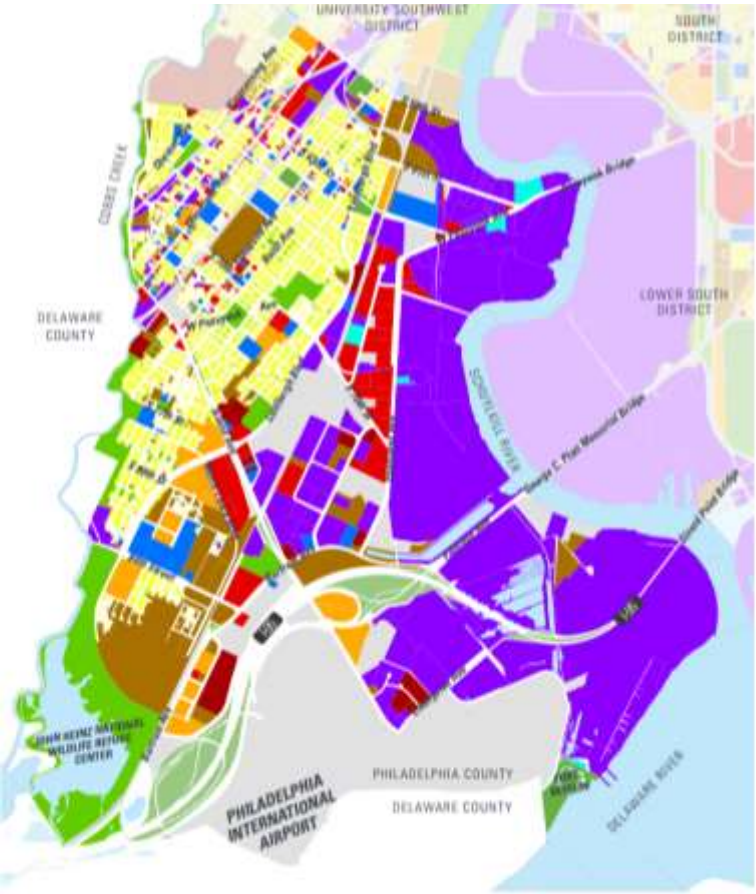
21.1.7.2 *Current and Future Land Use*

Zoning in the Lower Southwest District is varied, but is predominantly heavy industrial (I-3), medium industrial (I-2), and special airport zoning (SP-AIR), which collectively account for 61 percent of all zoning categories in the district. Multifamily residential and open space are the next most prevalent zoning classifications, followed by single family residential. Other commercial, light industrial and institutional classifications make up less than three percent each of total district zoning. Floodplain and airport hazard control areas complicate zoning, as both flooding and airport noise are considerations as development occurs.[446] The maps on the following page show the existing and proposed land use for the Lower Southwest Planning District.

---

[446] Philadelphia 2035: Lower Southwest District Plan 2016 (Draft). Philadelphia City Planning Commission. Retrieved May 13, 2016.

Lower Southwest Existing Land Use



Lower Southwest 2035 Proposed Land Use

RESIDENTIAL

- ■ Residential Single-Family Detached [RSD-1-3]
- ■ Residential Single-Family Attached [RSA-1-5]
- ■ Residential Two-Family Attached [RTA-1]
- ■ Residential Multi-Family Attached [RM-1-4]
- ■ Residential Mixed-Use [RMX-1-3]

COMMERCIAL

- ■ Auto Oriented Commercial [CA-1,2]
- ■ Neighborhood Commercial Mixed-Use [CMX-1, 2, 2.5]
- ■ Community Commercial Mixed-Use [CMX-3,4]
- ■ Center City Core Mixed-Use [CMX-5]

SPECIAL PURPOSE

- ■ Commercial Entertainment (Casinos) [SP-ENT]
- ■ Airport [SP-AIR]
- ■ Institutional Development [SP-INS]
- ■ Stadium [SP-STA]
- ■ Recreation [SP-PO-A, SP-PO-P]

INDUSTRIAL

- ■ Industrial Residential Mixed-Use [IRMX]
- ■ Industrial Commercial Mixed-Use [ICMX]
- ■ Light Industrial [I-1]
- ■ Medium Industrial [I-2]
- ■ Heavy Industrial [I-3]
- ■ Port Industrial [I-P]

21.1.7.3 Social Characteristics

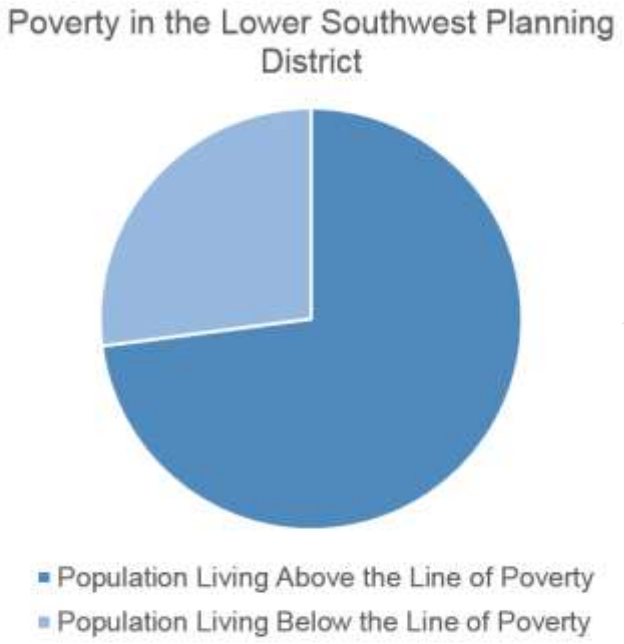
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

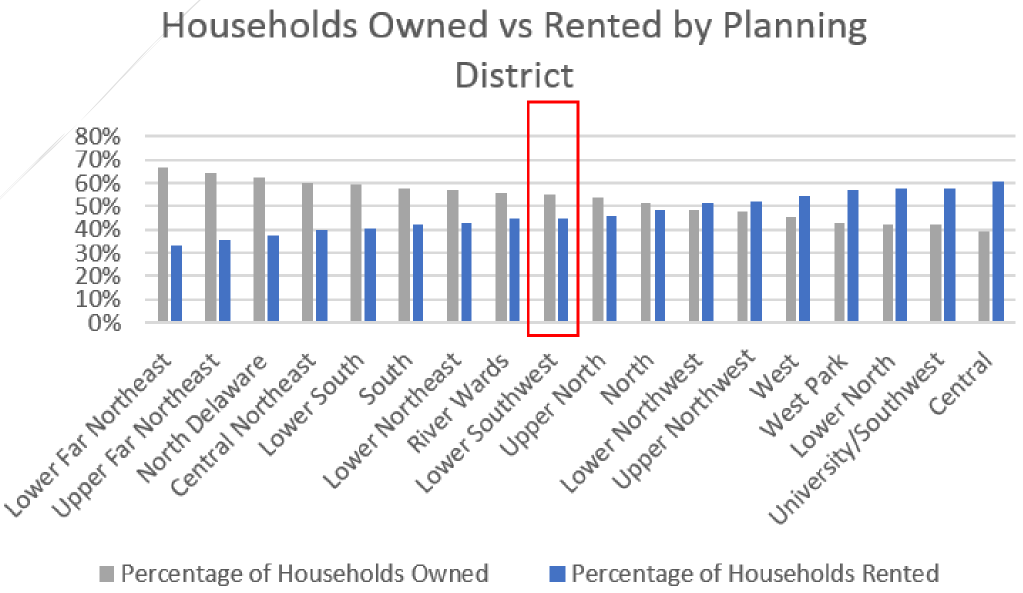
Population, Gender and Age Characteristics of the Lower Southwest Planning District	
Population	152,101
▪ Male population	69,601
▪ Female population	82,500
Median Age	38
Age dependency ratio (the percentage of the population under 15 and over 64)	62.4%
Population under 15	34.6%
Population over 64	27.8%

21.1.7.4 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Lower Southwest Planning District	
Number of households	123,472
▪ Households owned	48,278
▪ Households rented	75,194
No vehicle access	12,801
Population below the federal line of poverty	28.2%


Poverty in the Lower Southwest Planning District


Households Owned vs Rented by Planning District

21.1.7.5 Disability

Of those individuals residing within the Lower Southwest Planning District, 10.7 percent reported having a disability. The table below lists disabilities reported by individuals in the Lower Southwest Planning District by the percentage of the total population of the District. Disabilities are not exclusive, as some individuals may report having more than one disability type.

Disability Reported	Percentage of Population
Hearing difficulty	5.8%
Vision difficulty	6.1%
Cognitive difficulty	6.4%
Ambulatory Difficulty	6.4%
Self-care Difficulty	6.5%
Independent Living Difficulty	6.5%

21.1.7.6 *Lower Southwest Hazards*

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Lower Southwest Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[447] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[448] [449] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the Lower Southwest Planning District.[450]

Structurally Deficient Bridges in the Lower Southwest Planning District

Name	Location	Year Built
COBBS CREEK	Church Lane 0.5 miles south of US-13	1949
SEPTA (AHSL)	70th St at Lindbergh Blvd	1980
CSX TRANSPORTATION	Cemetery Ave	1886
SEPTA (AHSL)	61st St and Eastwick Ave	1928
AMTRAK (NE Corridor)	62nd St and South Paschall Ave	1910
AMTRAK (NE Corridor)	72nd St and South Paschall Ave	1913
CSX	68th St at Kingsessing St	1926

---

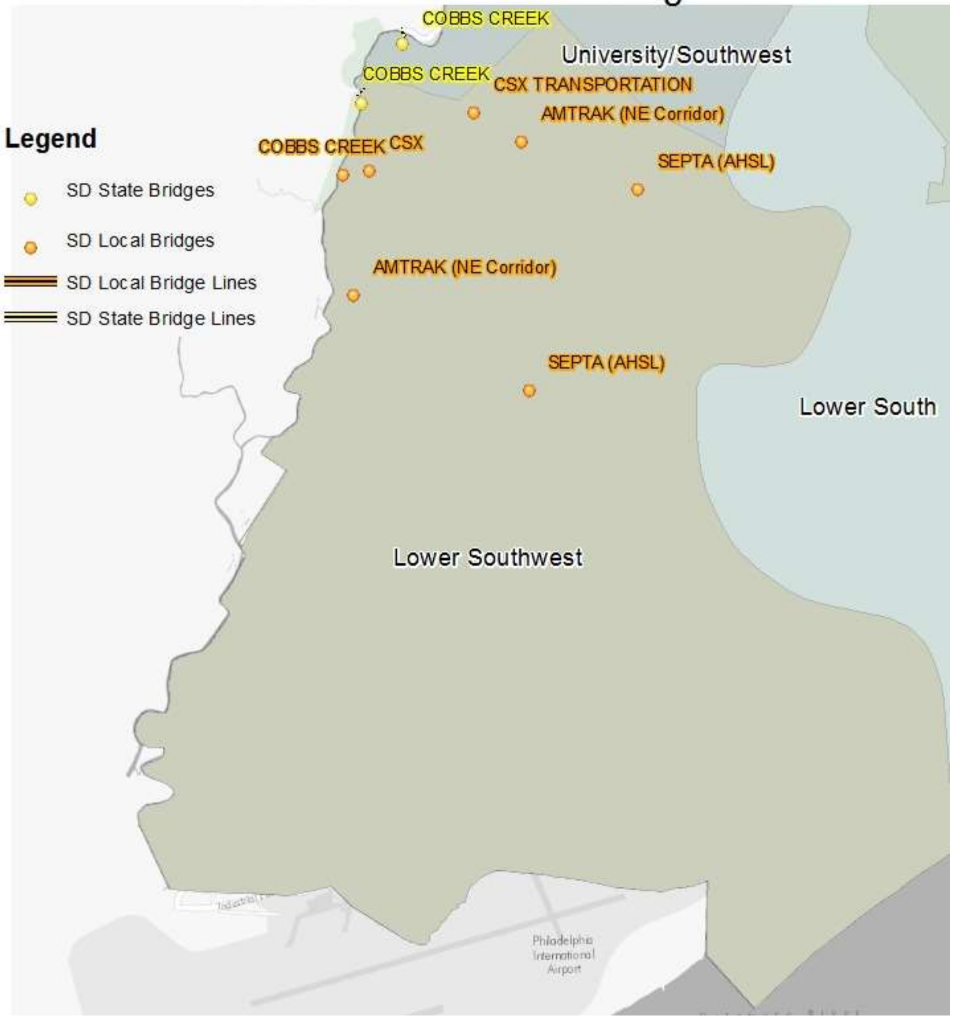
[447] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[448] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[449] Ibid.

[450] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the Lower Southwest Planning District



Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. There are no dams in the Lower Southwest Planning District.

Building Collapse

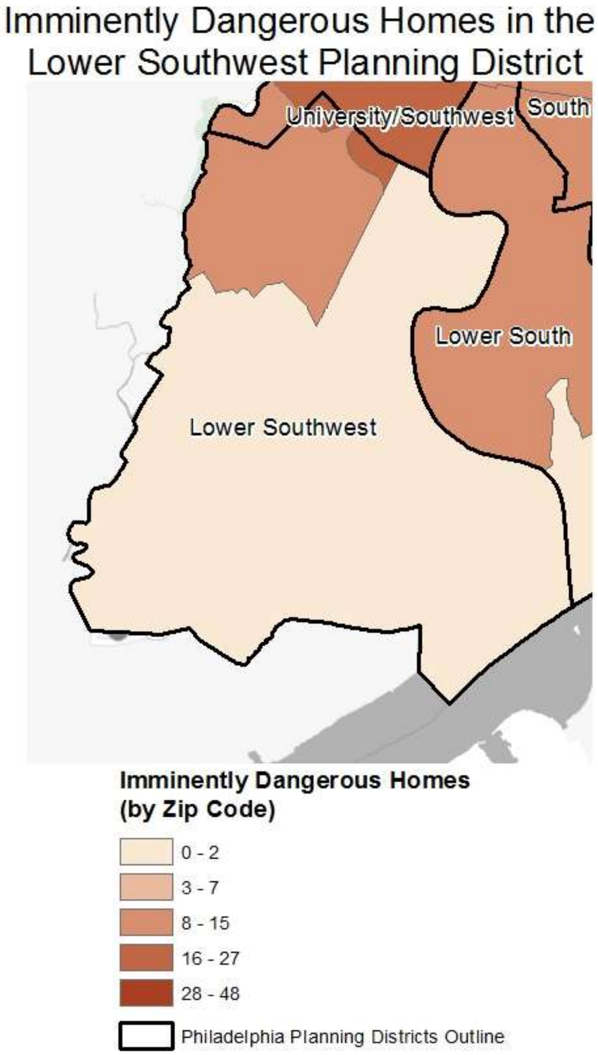
Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the Lower Southwest Planning District built before 1939.

Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map below shows the number of vacant properties in the Lower Southwest Planning District.

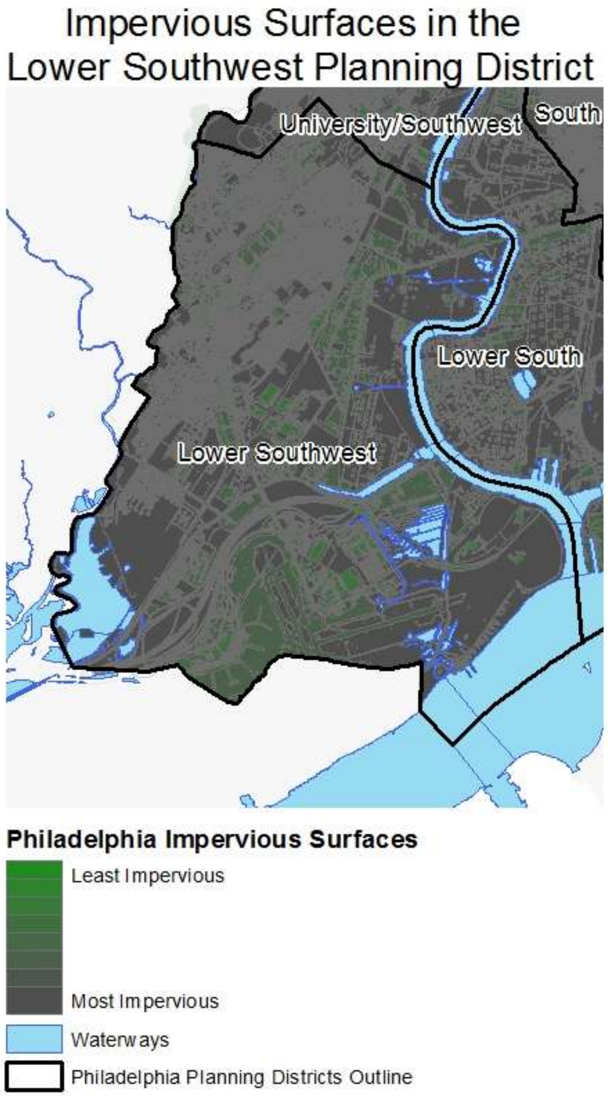
Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the Lower Southwest Planning District.



Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[451] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[452] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Lower Southwest Planning District.



Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[453] As the map shows, the Lower Southwest is not located in the areas which experience

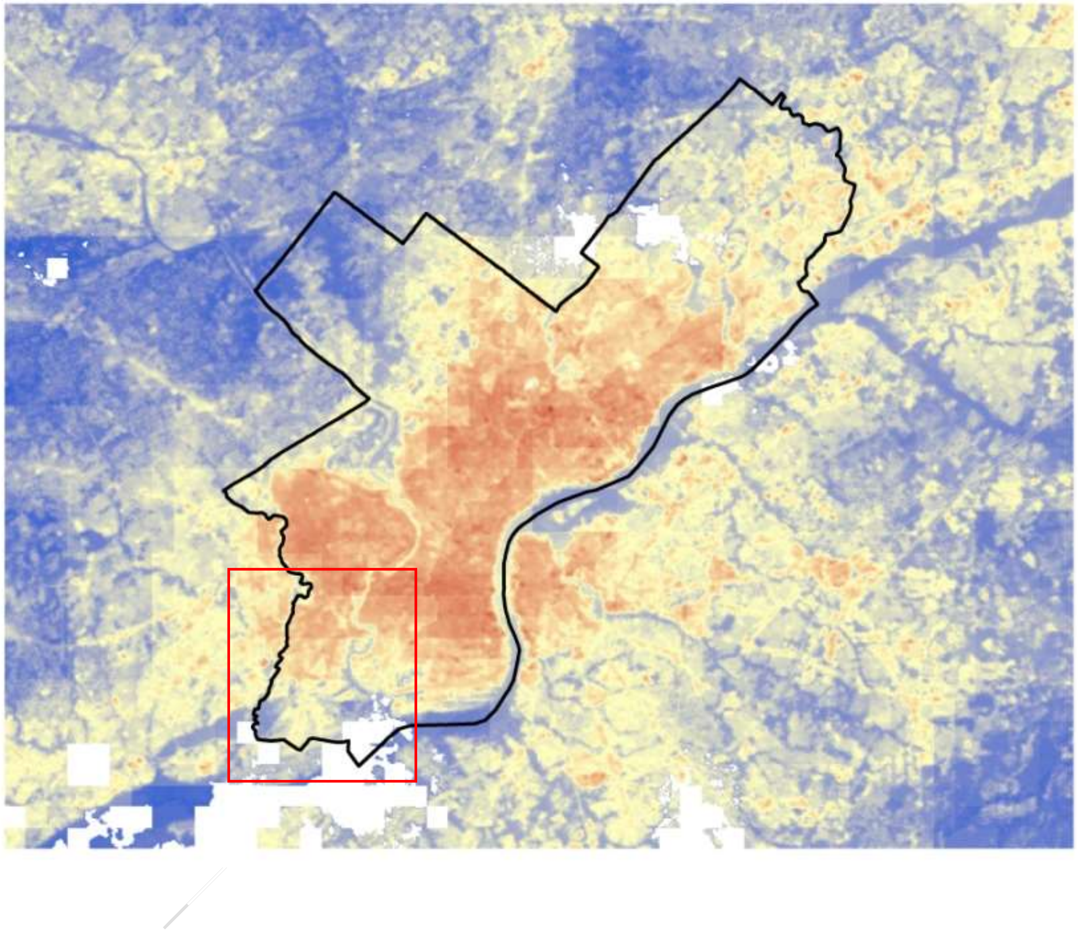
---

[451] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.

[452] “Heat Island Effect”. US EPA. Retrieved March 3, 2016.

[453] “Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002”. URSA. Retrieved March 7, 2016.

the highest heat island effects, but the Lower Southwest still feels some of the effects of such an event more than the surrounding counties.



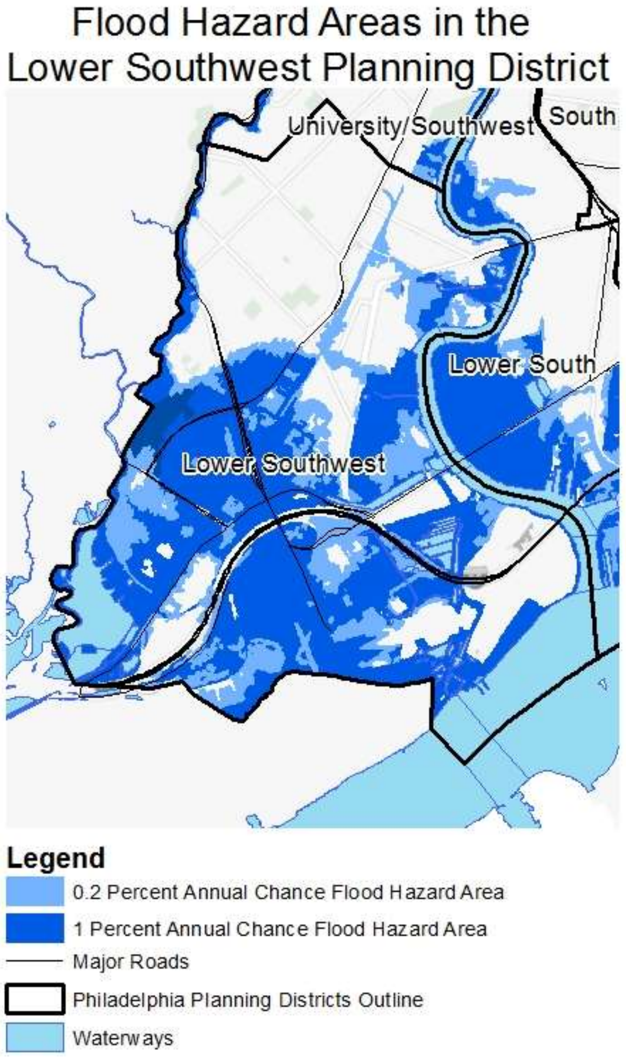
Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[454]

Winter flooding includes 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. All forms of flooding can damage infrastructure.[455] For more



Flood Hazard Areas in the Lower Southwest Planning District

---

[454] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

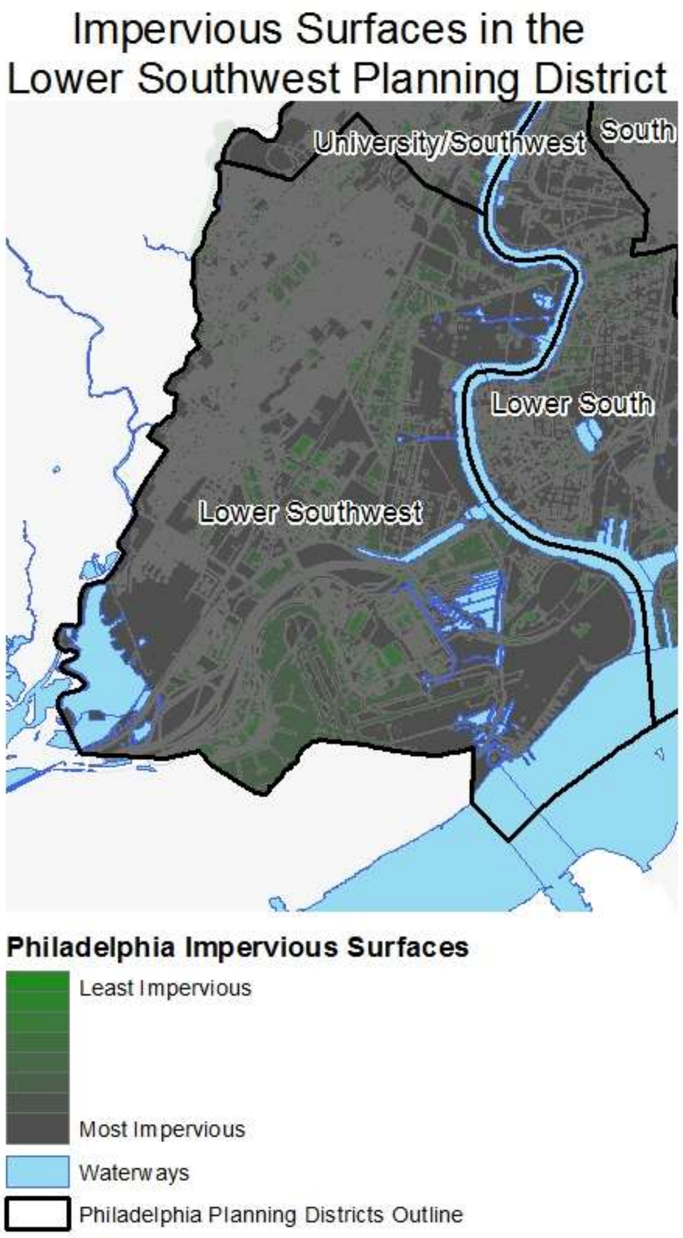
[455] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

The majority of the Lower Southwest Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event, with the majority of flooding caused by riverine flooding rather than surface flooding. The map above shows the one and 0.2 percent annual percent flood hazard areas.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the Lower Southwest Planning District there are 874 of policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

Flash flooding is also a concern for some areas of the Lower Southwest Planning District. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Lower Southwest Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



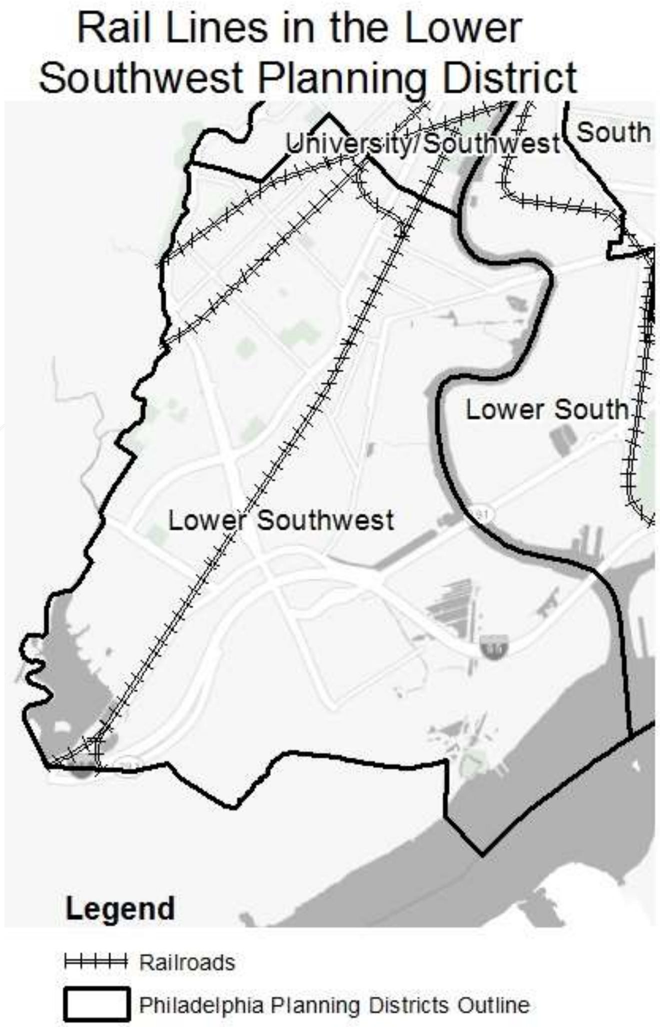
Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[456]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see [Hazardous Material Train Derailment]() under the [Risk Assessment]() section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.



Rail Lines in the Lower Southwest Planning District

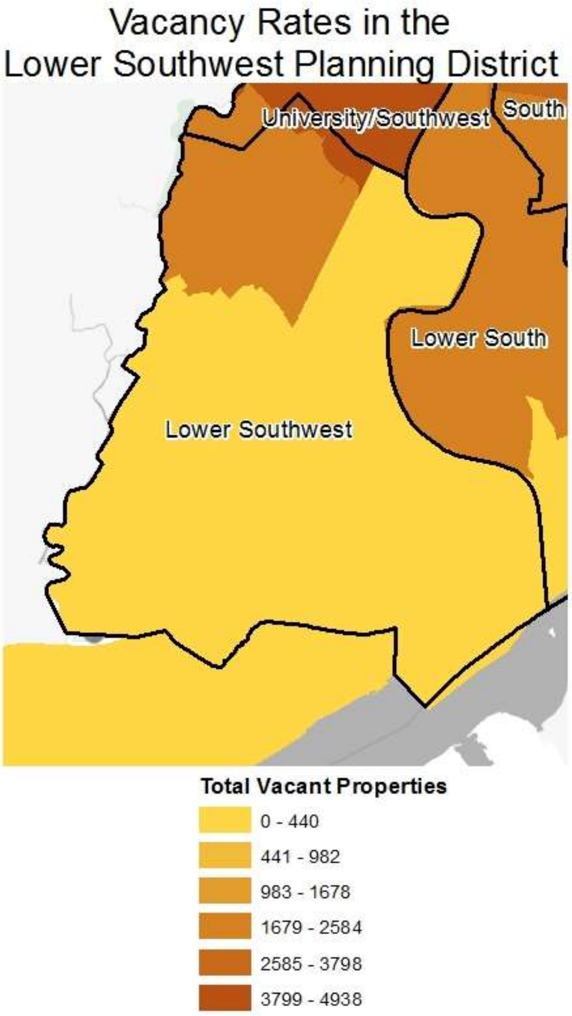
---

[456] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[457] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

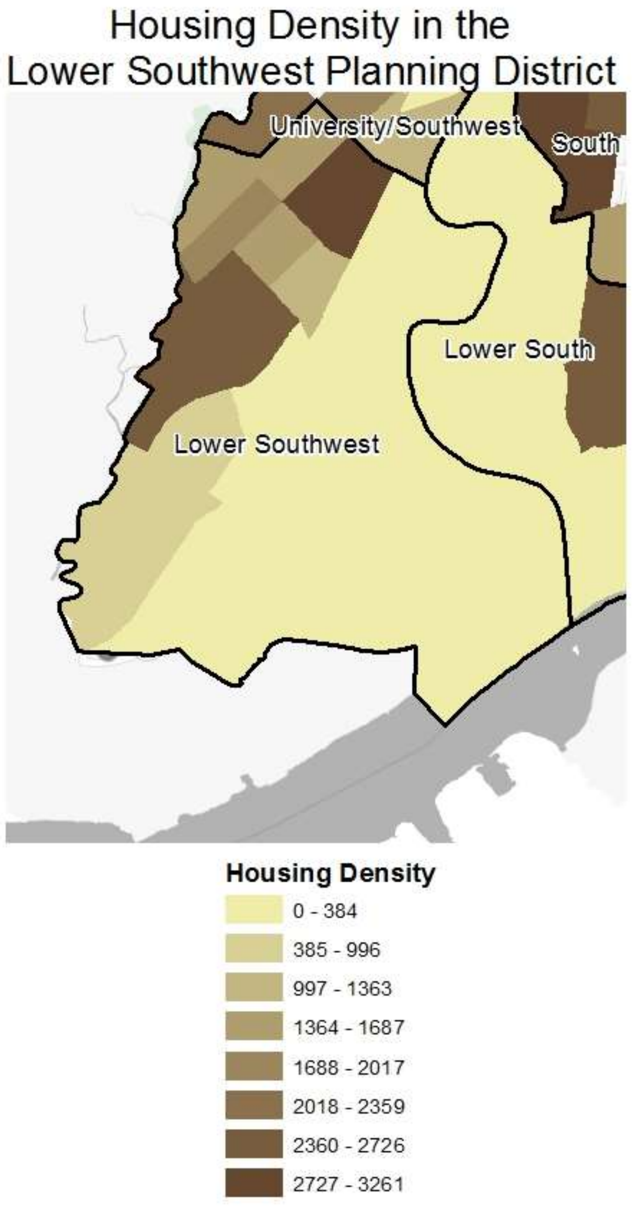
Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[458] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The Lower Southwest Planning District has comparatively fewer vacant properties than many other parts of Philadelphia, and therefore has a slightly lower risk for urban conflagration.


Vacancy Rates in the Lower Southwest Planning District

---

[457] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.
[458] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose several risks for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. This increases the risk of urban conflagration. Density mapping assists in the identification of densely built environments. The map to the right depicts the Lower Southwest Planning District’s housing density. The Lower Southwest has pockets of higher housing density in the northwest portion of the district.

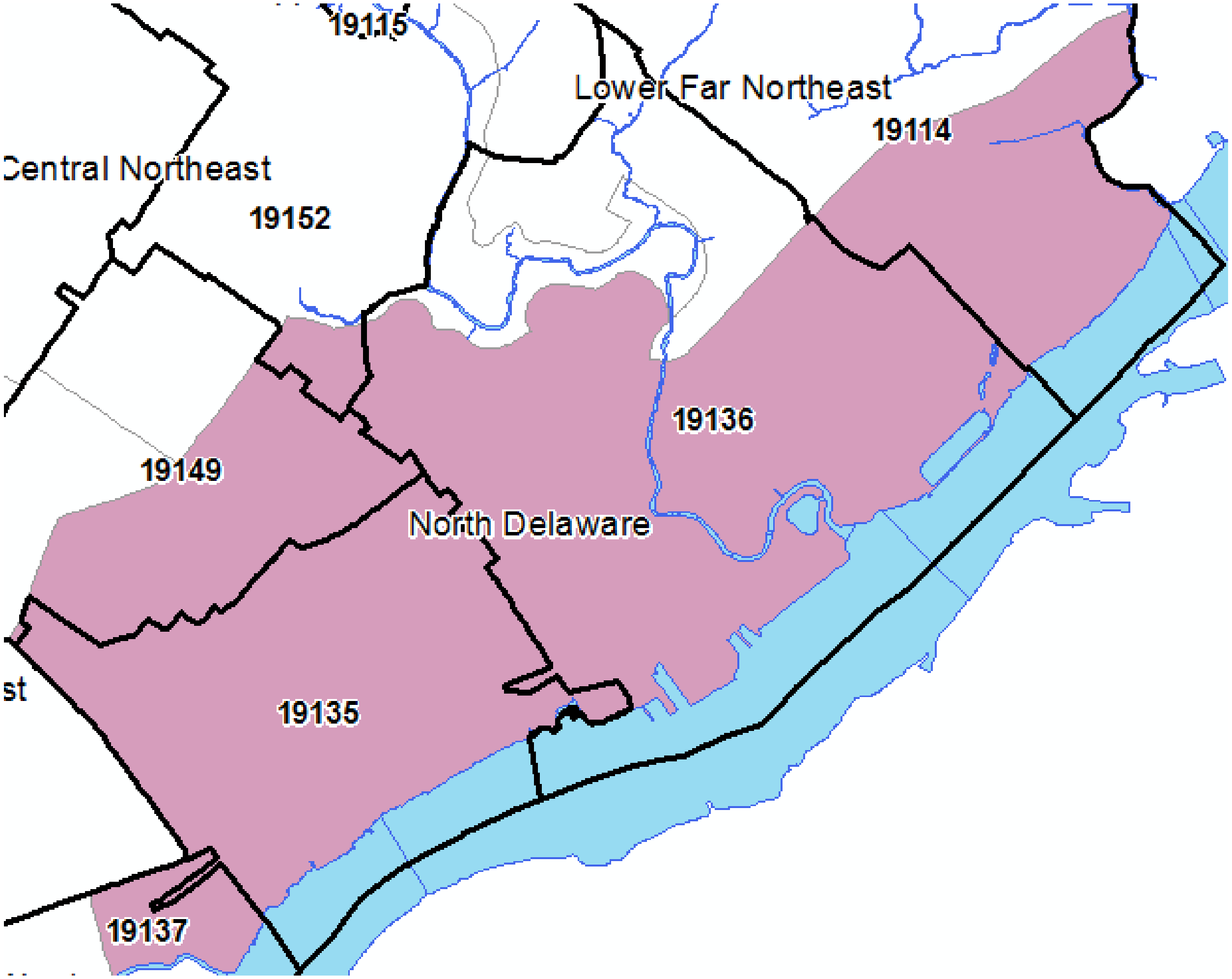


21.1.8 North Delaware

21.1.8.1 Geography and Hydrology

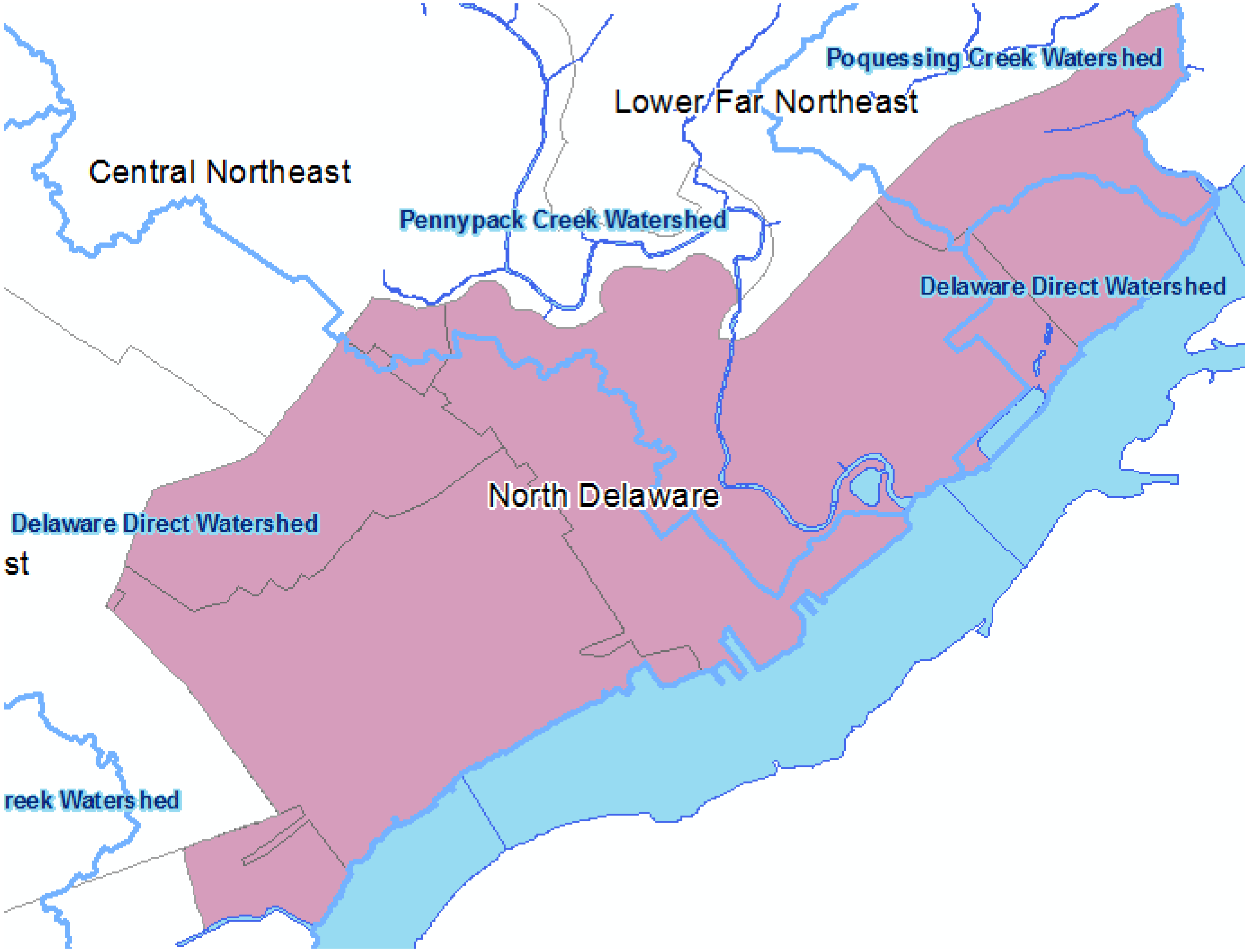
The North Delaware Planning District contains addresses in the zip codes 19136, 19149, 19152, 19111, and 19115.

Zip codes in the North Delaware Planning District



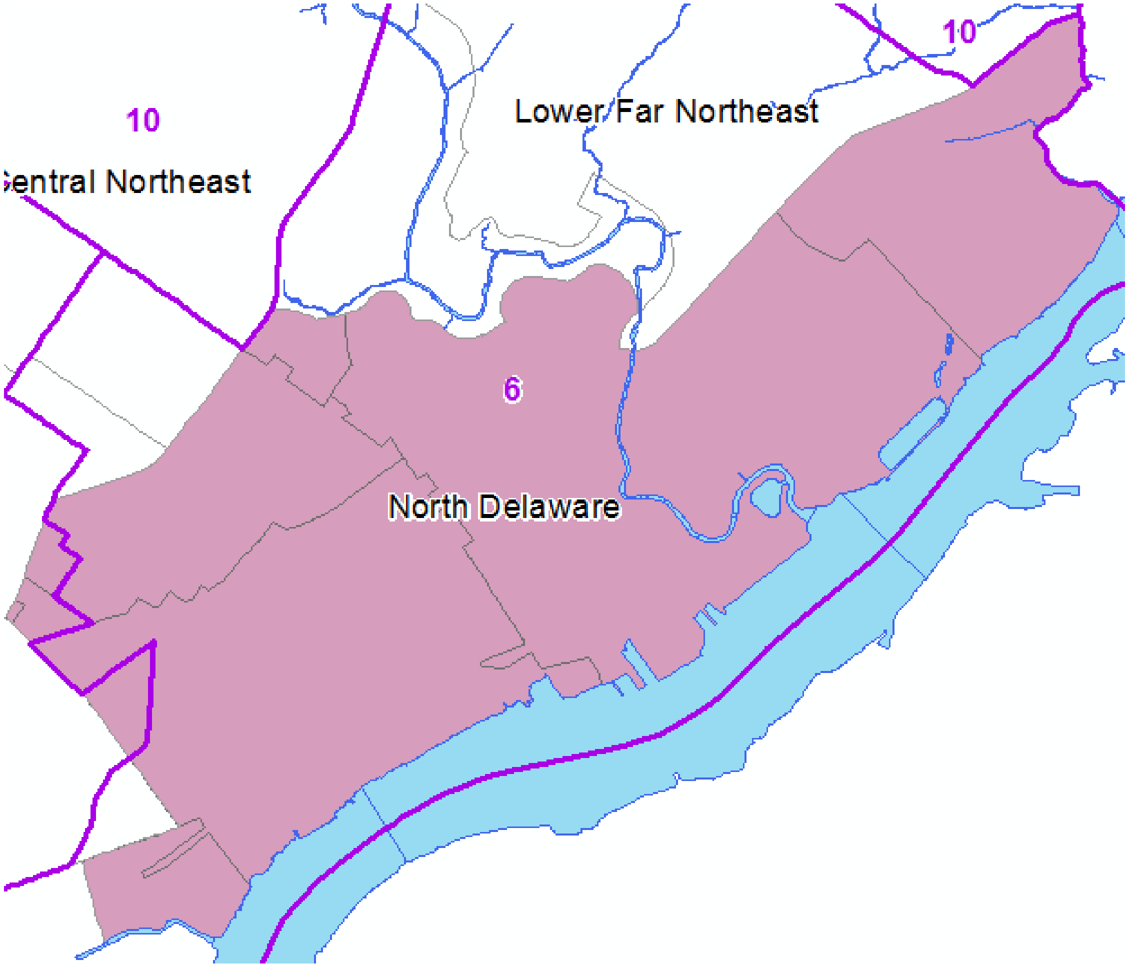
The North Delaware planning district falls partially in the Delaware Direct, Pennypack Creek, and Tookany/Tacony-Frankford Watersheds.

Watersheds in the North Delaware Planning District



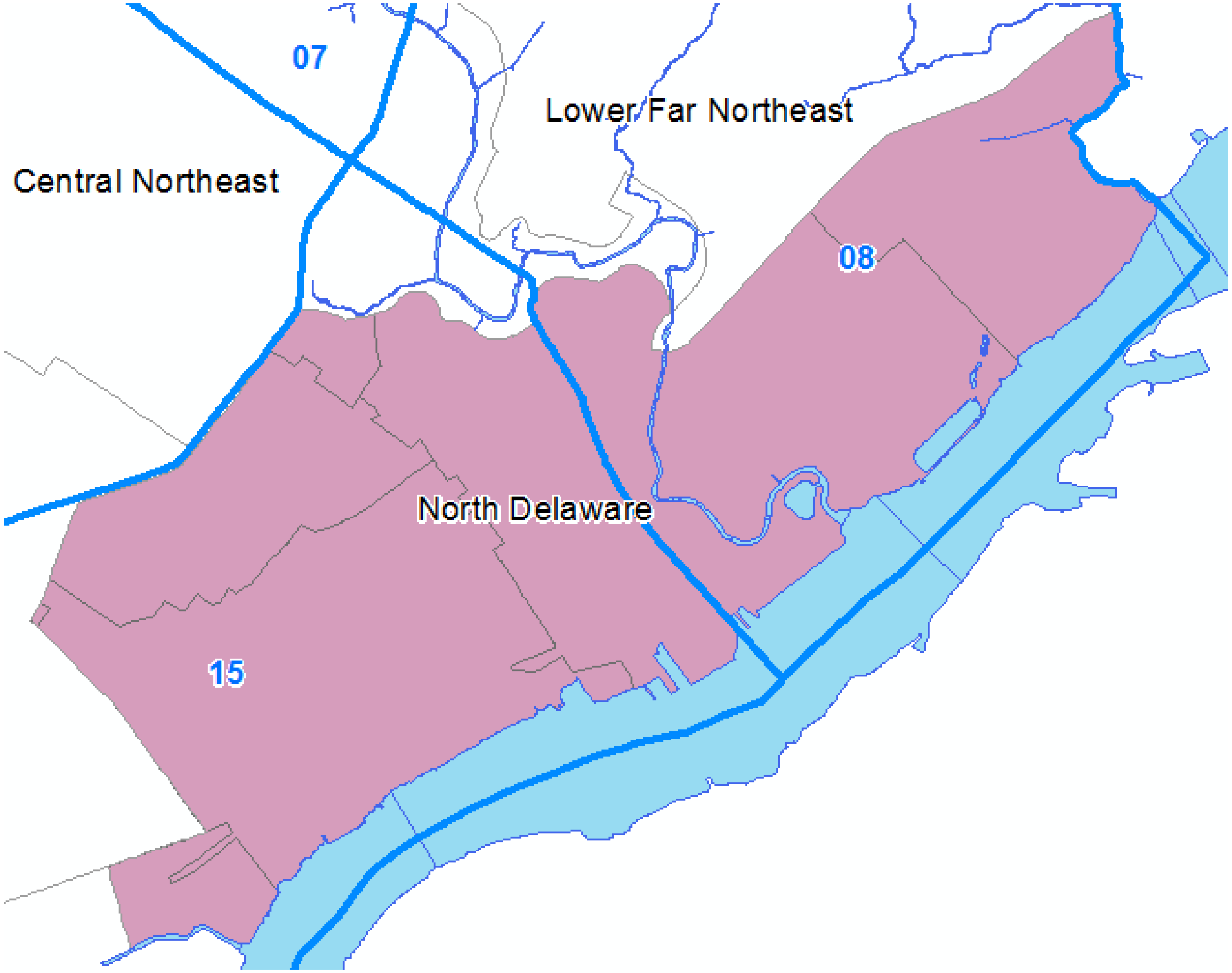
The North Delaware Planning District resides largely within the 6th Council District of Philadelphia.

Council Districts in North Delaware Planning District



The North Delaware Planning District falls mostly within the 8th and 15th Police Districts.

Police Districts in the North Delaware Planning District



21.1.8.2 Social Characteristics

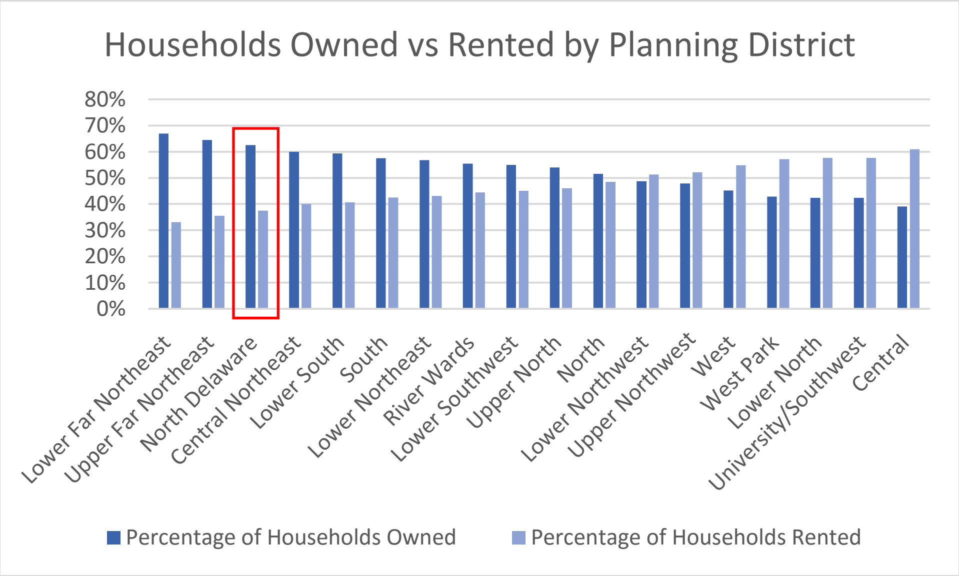
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

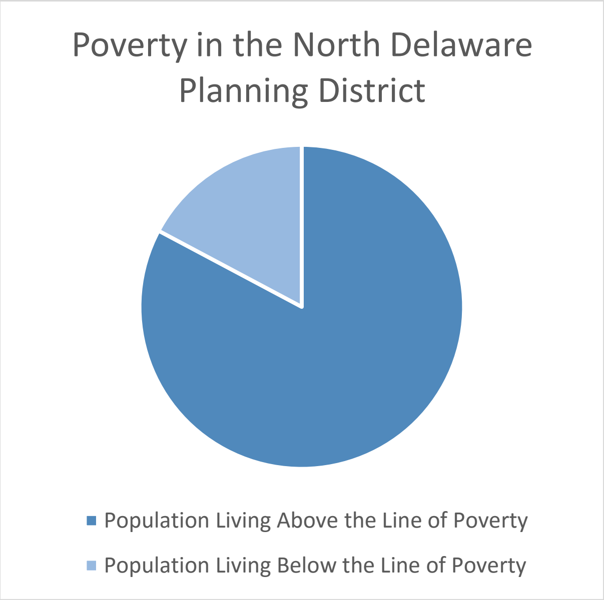
Population, Gender and Age Characteristics of the North Delaware Planning District	
Population	195,791
- Male population	95,334
- Female population	100,457
Median Age	37.6
- Age dependency ratio (the percentage of the population under 15 and over 64)	57.6%
- Population under 15	35.5%
- Population over 64	22.1%

21.1.8.3 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the North Delaware Planning District	
Number of households	70,801
- Households owned	44,231
- Households rented	26,570
No vehicle access	11,432
Population below the federal line of poverty	16.8%





21.1.8.4 Disability

Of those individuals residing within the North Delaware Planning District, 15.4 percent reported having a disability. Disabilities reported by individuals in the North Delaware Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	**Percentage of Population**
Hearing difficulty	6.5%
Vision difficulty	6.8 %
Cognitive difficulty	7.5%
Ambulatory Difficulty	7.5%
Self-care Difficulty	7.5%
Independent Living Difficulty	7.5%

21.1.8.5 North Delaware Northeast Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the North Delaware Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

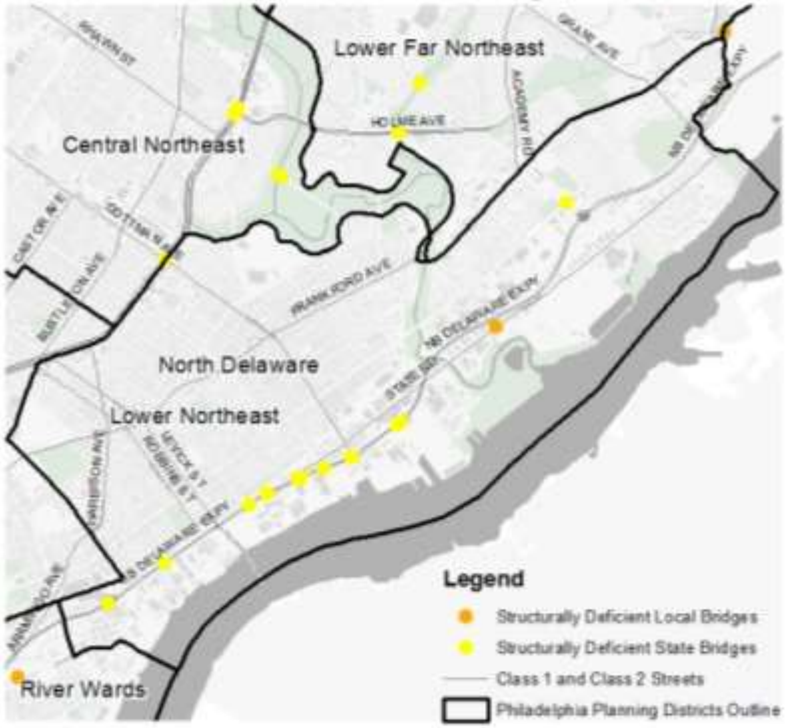
Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[459] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A “structurally deficient bridge” typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[460] [461] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the North Delaware Planning District.[462]

Structurally Deficient Bridges in the North Delaware Planning District



---

[459] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[460] 2010 Status of the Nation’s Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

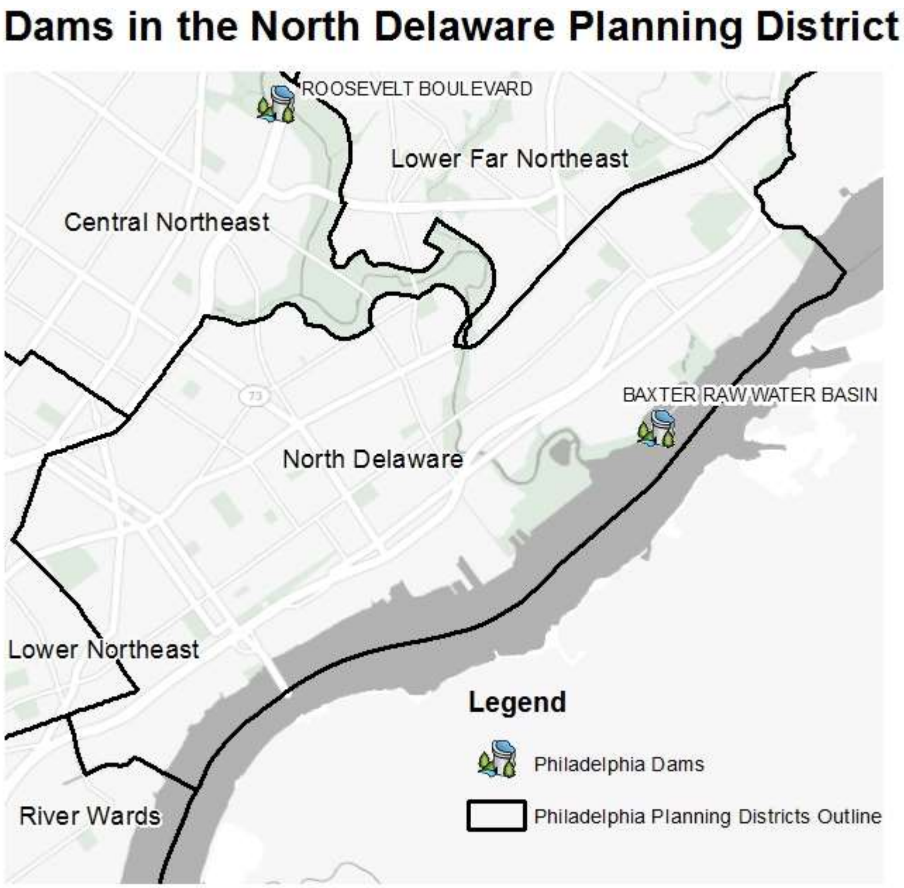
[461] Ibid.

[462] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the North Delaware Planning District		
Name	**Location**	**Year Built**
Delaware Expressway (I-95)	Delaware Expressway (I-95) at Ashburner St	1964
Delaware Expressway (I-95)	Delaware Expressway (I-95) near Bridge St	1967
Delaware Expressway (I-95)	Delaware Expressway (I-95) near Van Kirk St	1967
Delaware Expressway (I-95)	Delaware Expressway (I-95) near Magee Ave	1966
Delaware Expressway (I-95) On-Ramp	Delaware Expressway (I-95) at Princeton Ave	1966
Roosevelt Blvd	Roosevelt Blvd at Cottman Ave	1967
Ramp C	Delaware Expressway (I-95) near Cottman Ave	1966
Academy Road	Academy Rd and Torresdale Ave	1964
Delaware Expressway (I-95)	Delaware Expressway (I-95) near Magee Ave	1966
Delaware Expressway (I-95)	Delaware Expressway (I-95) and Unruh Ave	1966
Delaware Expressway (I-95) Ramp B (Cottman Ave)	Delaware Expressway (I-95) near Bleigh Ave	1966
Delaware Expressway (I-95) Ramp C	Delaware Expressway (I-95) and Cottman Ave	1966

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see [Dam Failure]() under the [Risk Assessment]() section of the 2017 Hazard Mitigation Plan. The table below shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.



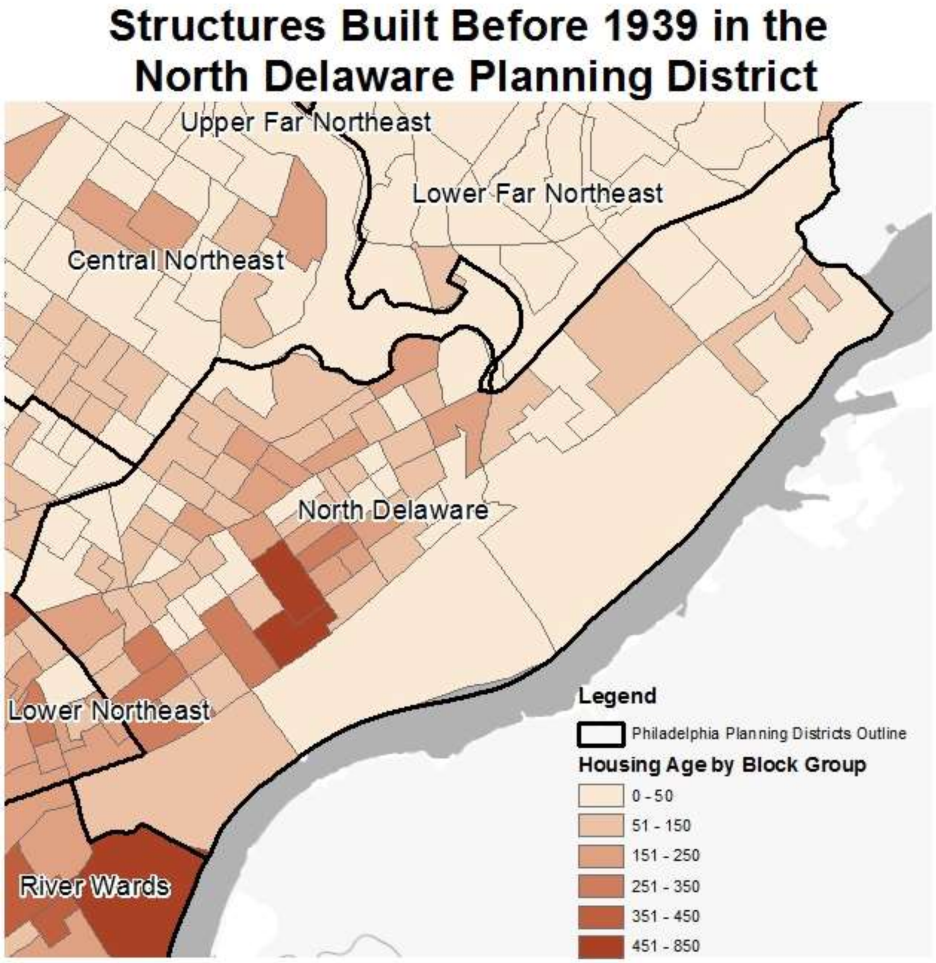
Dam Name	Waterway	High Hazard?	Permitted Owner
Baxter Raw Water Basin	Delaware River Watershed	No	Philadelphia Water Department

Building Collapse

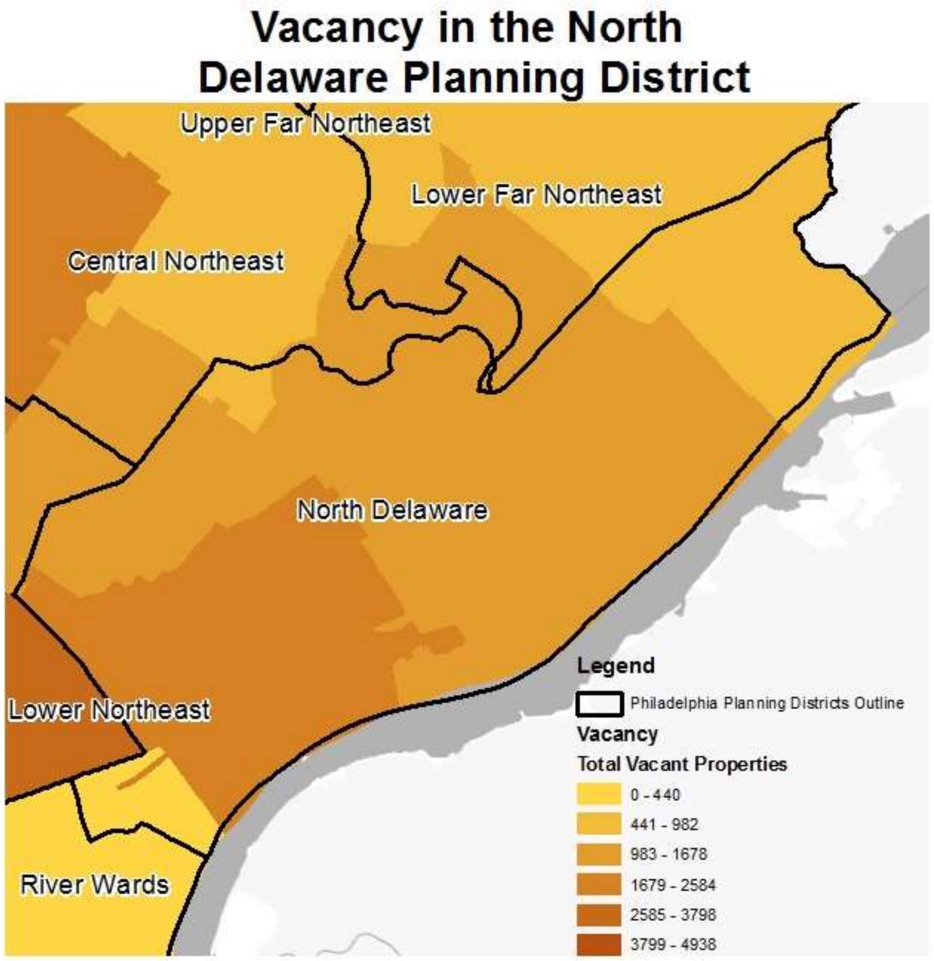
Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

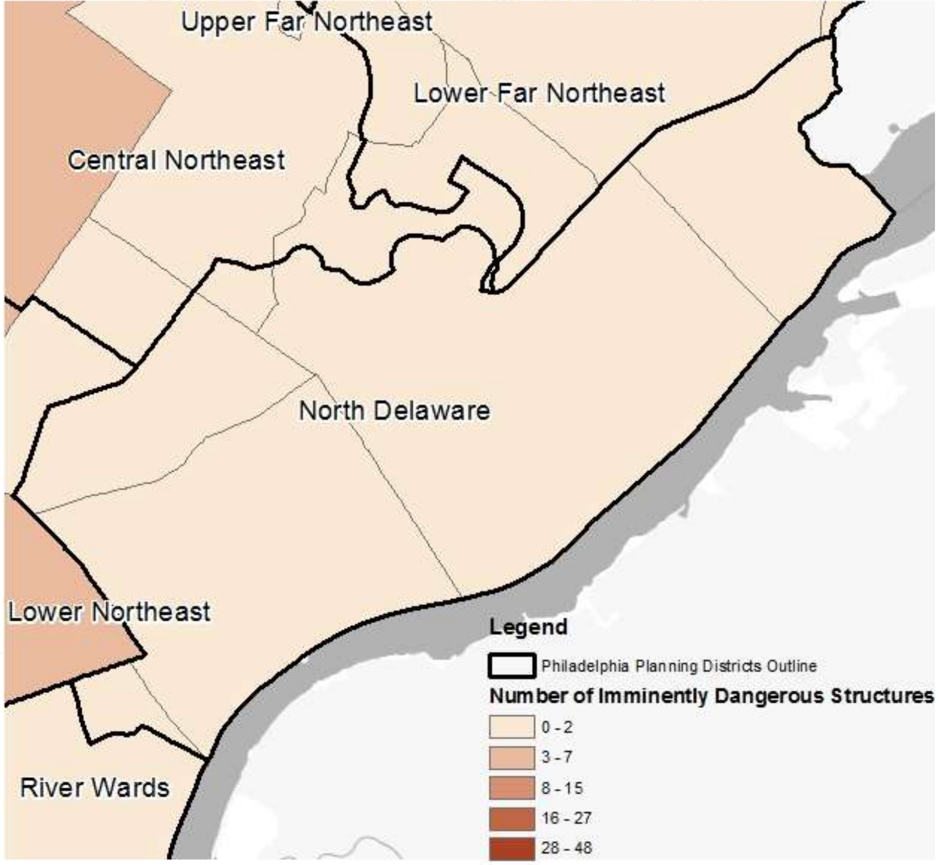
Building age increases the risk of collapse. The map to the right shows the number of properties built in the North Delaware Planning District built before 1939.



Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the North Delaware Planning District.



Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the North Delaware Planning District.

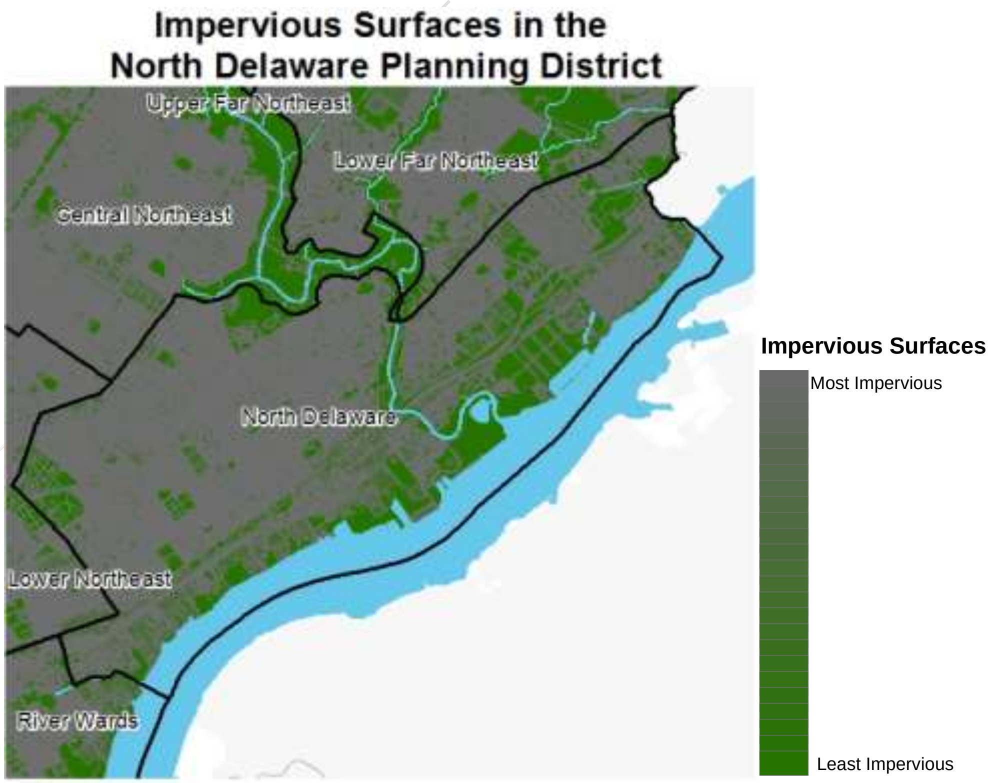


Immenently Dangerous Structures in the North Delaware Planning District

Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[463] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

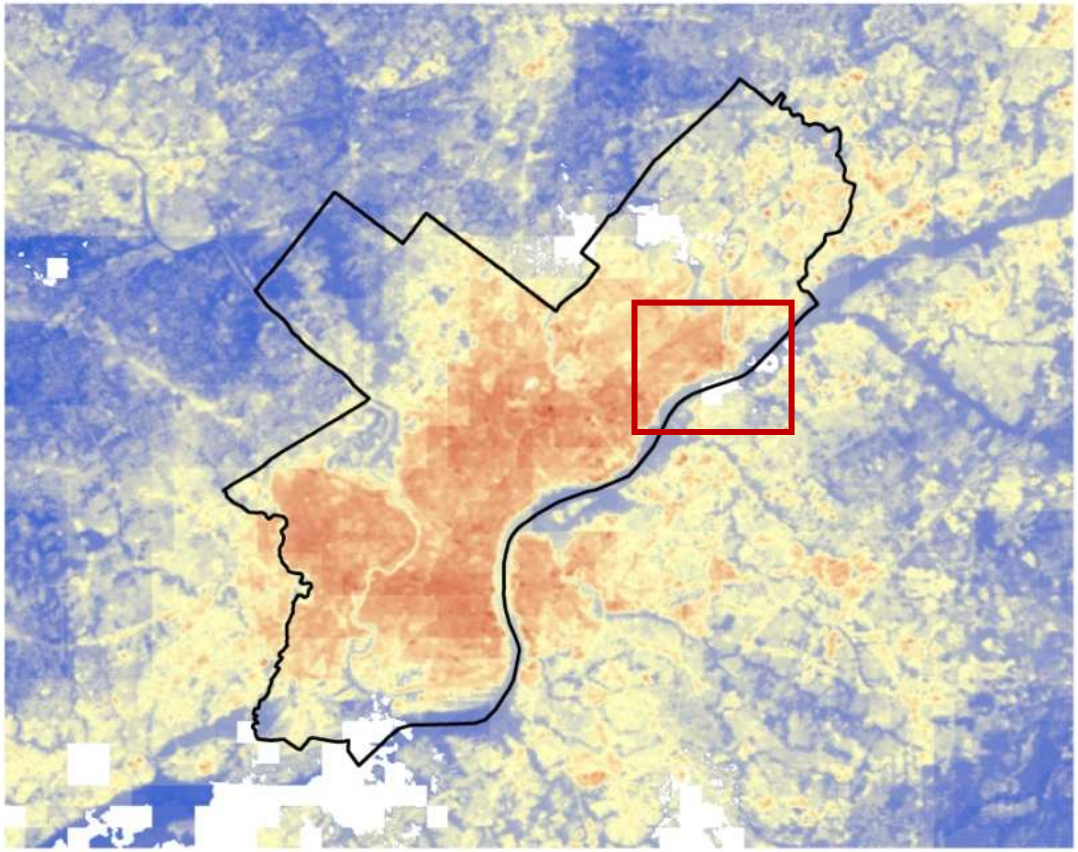
Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[464] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the North Delaware Planning District.



---

[463] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[464] "Heat Island Effect". US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[465] As the map shows, the North Delaware is not located in the areas which experience the highest heat island effects, but the North Delaware still feels some of the effects of such an event more than the surrounding counties.



---

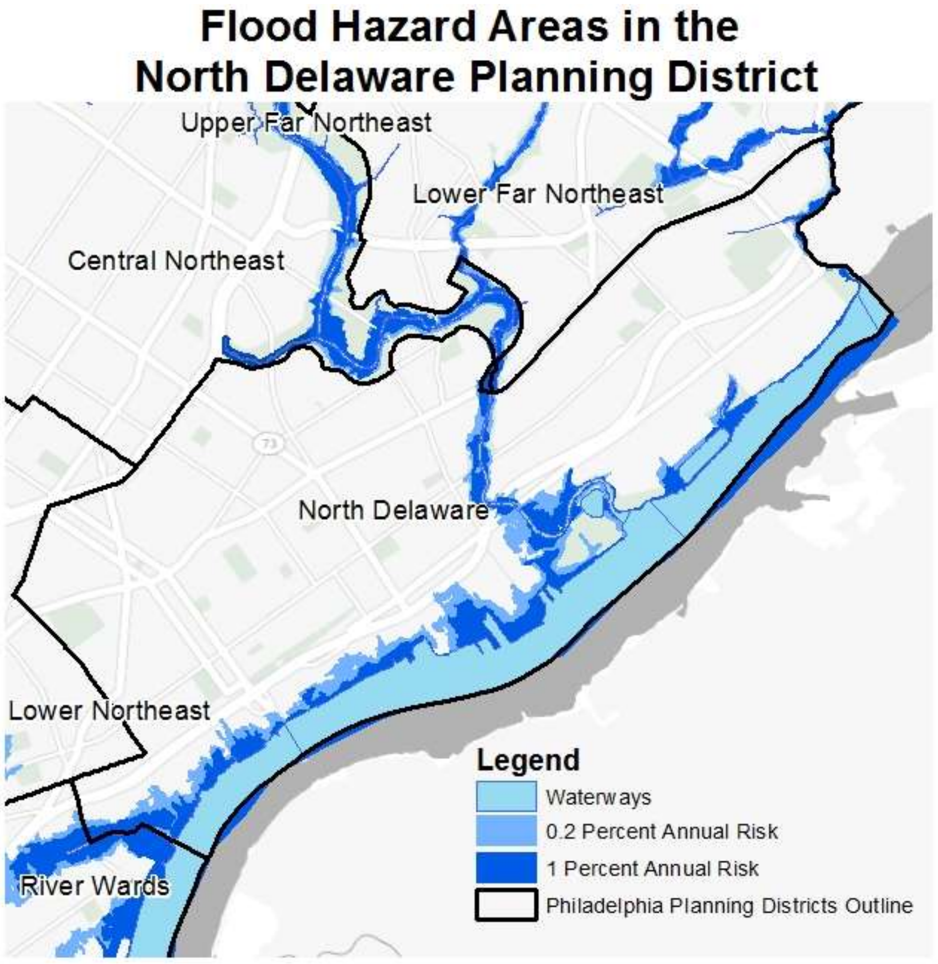
[465] “Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002”. URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[466]



Flood Hazard Areas in the North Delaware Planning District

---

[466] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Winter flooding includes 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. All forms of flooding can damage infrastructure.[467] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

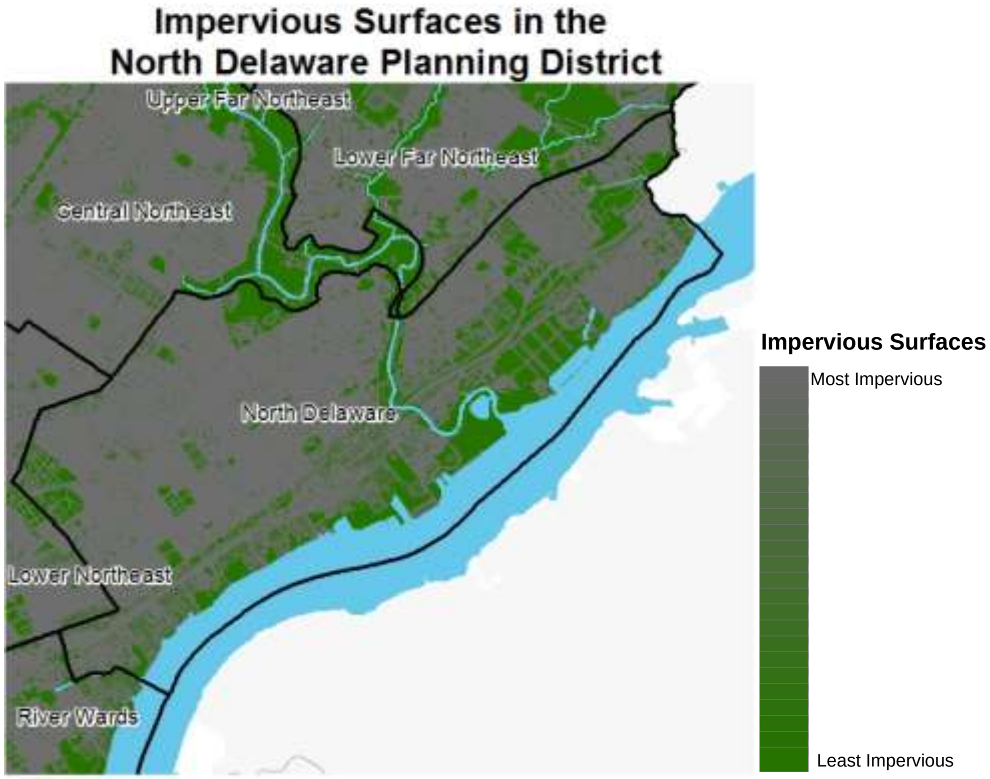
A small portion of the North Delaware Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the North Delaware Planning District there are 14 National Flood Insurance Program (NFIP) policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

---

[467] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Flash flooding is a concern for some areas of the North Delaware Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the North Delaware Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Impervious Surfaces in the North Delaware Planning District

Hazardous Material Train Derailment

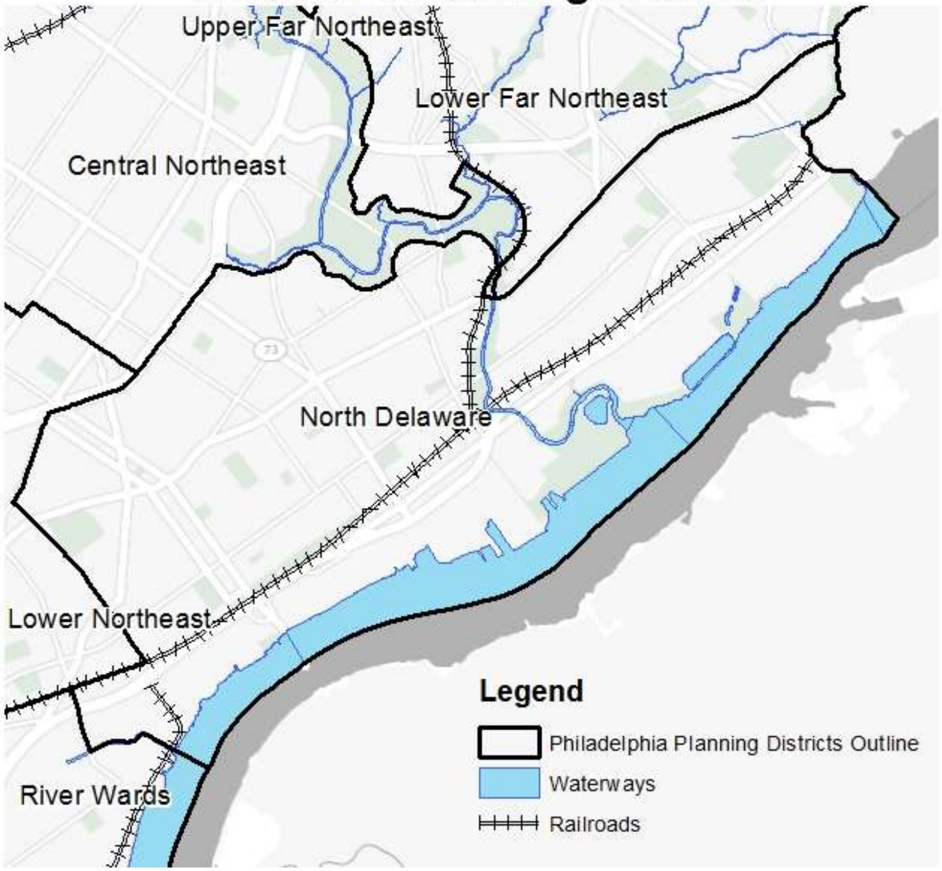
Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[468]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the North Delaware Planning District



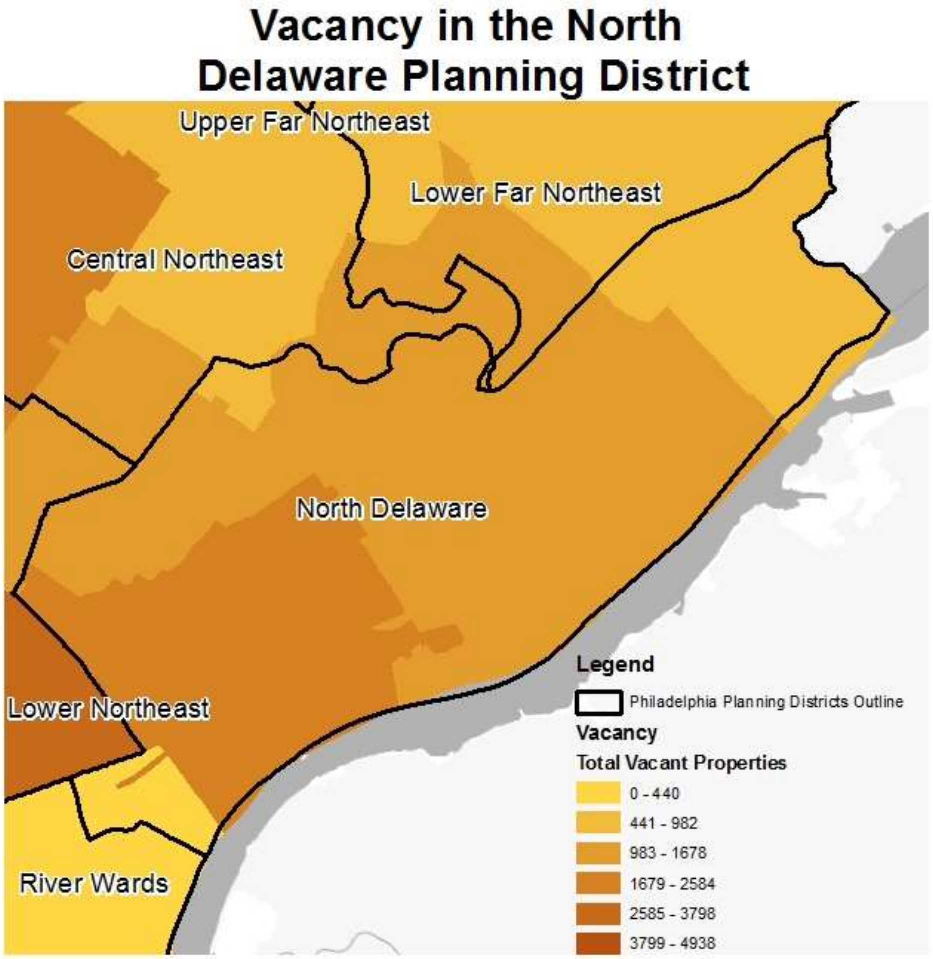
---

[468] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[469] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

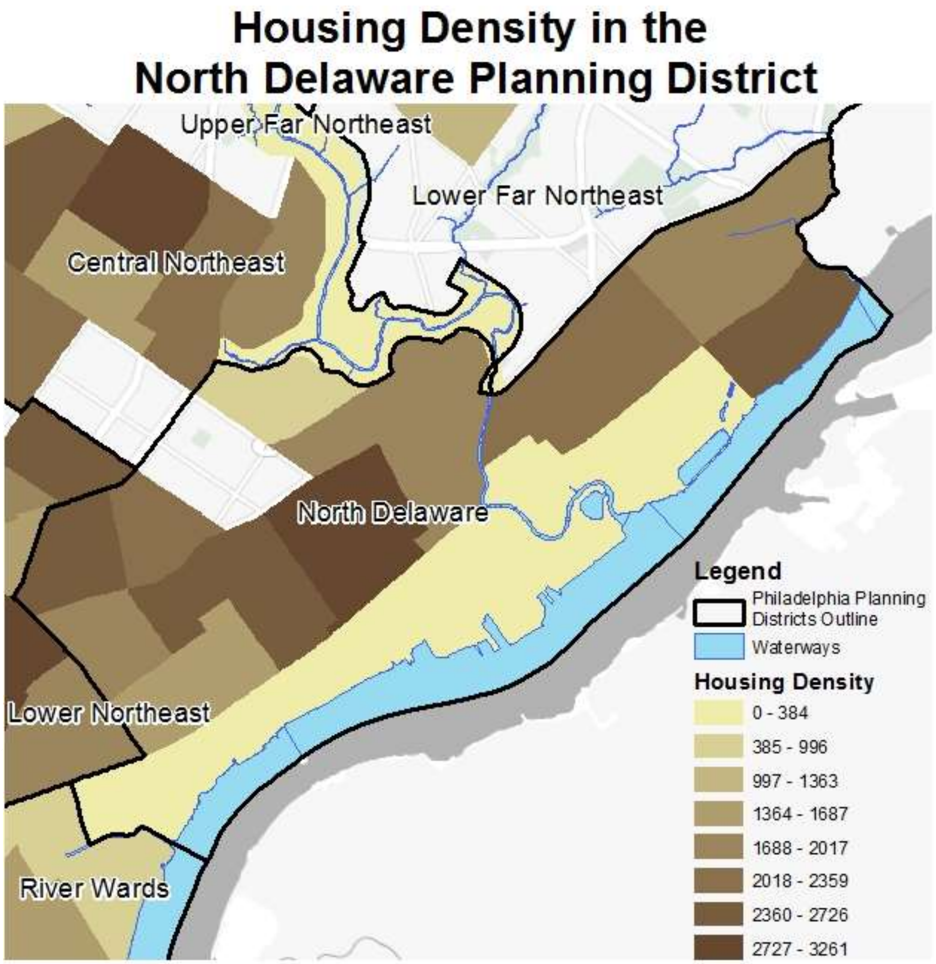
Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[470] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The North Delaware Planning District has comparatively fewer vacant properties than many other parts of Philadelphia, and therefore has a slightly lower risk for urban conflagration.



---

[469] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.
[470] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the North Delaware Planning District's housing density. Data was unavailable for those portions of the map left uncolored.



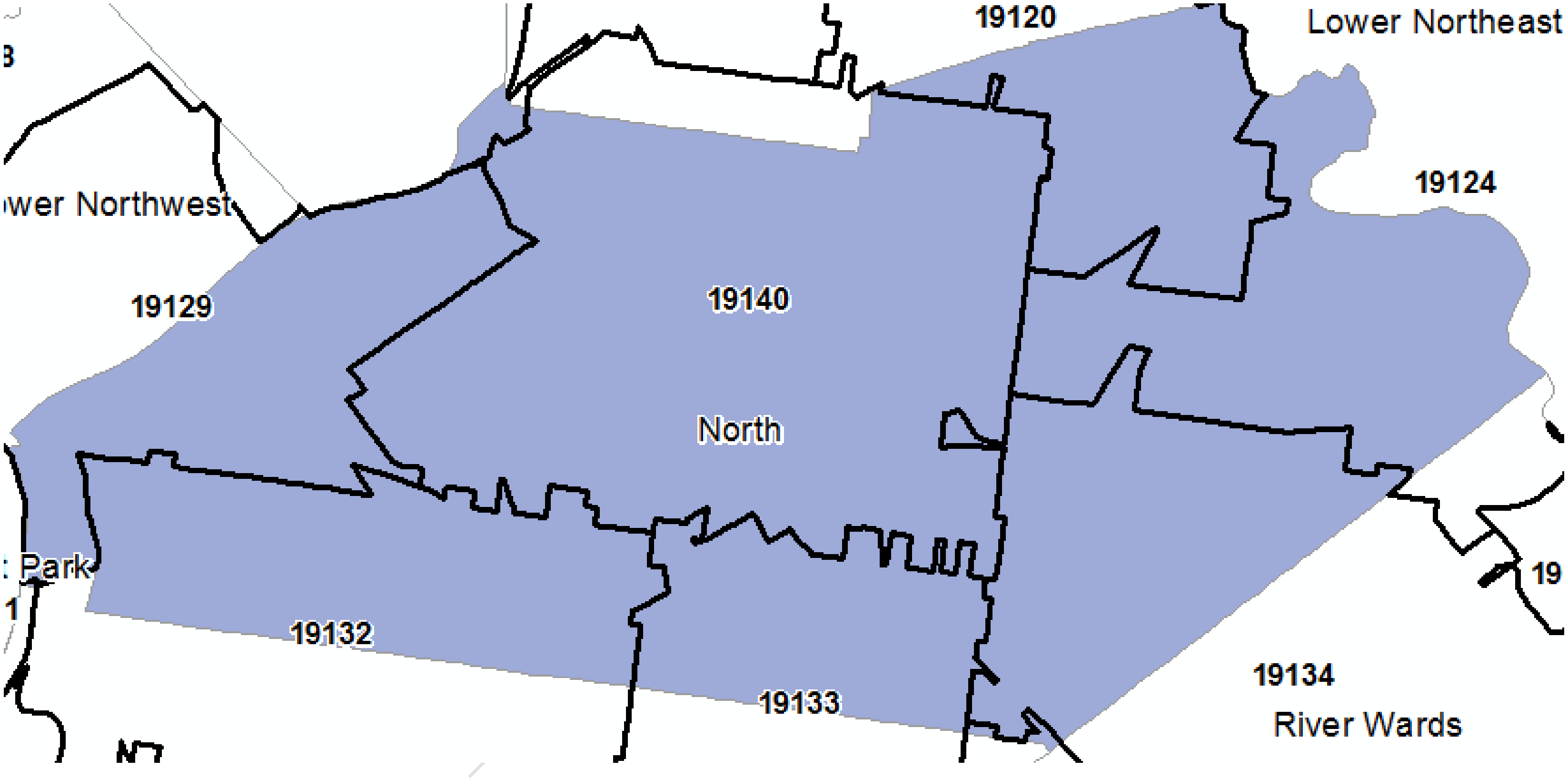
Housing Density in the North Delaware Planning District

21.1.9 ***<u>North</u>***

21.1.9.1 Geography and Hydrology

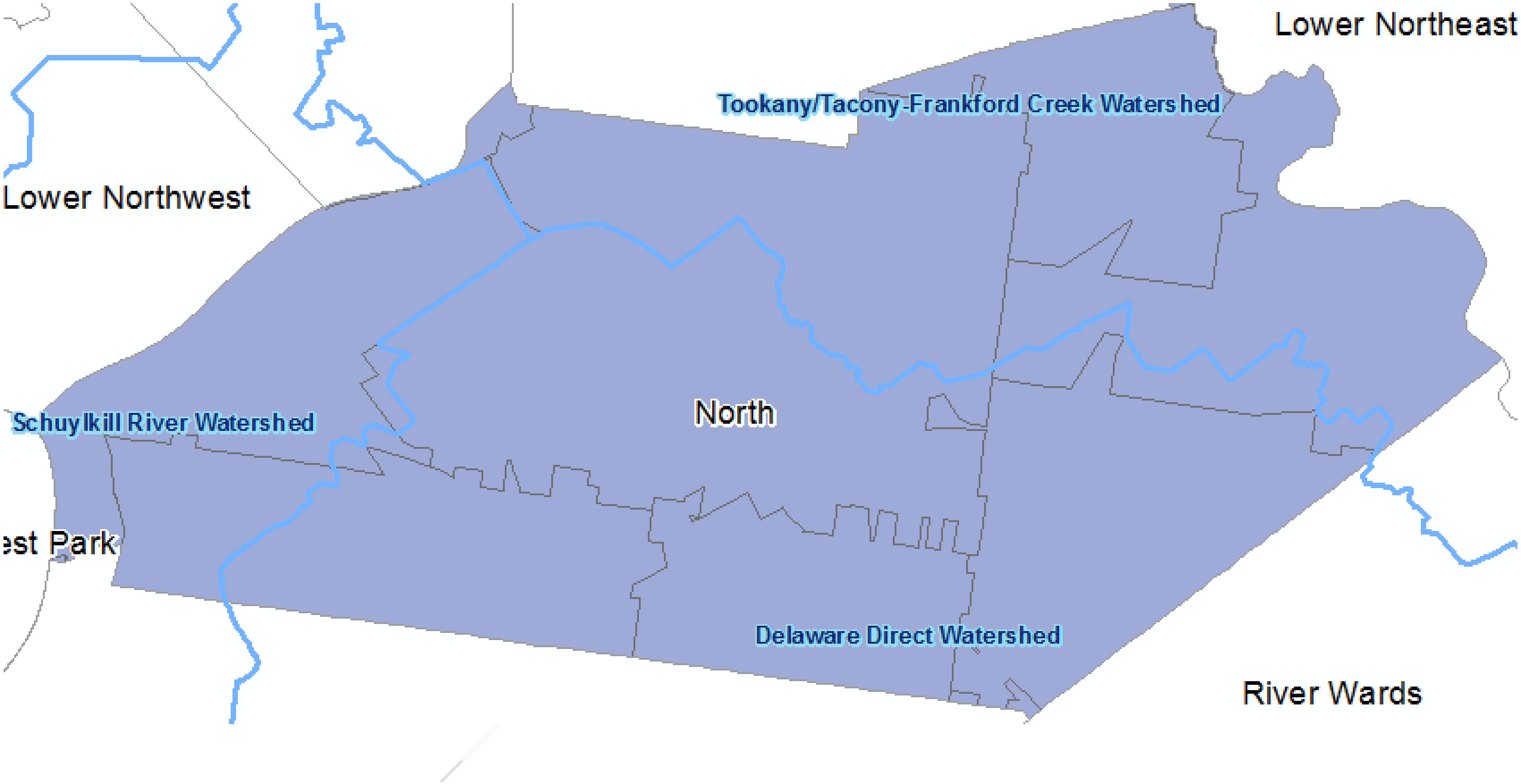
The North Planning District contains addresses in the zip codes 19129, 19132, 19140, 19133, 19134, 19120, and 19124.

Zip codes in the North Planning District



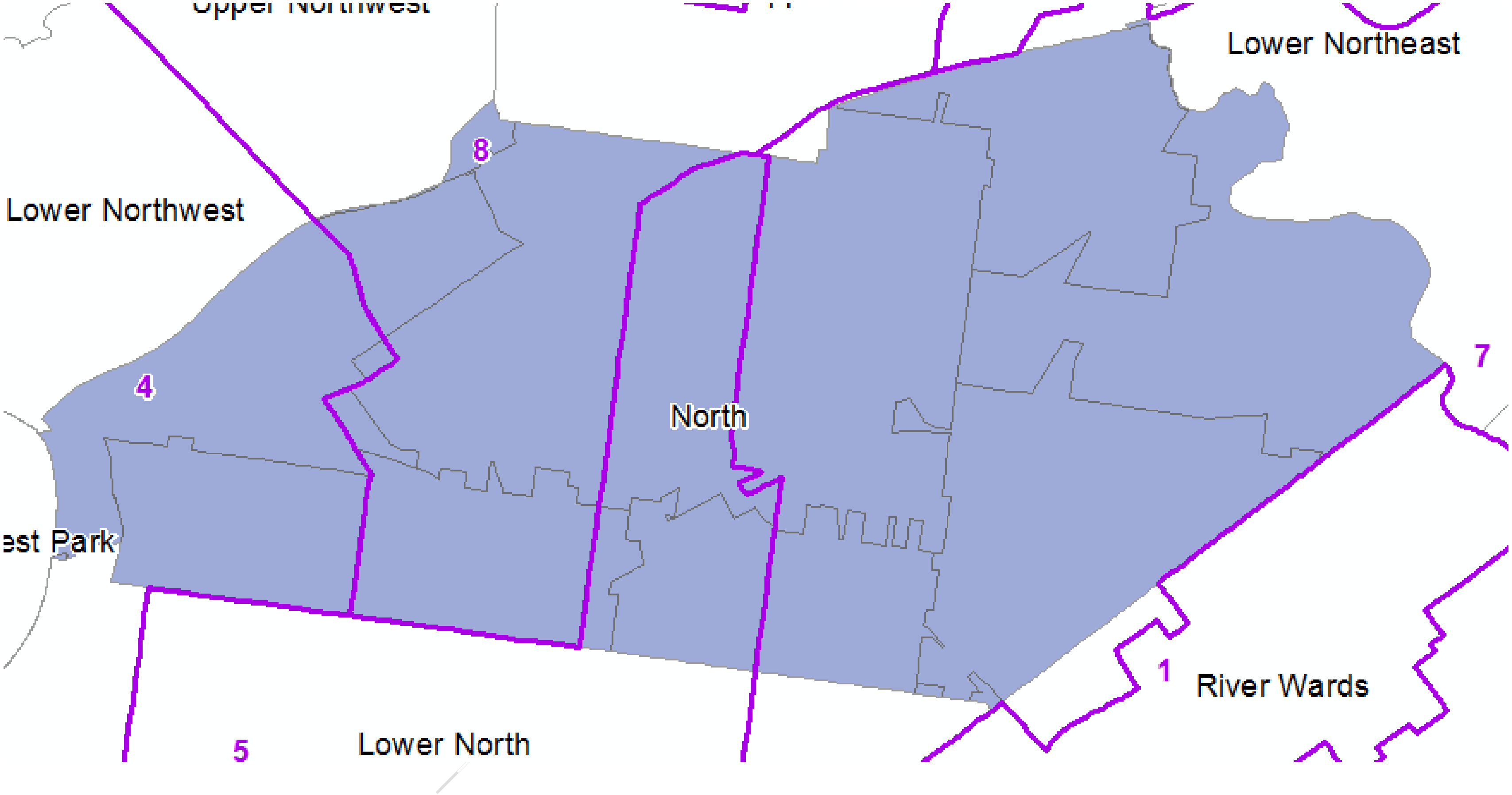
The North planning district falls partially in the Delaware Direct, Schuylkill River, and Tookany/Tacony-Frankford Watersheds.

Watersheds in the North Planning District



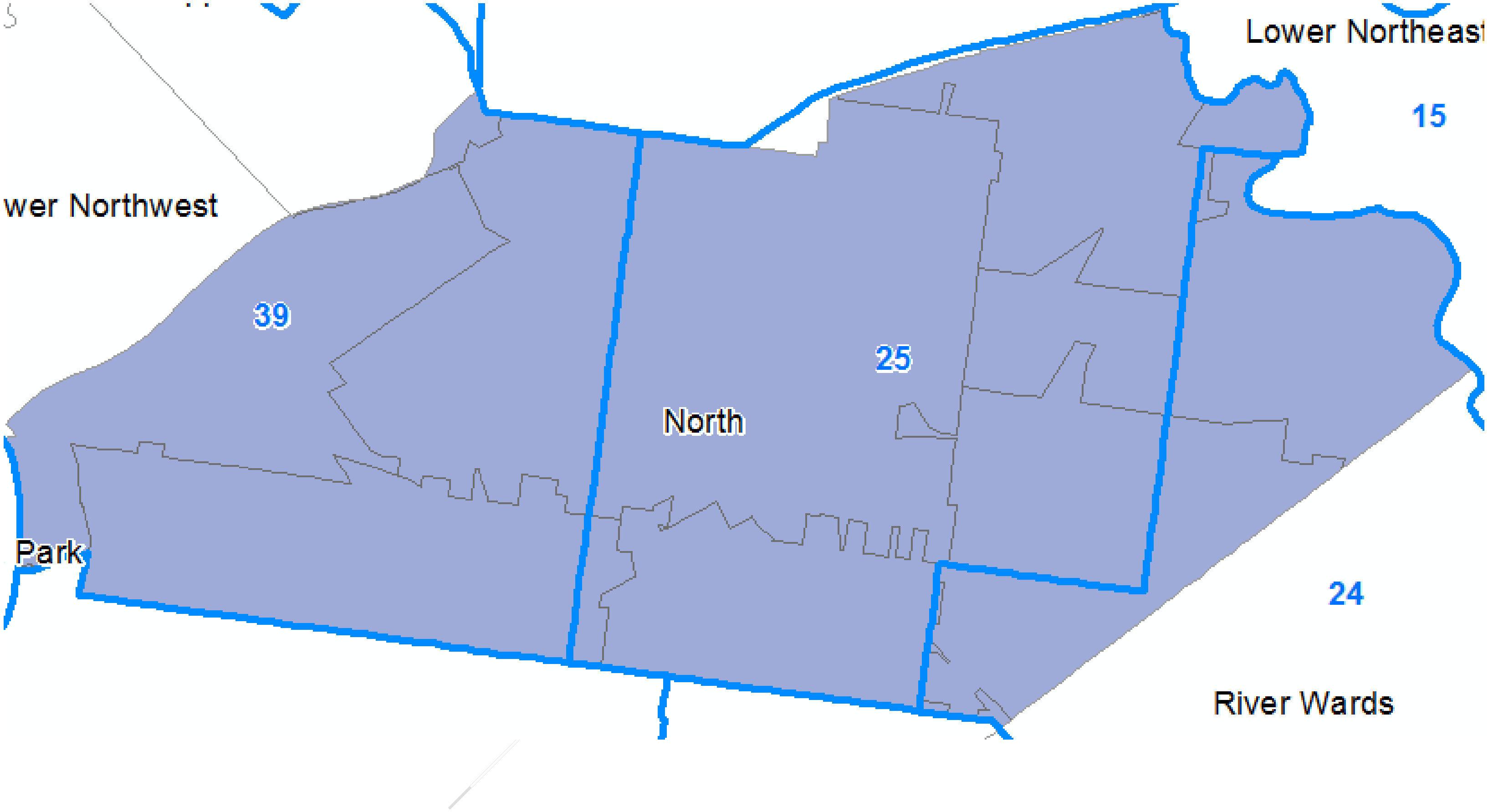
The North Planning District resides within the 4th, 8th, 5th, and 7th Council Districts of Philadelphia.

Council Districts in North Planning District



The North Planning District falls within the 39th, 25th, and 24th Police Districts, and also crosses into the 8th and 15th Police Districts.

Police Districts in the North Planning District



21.1.9.2 Social Characteristics

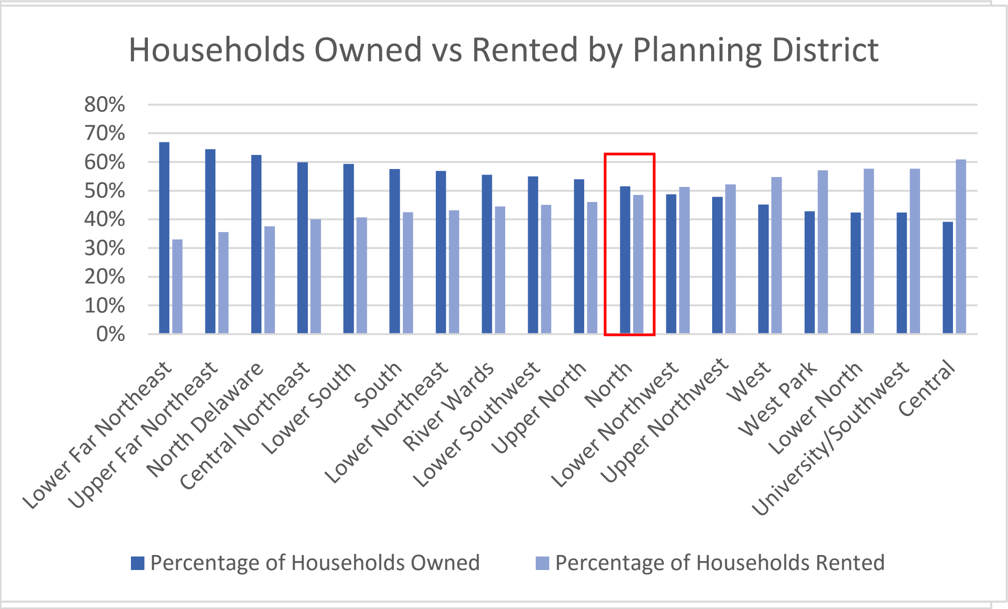
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

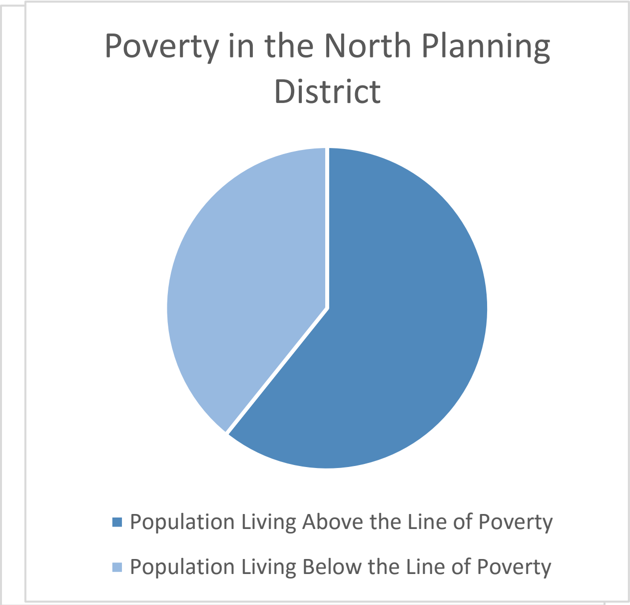
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	365,954
- Male population	172,171
- Female population	193,783
Median Age	31.5
- Age dependency ratio (the percentage of the population under 15 and over 64)	57.9%
- Population under 15	43.2%
- Population over 64	14.8%

21.1.9.3 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	110,078
- Households owned	56,734
- Households rented	53,344
No vehicle access	45,214
Population below the federal line of poverty	38.6%





21.1.9.4 Disability

Of those individuals residing within the North Planning District, 19.5 percent reported having a disability. Disabilities reported by individuals in the North Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	8.8%
Vision difficulty	9.0%
Cognitive difficulty	10.0%
Ambulatory Difficulty	9.9%
Self-care Difficulty	9.9%
Independent Living Difficulty	10.3%

21.1.9.5 North Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

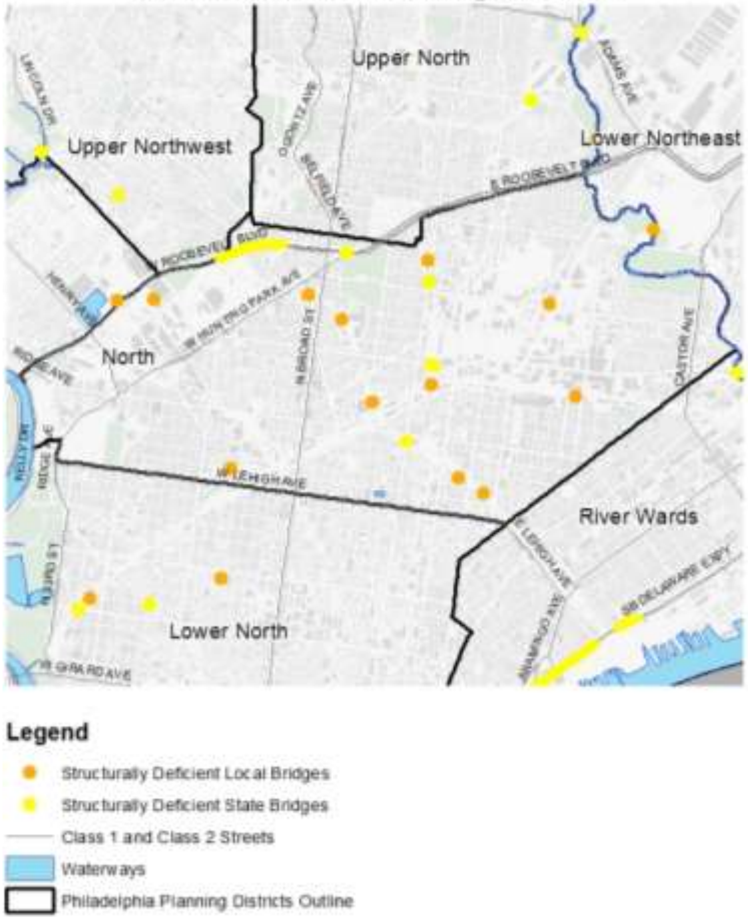
Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[471] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[472] [473] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the North Planning District.[474]

Structurally Deficient Bridges in the North Planning District



---

[471] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[472] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[473] Ibid.

[474] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the North Planning District

Name	Location	Year Built
Conrail: Richmond Bridge	Mascher St, north of Indiana Ave	1931
Amtrak, Northeast Corridor	2nd St, north of Venango St	1926
Conrail	Cambria and “A” Sts	1916
Conrail (Abandoned)	Cayuga St, west of 5th St	1930
Conrail	Old York Rd, .5 mile south of US-13	1913
Conrail and SEPTA	Abbottsford Ave	1929
Conrail, Fairhill Bridge	Hunting Park Ave	1930
Tacony Creek	Fisher’s Lane	1801
Amtrak, Northeast Corridor	G St, north of Venango	1914
SEPTA	Glenwood Ave at 15th St	1912
Conrail	Sedgley Ave, west of 7th St	1907
Conrail, Richmond Bridge	Lycoming St, west of Broad St	1929
Roosevelt Blvd Extension	Southbound off ramp, .5 north of Broad St	1961
Conrail (tracks removed)	Erie Ave, between 3rd and 5th Sts	1896
Conrail (tracks removed)	5th St	1917
Conrail, Richmond Branch	5th St near Allegheny Ave	1918

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. The table below shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.

Dams in the North Planning District

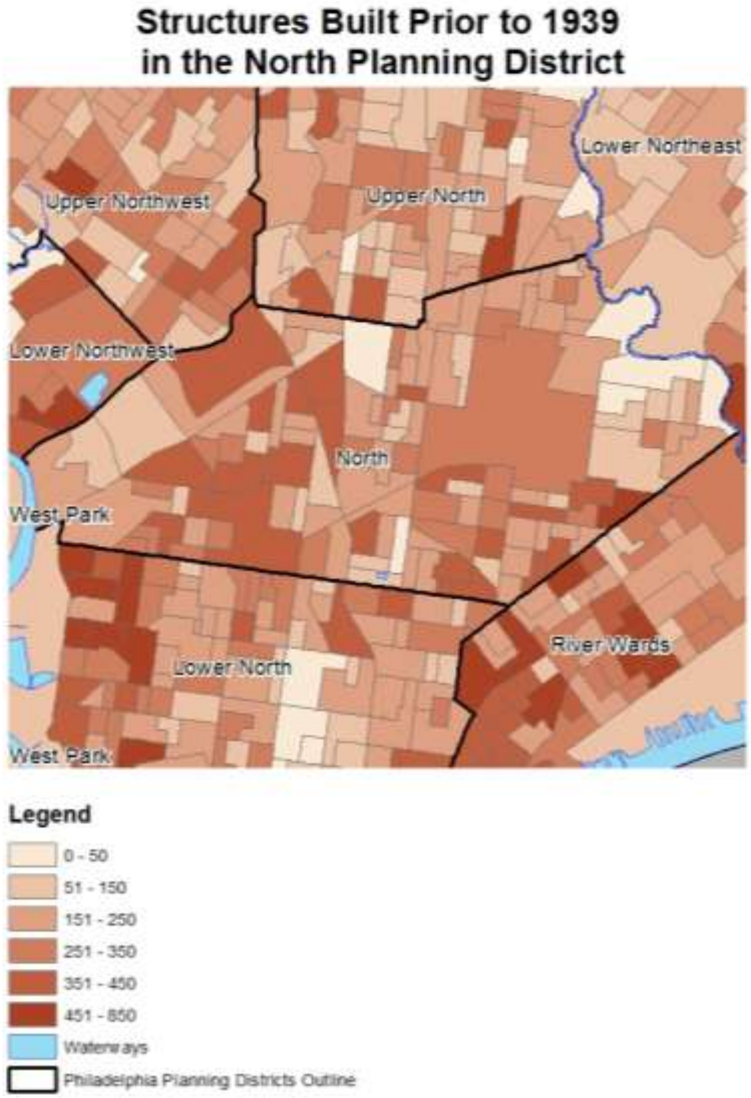
Dam Name	Waterway	High Hazard?	Permitted Owner
Debris Dam	Tacony Creek	No	City of Philadelphia

Building Collapse

Buildings may collapse for a variety of reasons, including:

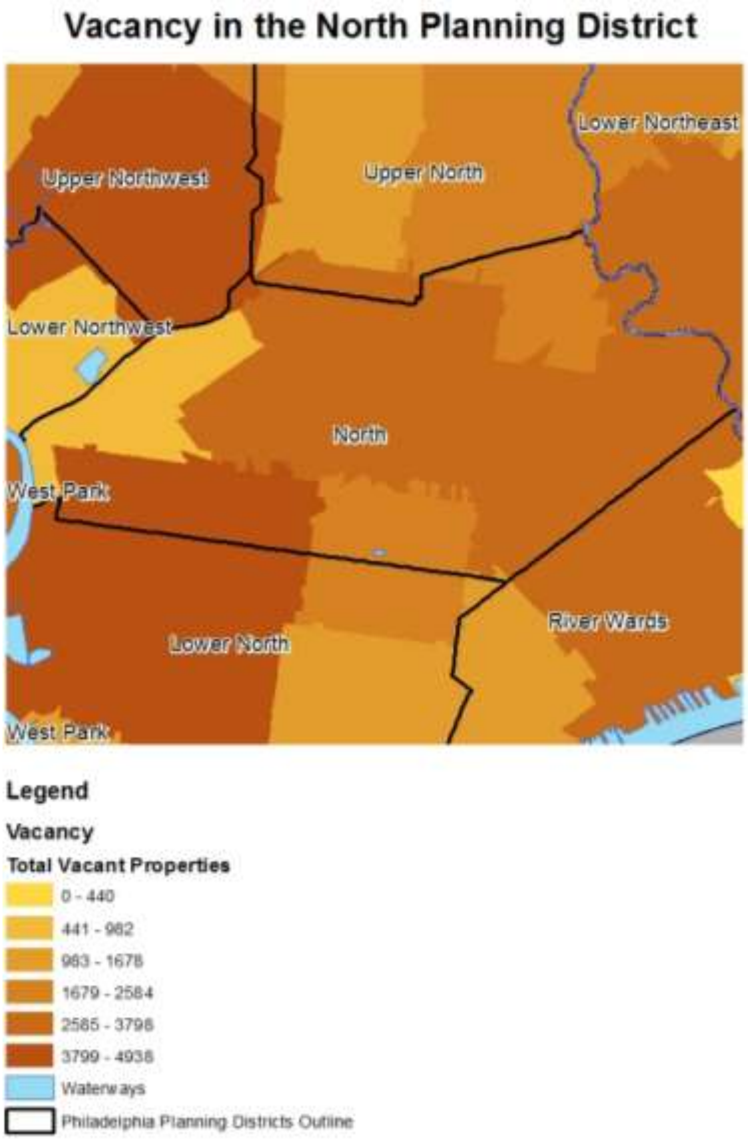
- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the North Planning District built before 1939.

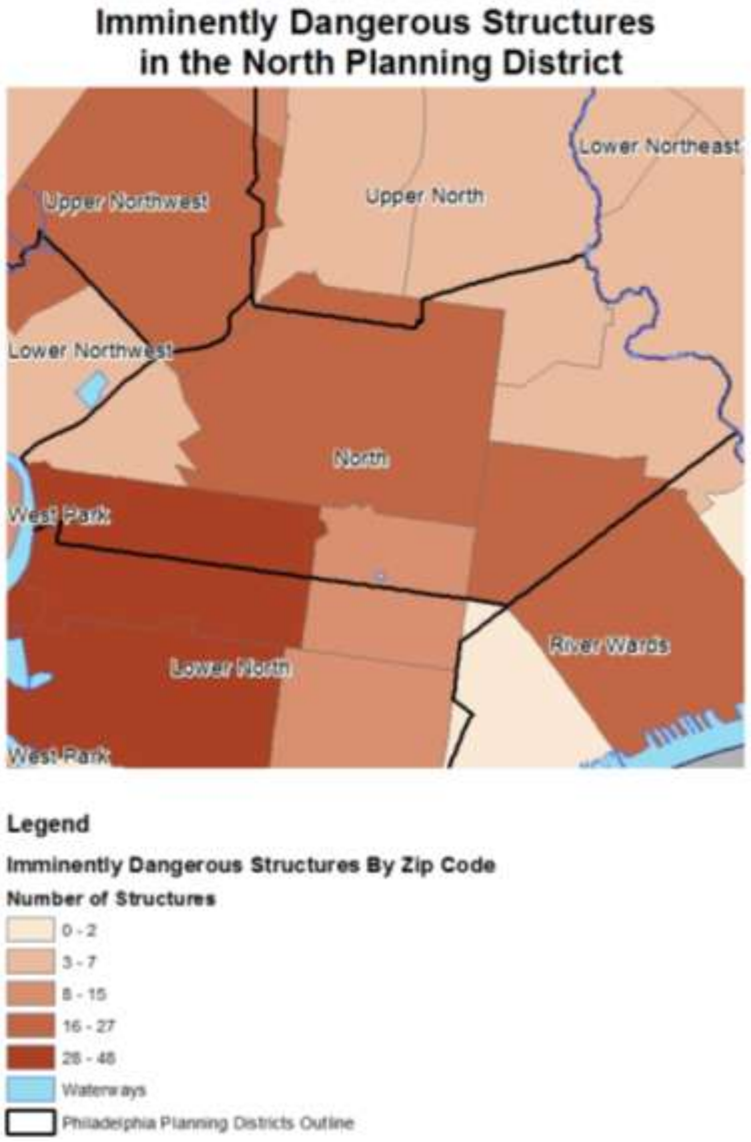


Structures Built Prior to 1939 in the North Planning District

Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the North Planning District. The North Planning District has a moderately high level of vacancy compared to the rest of the City of Philadelphia.



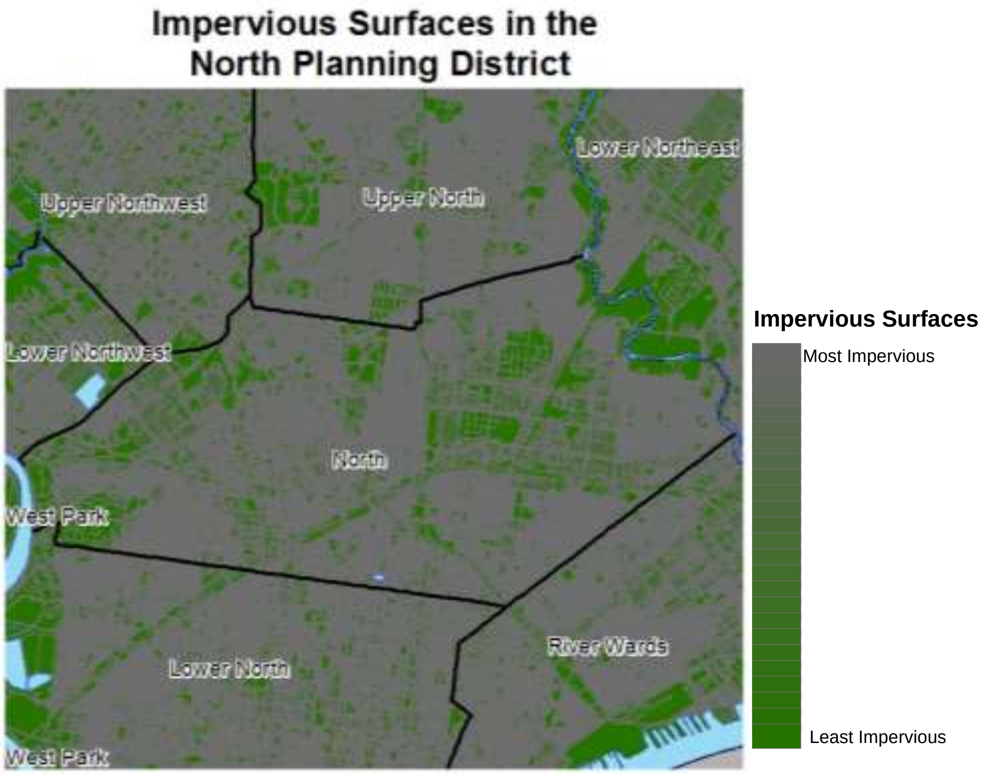
Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the North Planning District.



Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[475] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

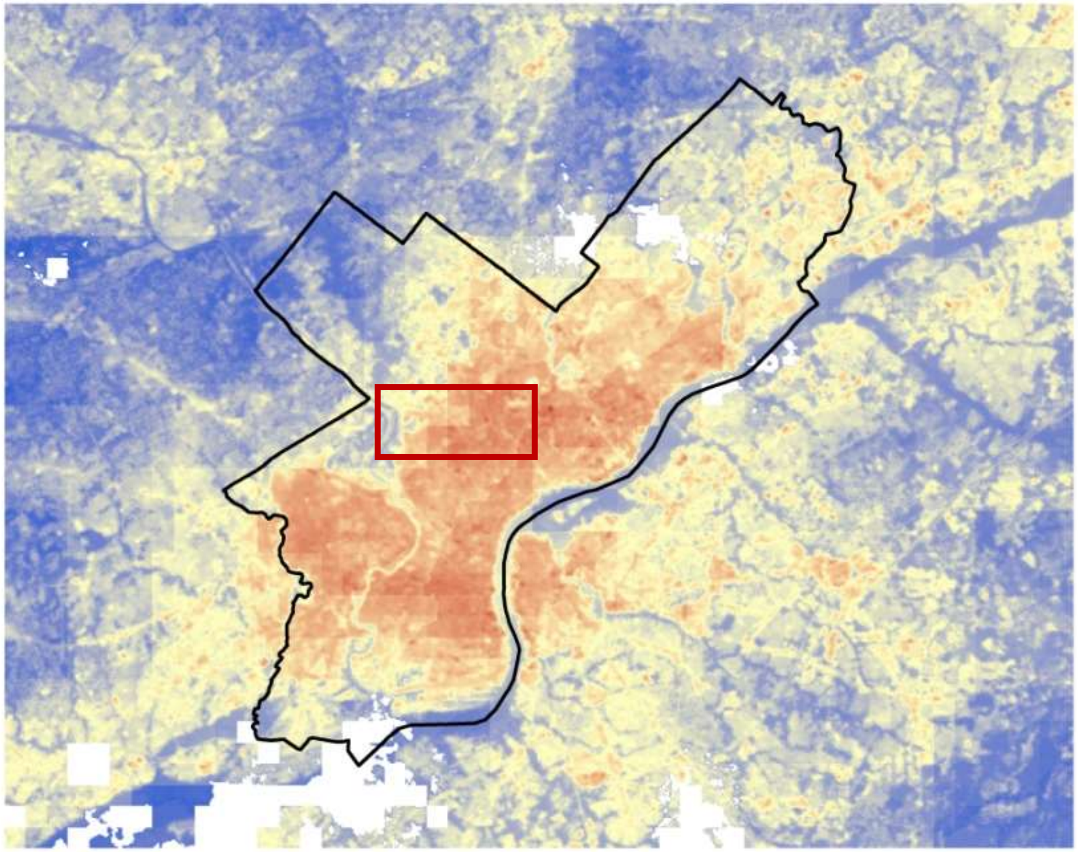
Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[476] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the North Planning District.



---

[475] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[476] "Heat Island Effect". US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[477] As the map shows, the North is located in an area which experiences higher heat island effects than other parts of the city.



---

[477] "Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002". URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[478]

Winter flooding includes 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. All forms of flooding can damage

---

[478] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

infrastructure.[479] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

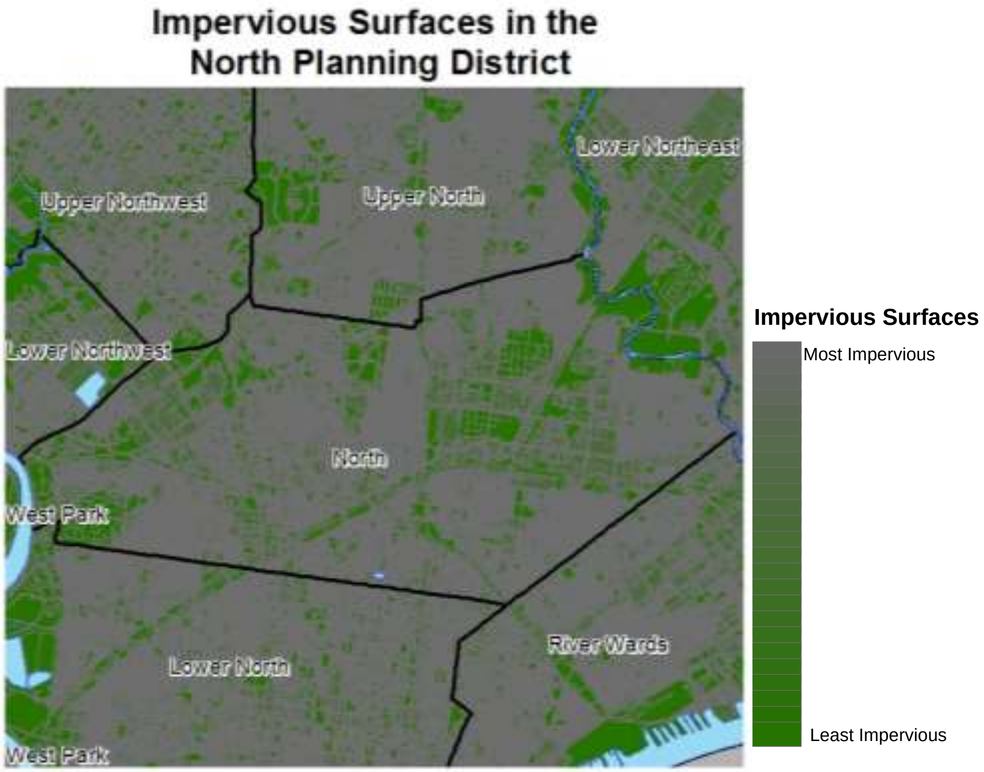
A small portion of the North Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the North Planning District there are 35 National Flood Insurance Program (NFIP) policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

---

[479] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Flash flooding is a concern for some areas of the North Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the North Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.


Impervious Surfaces in the North Planning District

Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[480]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

---

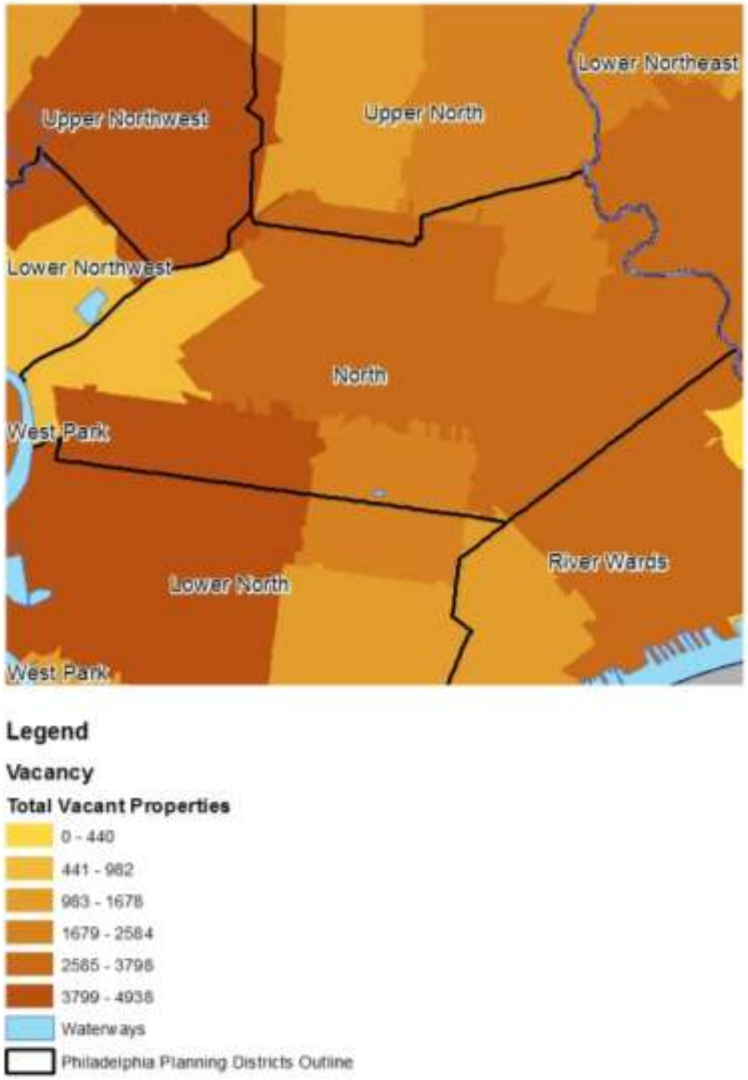
[480] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[481] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[482] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The North Planning District has a moderately high level of vacancy compared to the rest of the City of Philadelphia.

Vacancy in the North Planning District

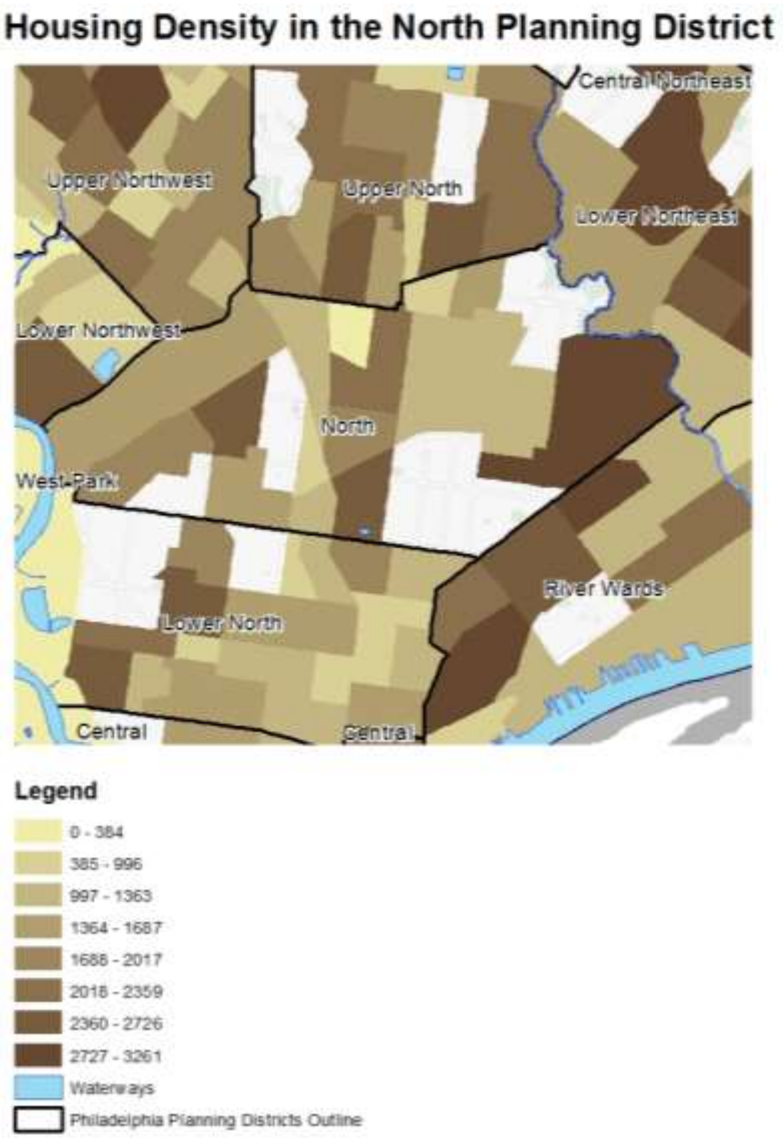


---

[481] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.

[482] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the North Planning District's housing density. Data was unavailable for those portions of the map left uncolored.

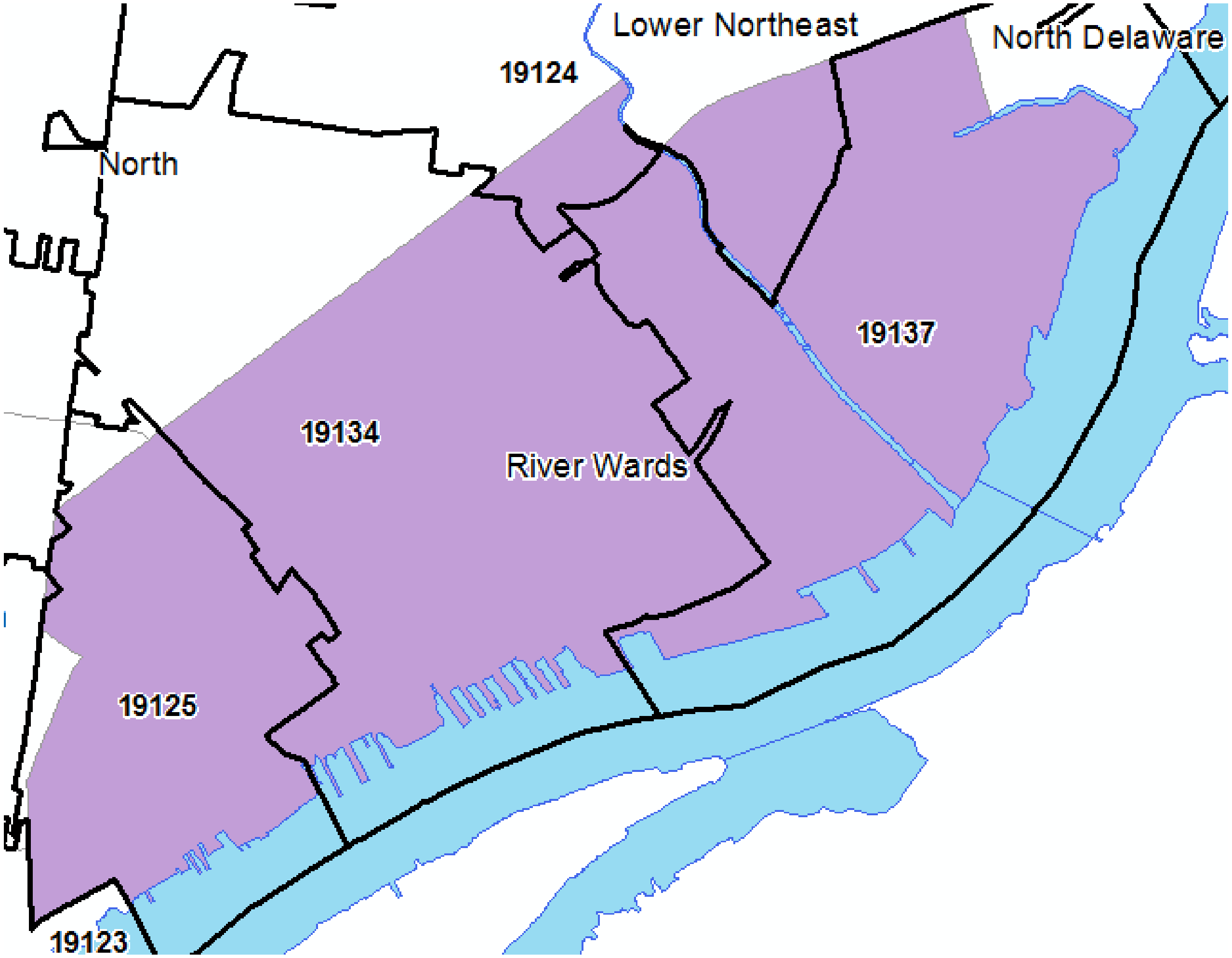


21.1.10 River Wards Planning District

21.1.10.1 Geography and Hydrology

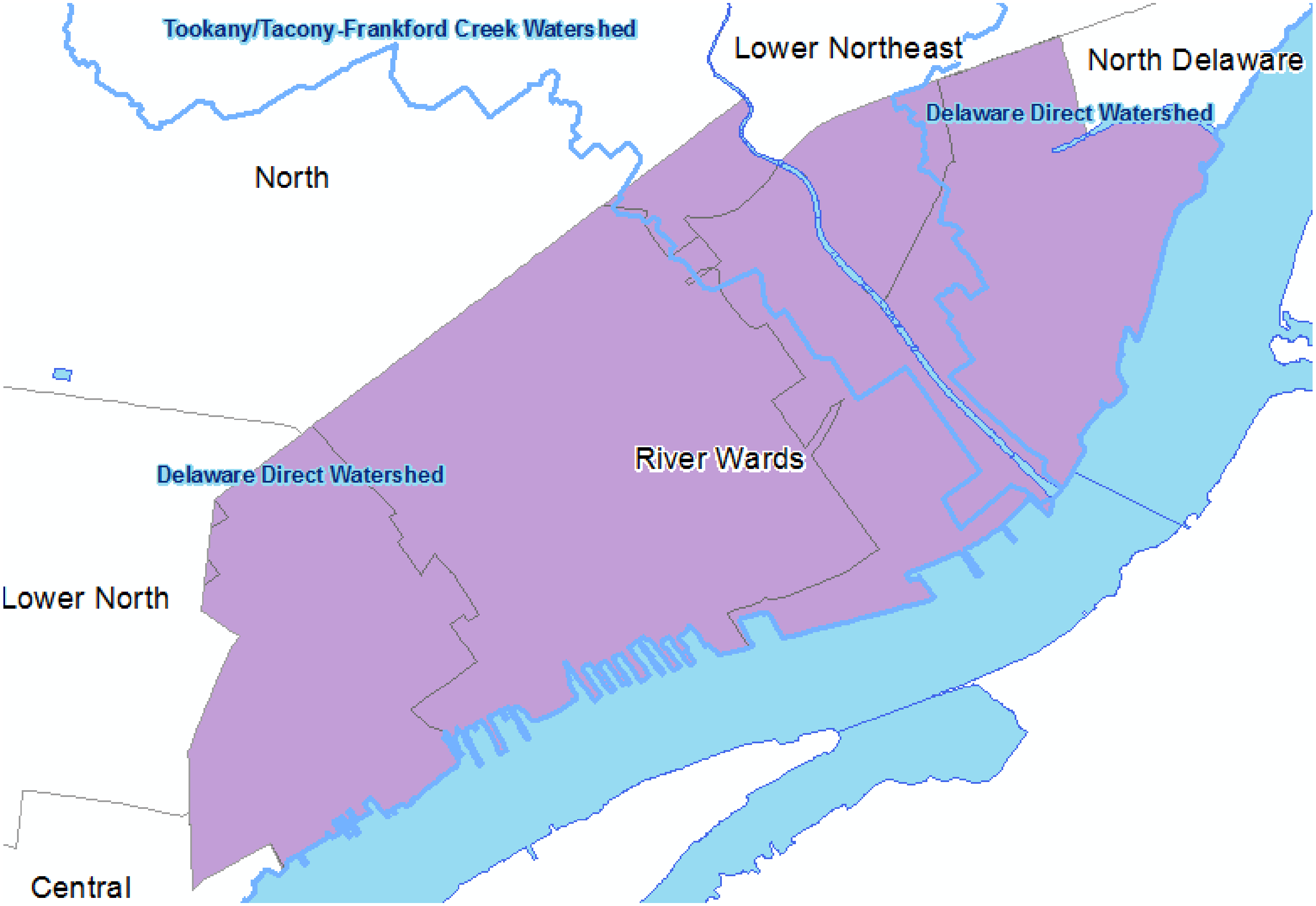
The River Wards Planning District contains addresses in the zip codes 19125, 19124, 19134, and 19137.

Zip codes in the River Wards Planning District



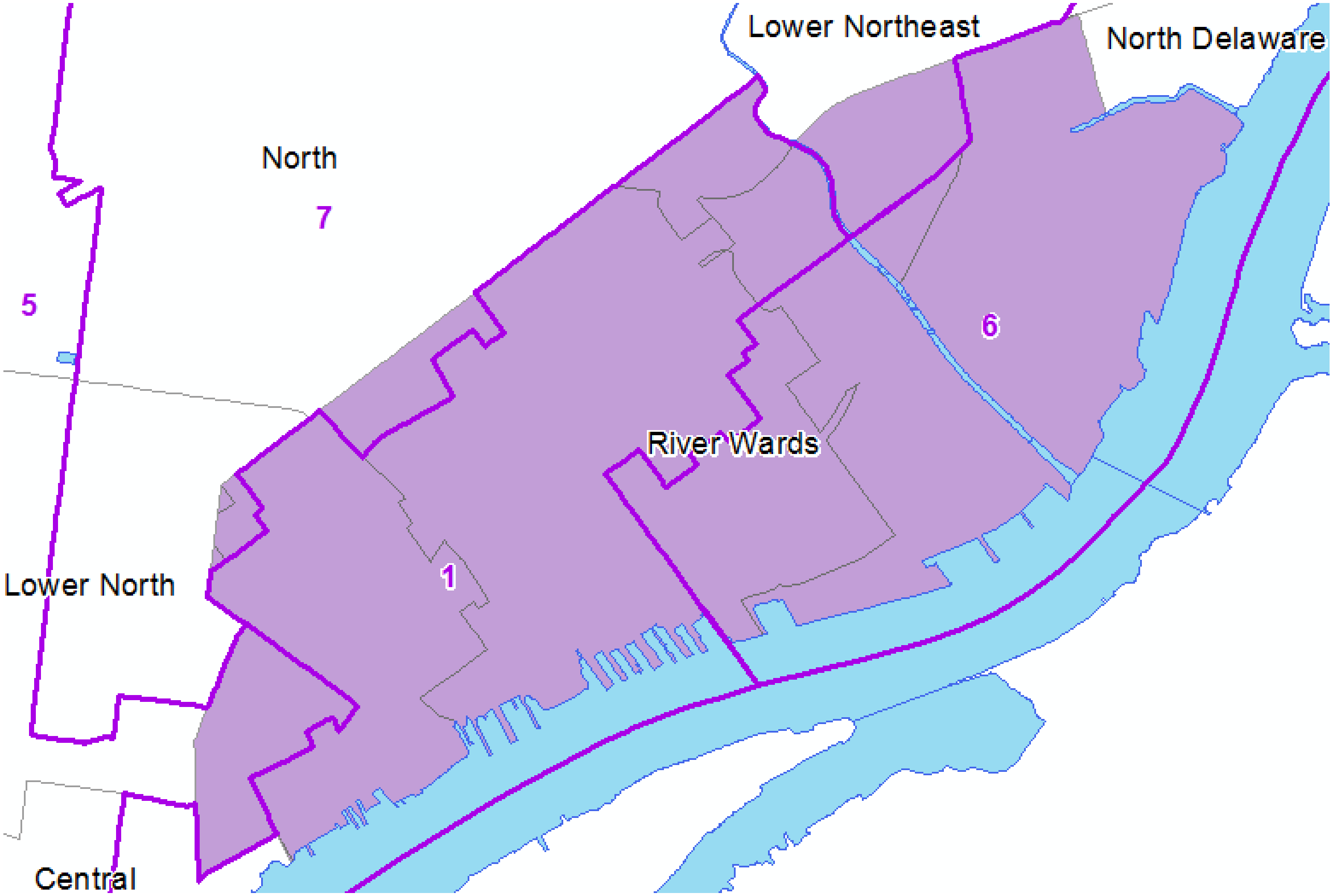
The River Wards planning district falls partially in the Delaware Direct and Tookany/Tacony-Frankford Watersheds.

Watersheds in the River Wards Planning District



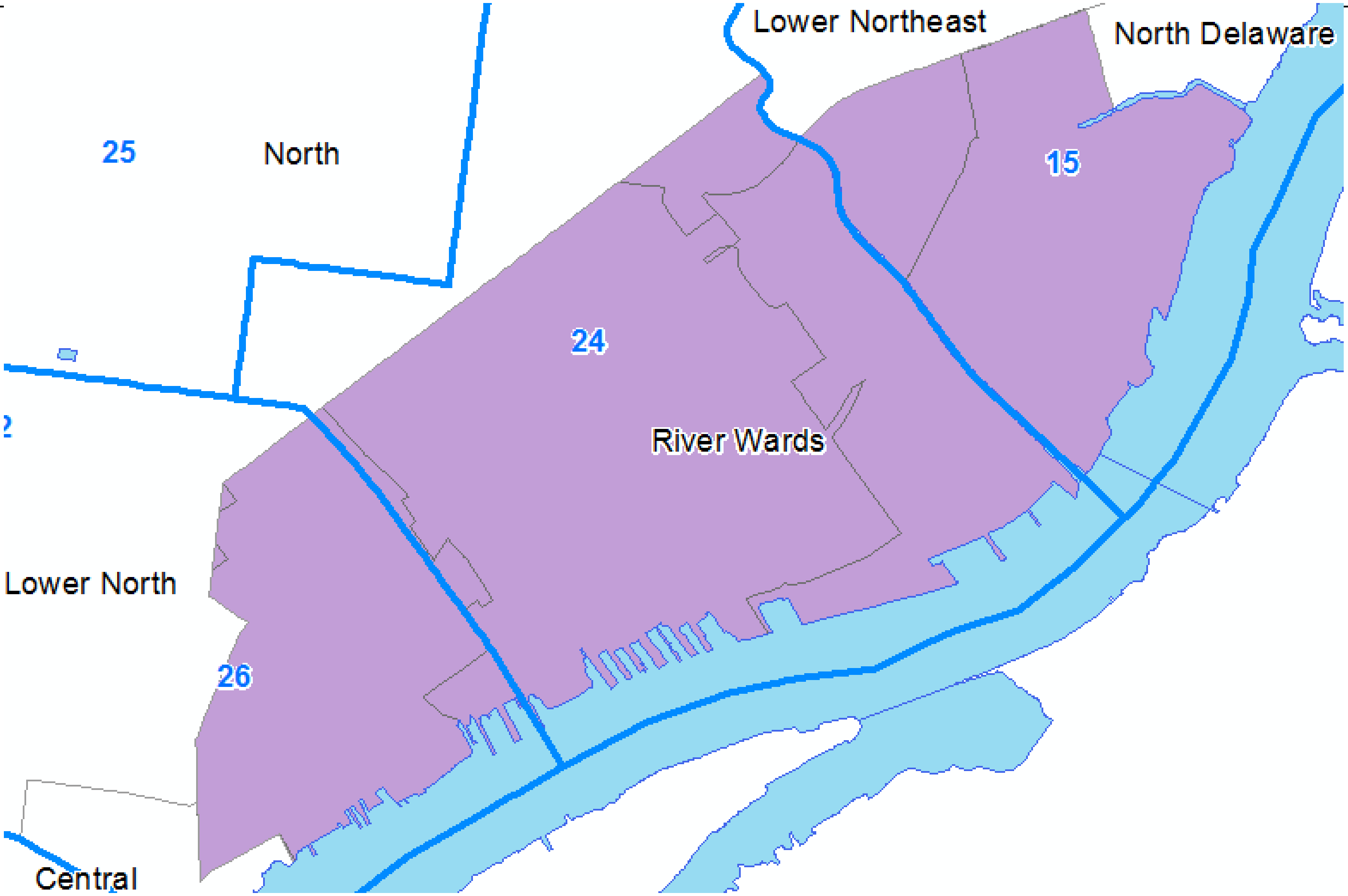
The River Wards Planning District resides within the 7th, 1st, and 6th Council Districts of Philadelphia.

Council Districts in River Wards Planning District



The River Wards Planning District falls within the 26th, 24th, and 15th Police Districts.

Police Districts in the River Wards Planning District



21.1.10.2 Current and Future Land Use

The River Wards District future land use moves to capitalize on the district's long-established residential neighborhoods and strong industrial core.[483] The proposed land use map provides a generalized road map for the appropriate distribution of residential densities, industrial uses, and intensity, and where commercial activity should be concentrated.[484] [485]

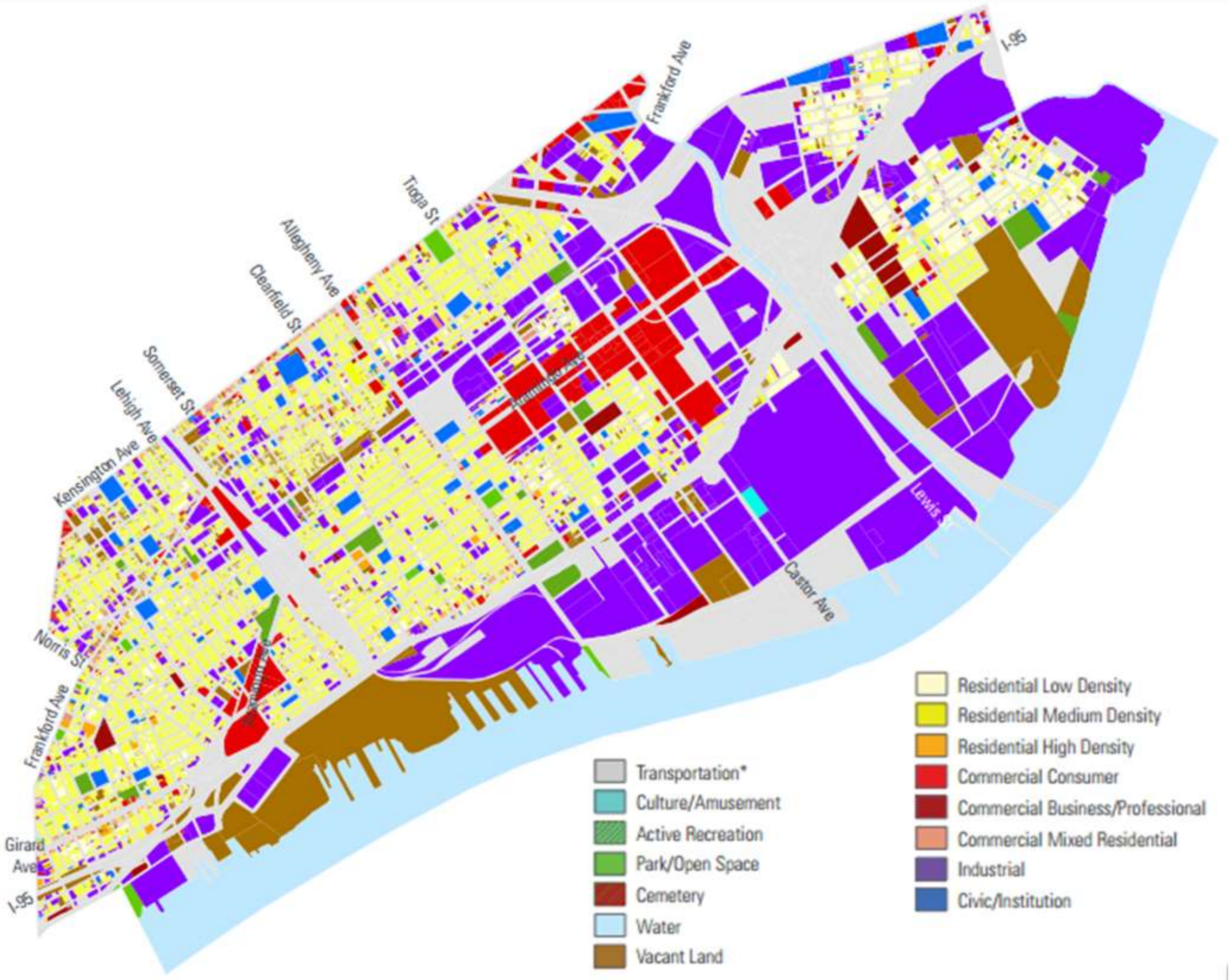
---

[483] City of Philadelphia, Philadelphia 2035. River Wards District Plan. Retrieved November 20, 2015.

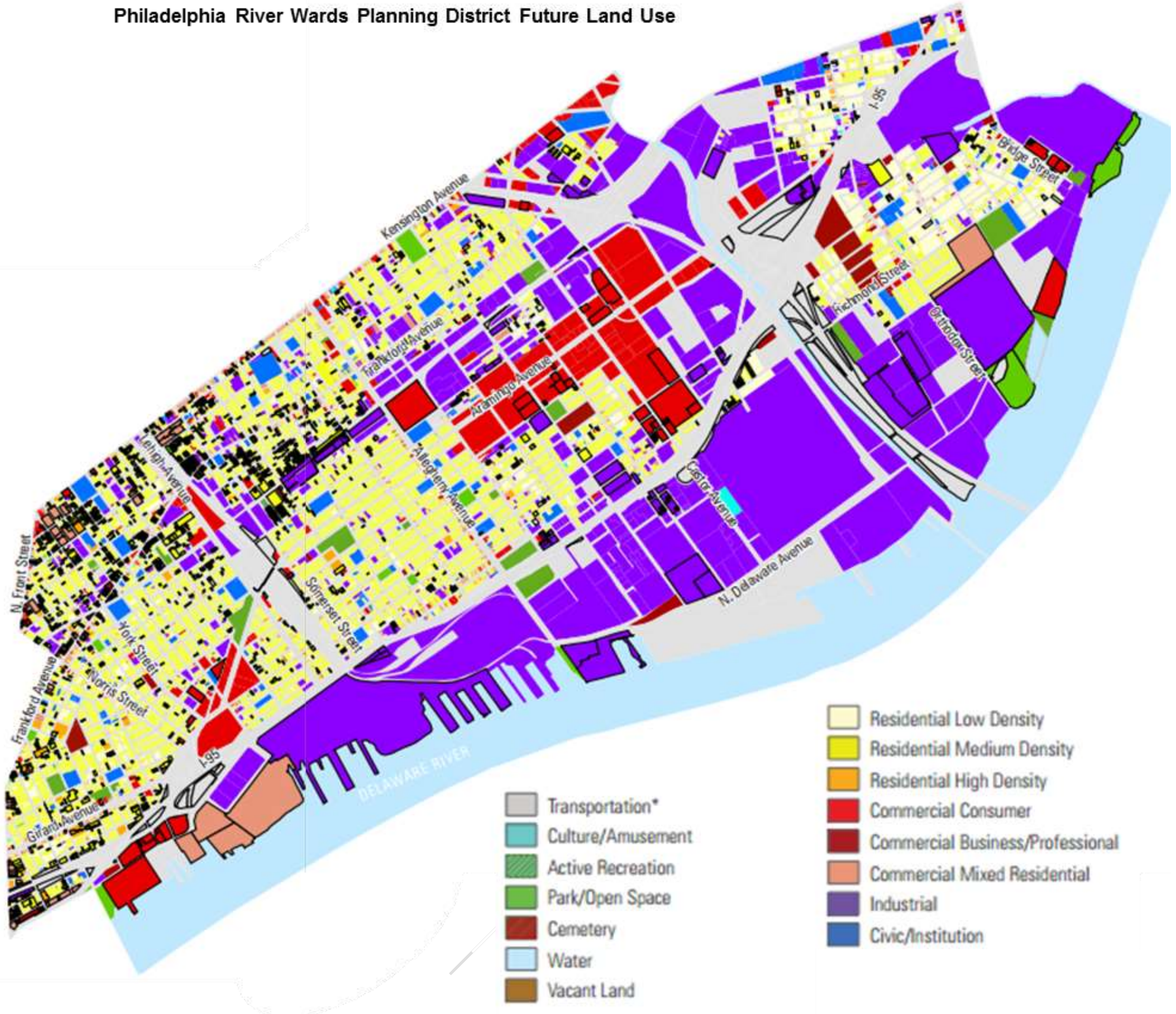
[484] Ibid.

[485] All graphics, charts, and recommendations come from the City of Philadelphia: Philadelphia 2035 River Wards District Plan. Retrieved November 20, 2015.

Philadelphia River Wards Planning District Existing Land Use



Philadelphia River Wards Planning District Future Land Use



21.1.10.3 Social Characteristics

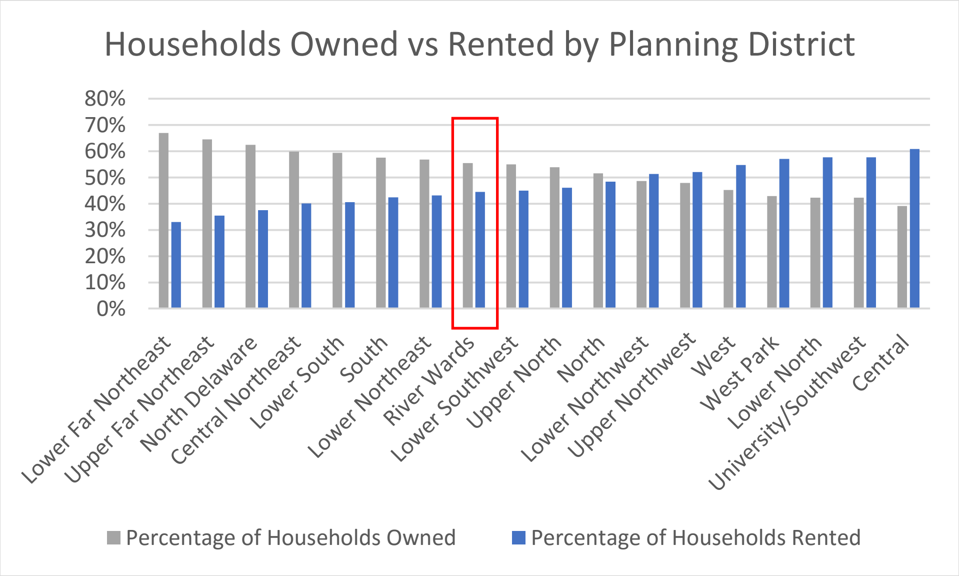
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

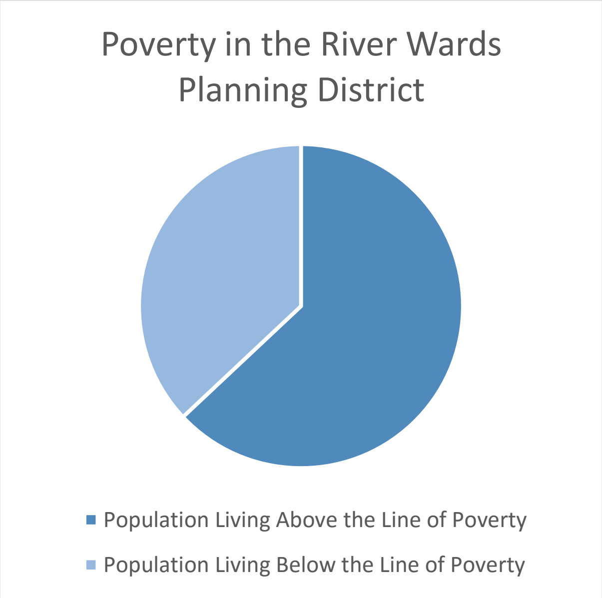
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	158,157
- Male population	76,917
- Female population	81,240
Median Age	33.8
- Age dependency ratio (the percentage of the population under 15 and over 64)	52.4%
- Population under 15	38.2%
- Population over 64	14.3%

21.1.10.4 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	62,524
- Households owned	26,796
- Households rented	35,728
No vehicle access	19,388
Population below the federal line of poverty	31.0%





21.1.10.5 Disability

Of those individuals residing within the River Wards Planning District, 20.7 percent reported having a disability. Disabilities reported by individuals in the River Wards Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	11.6%
Vision difficulty	11.8%
Cognitive difficulty	12.5%
Ambulatory Difficulty	12.5%
Self-care Difficulty	12.4%
Independent Living Difficulty	13.0%

21.1.10.6 River Wards Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[486] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[487] [488] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the River Wards Planning District.[489]

---

[486] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[487] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[488] Ibid.

[489] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the River Wards Planning District		
Name	**Location**	**Year Built**
Frankford Creek	Margaret and Lefevre Sts	1941
On-Ramp A Northbound on Delaware Expressway	Girard Ave Intersection	1971
Delaware Expressway	Near Tioga St	1965
Off- Ramp A Northbound on Delaware Expressway	Betsy Ross Interchange	1974
Delaware Expressway	Near Frankford Ave	1970
Delaware Expressway	Near Richmond St	1965
Frankford Ave	Near Hunting Park Ave	1903

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. There are no dams in the River Wards Planning District.

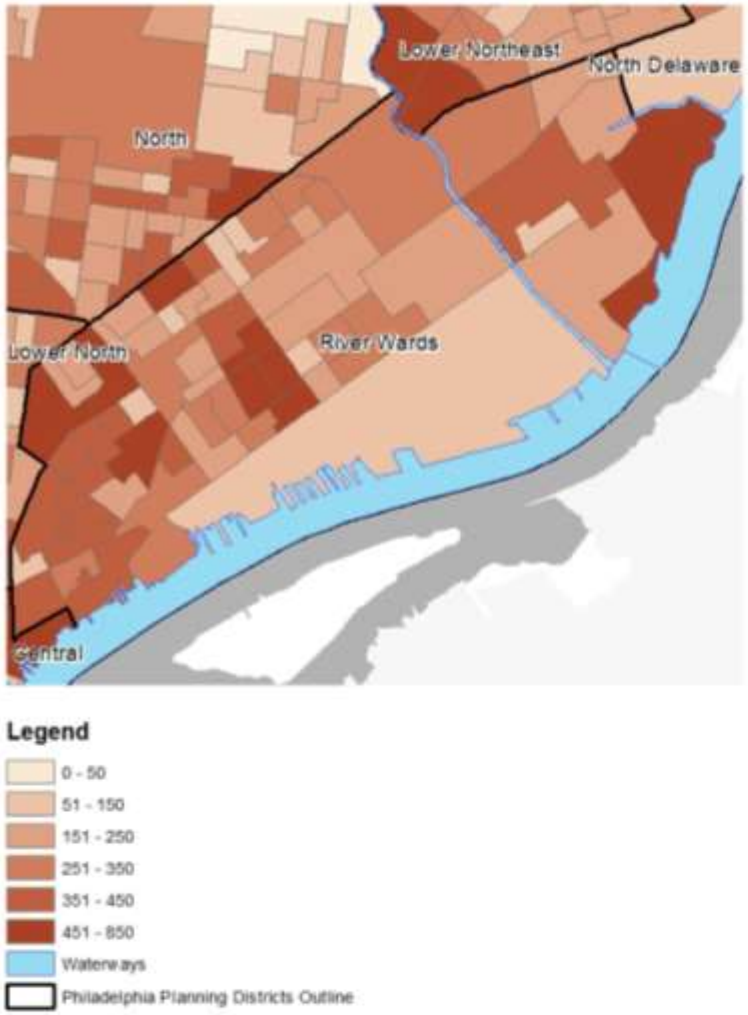
Building Collapse

Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

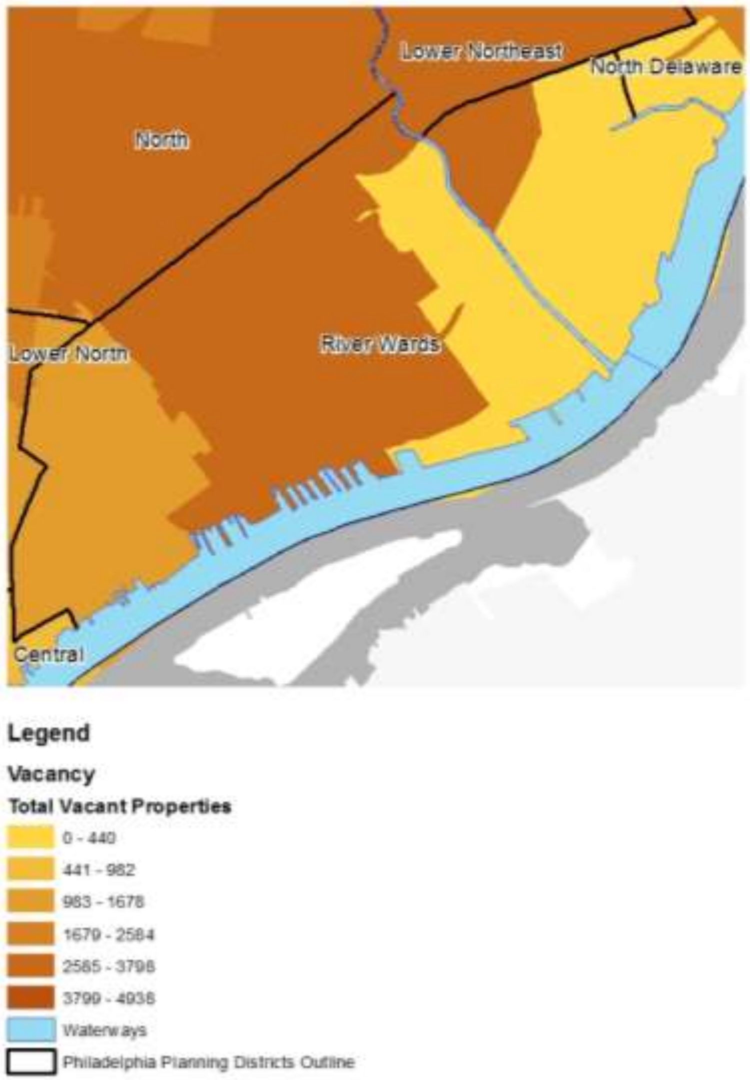
Building age increases the risk of collapse. The map to the right shows the number of properties built in the River Wards Planning District built before 1939.

Structures Built Prior to 1939 in the River Wards Planning District



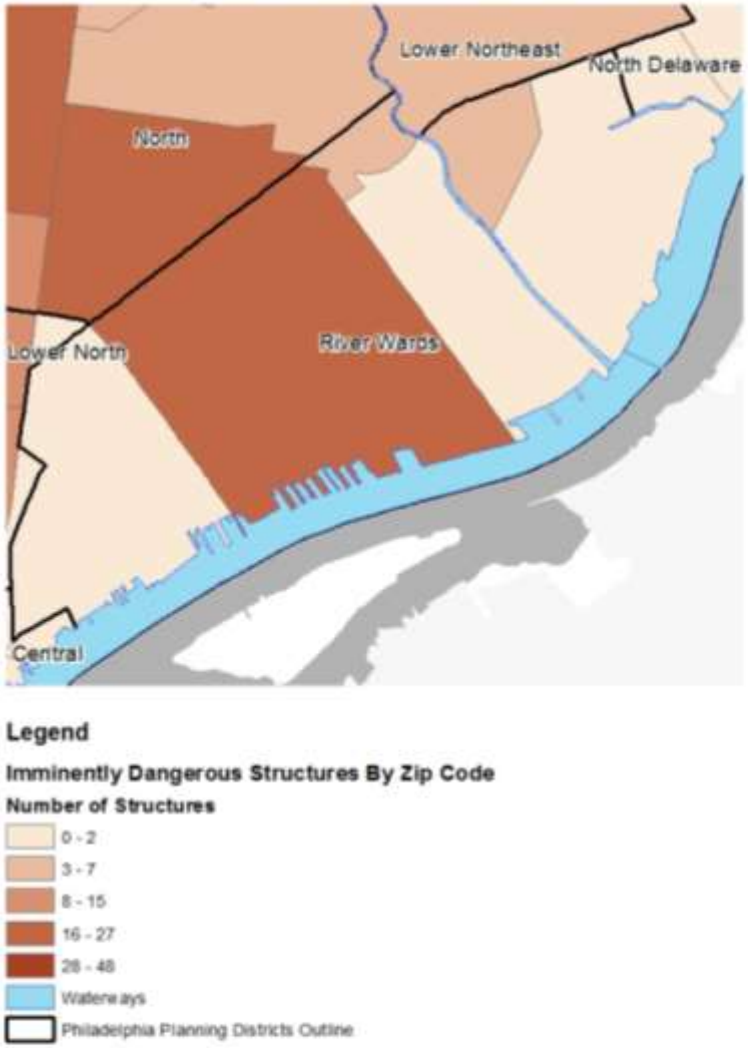
Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the River Wards Planning District. The River Wards Planning District has moderate levels of vacant properties compared to other districts in the city.

Vacancy in the River Wards Planning District



Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map to the right shows the location of imminently dangerous structures in the River Wards Planning District.

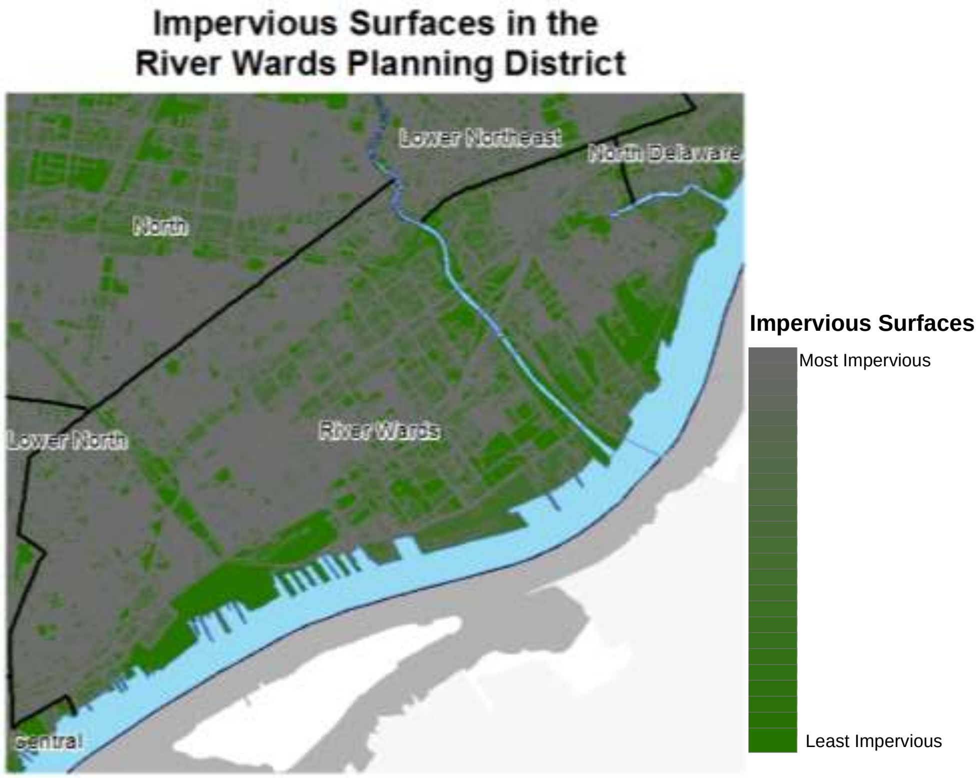
Imminently Dangerous Structures in the River Wards Planning District



Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[490] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[491] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the River Wards Planning District.

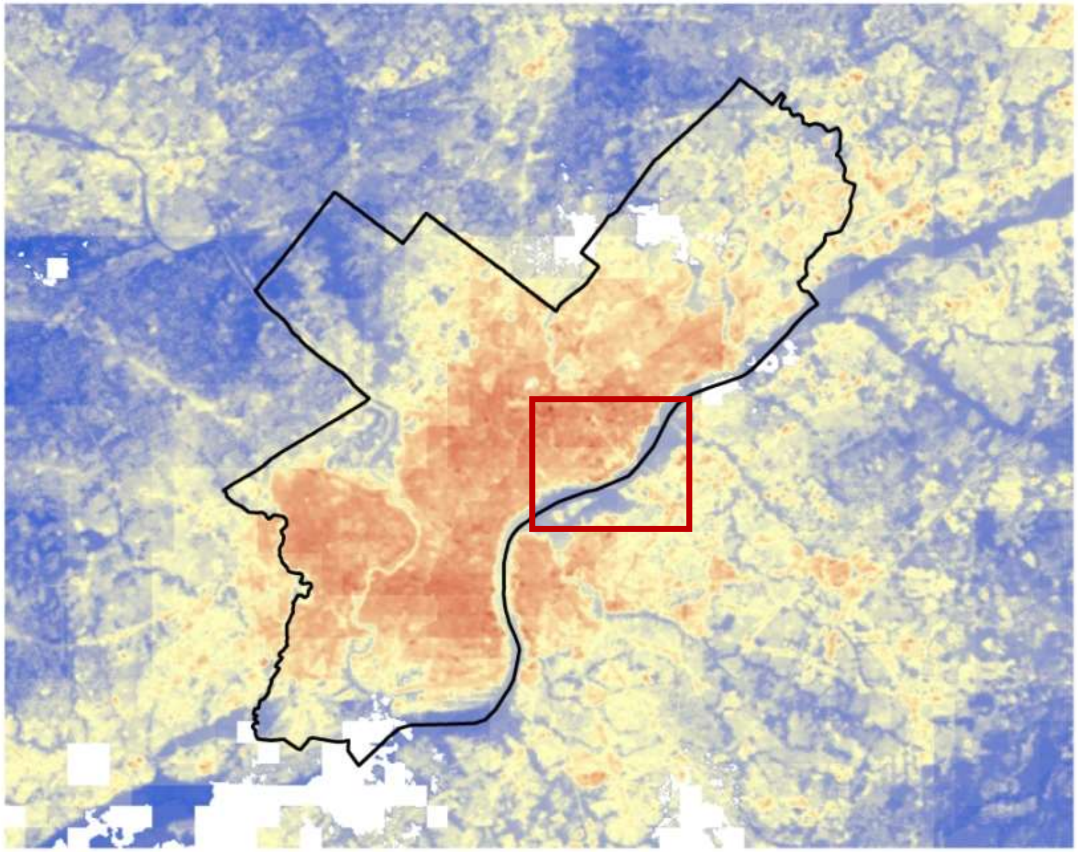


Impervious Surfaces in the River Wards Planning District

---

[490] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[491] "Heat Island Effect". US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[492] As the map shows, the River Wards is located in an area which experience higher heat island effects, and feels some of the effects of such an event more than the bordering counties.

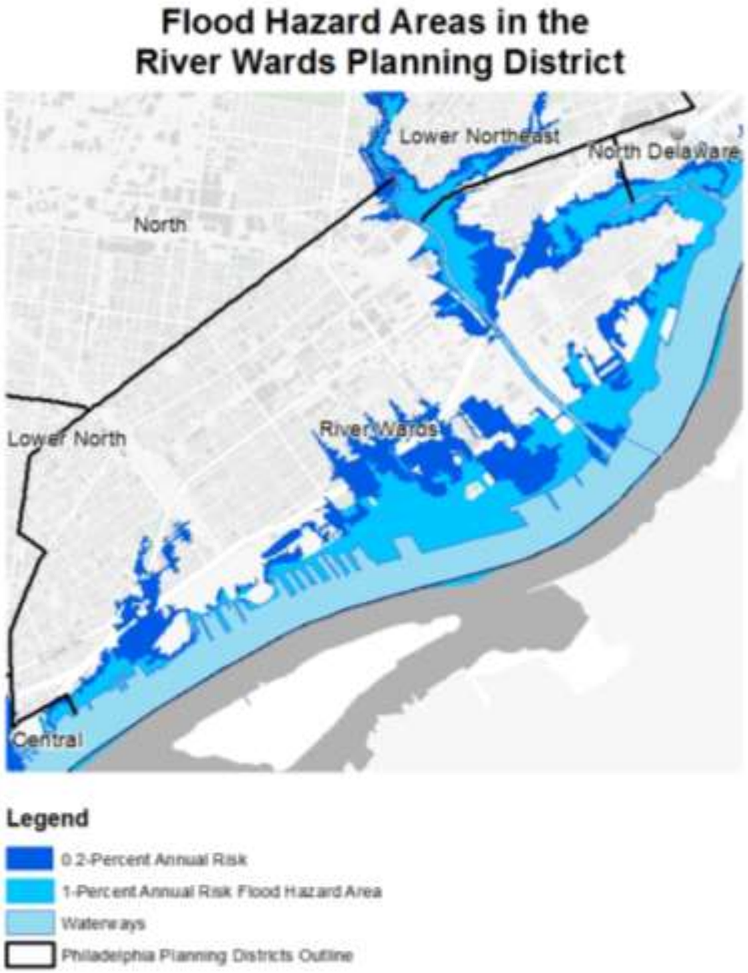


---

[492] “Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002”. URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.


Flood Hazard Areas in the River Wards Planning District

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[493]

Winter flooding includes 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

---

[493] “Standard Operating Guide”. Commonwealth of Pennsylvania’s All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

dams. All forms of flooding can damage infrastructure.[494] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

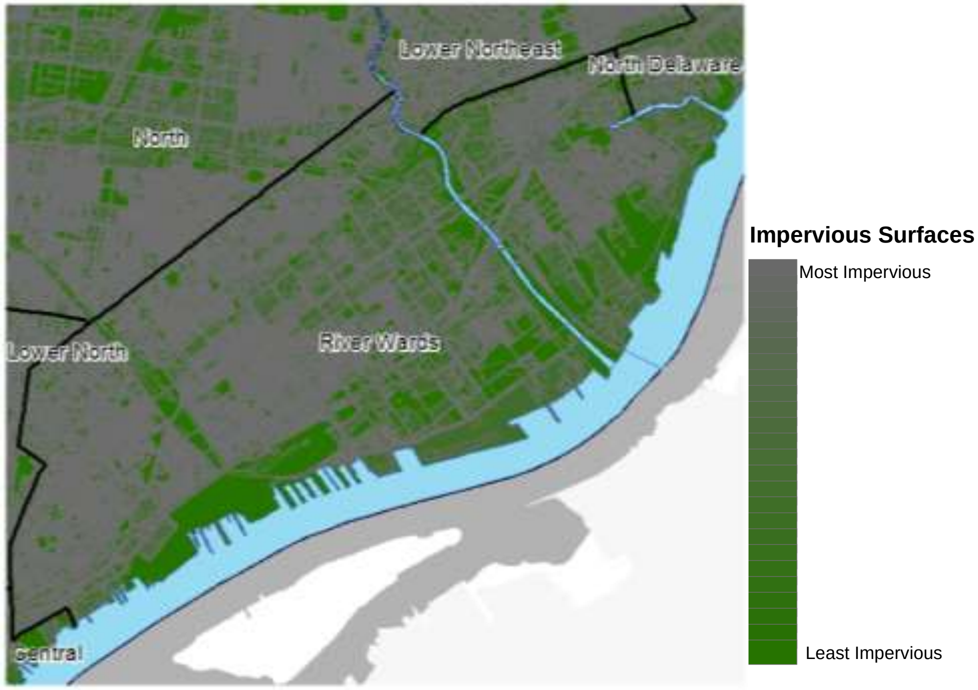
A small portion of the River Wards Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the River Wards Planning District there are 21 of policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

---

[494] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Flash flooding is a concern for some areas of the River Wards Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the River Wards Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Impervious Surfaces in the River Wards Planning District

Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[495]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the River Wards Planning District

---

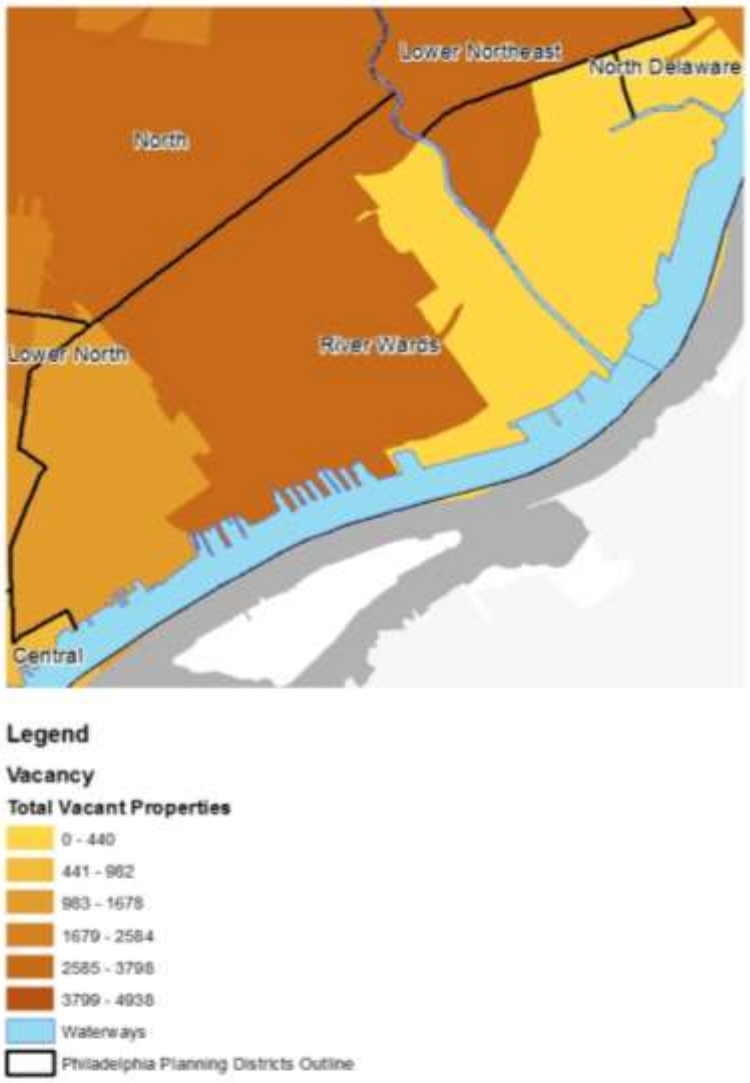
[495] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[496] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[497] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The River Wards Planning District has moderate levels of vacant properties compared to other districts in the city.

Vacancy in the River Wards Planning District

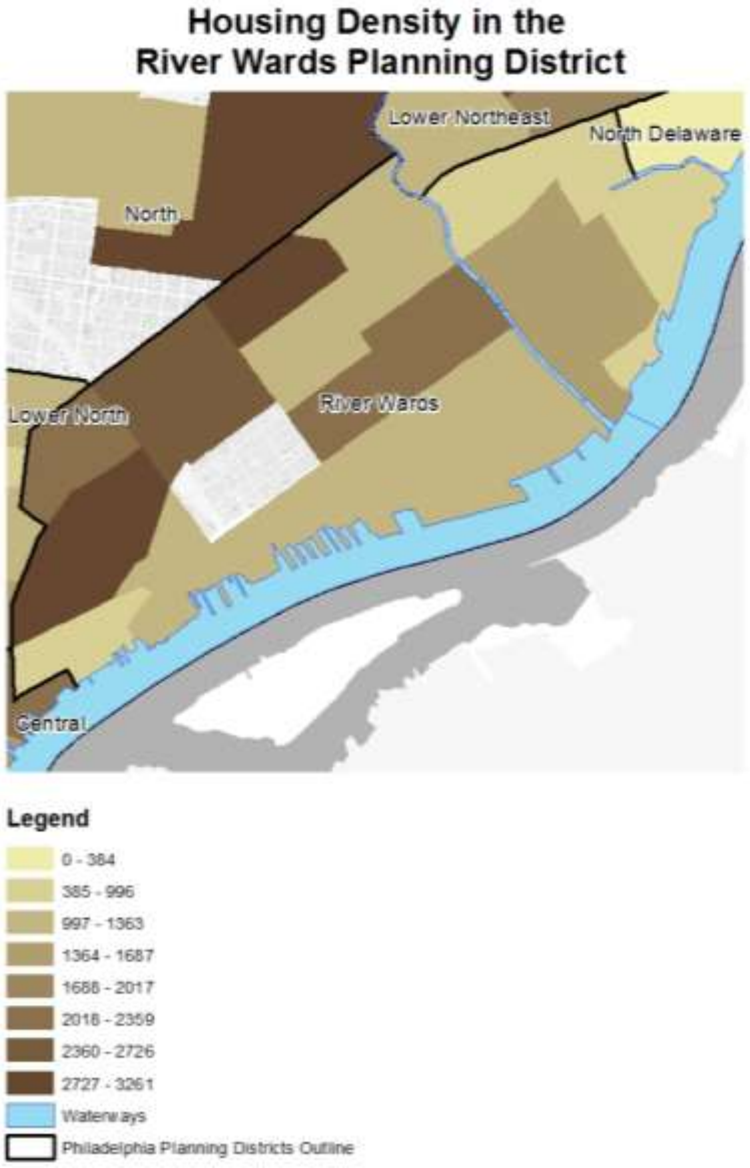


---

[496] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.

[497] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the River Wards Planning District's housing density. Data was unavailable for those portions of the map left uncolored.

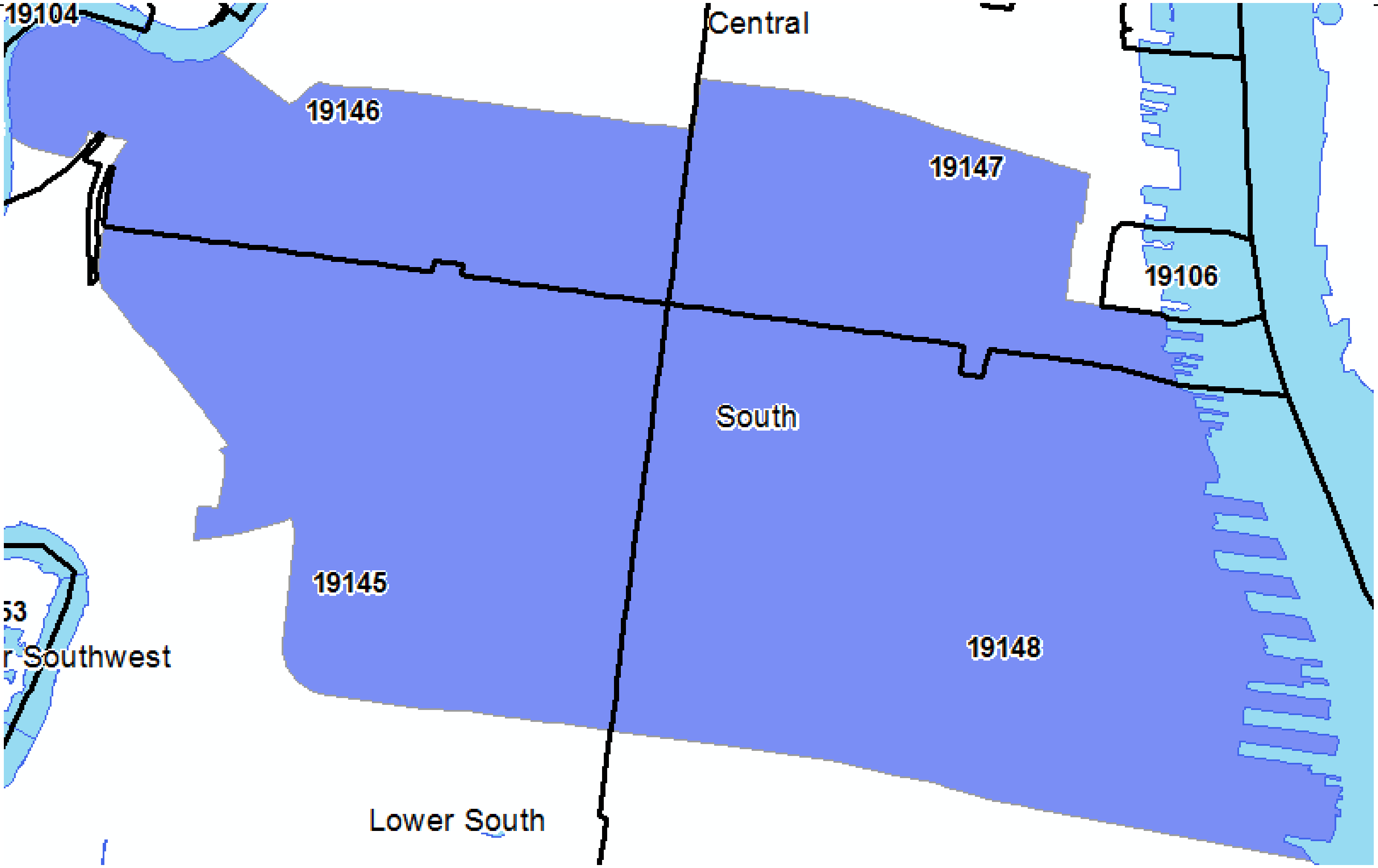


21.1.11 South Planning District

21.1.11.1 Geography and Hydrology

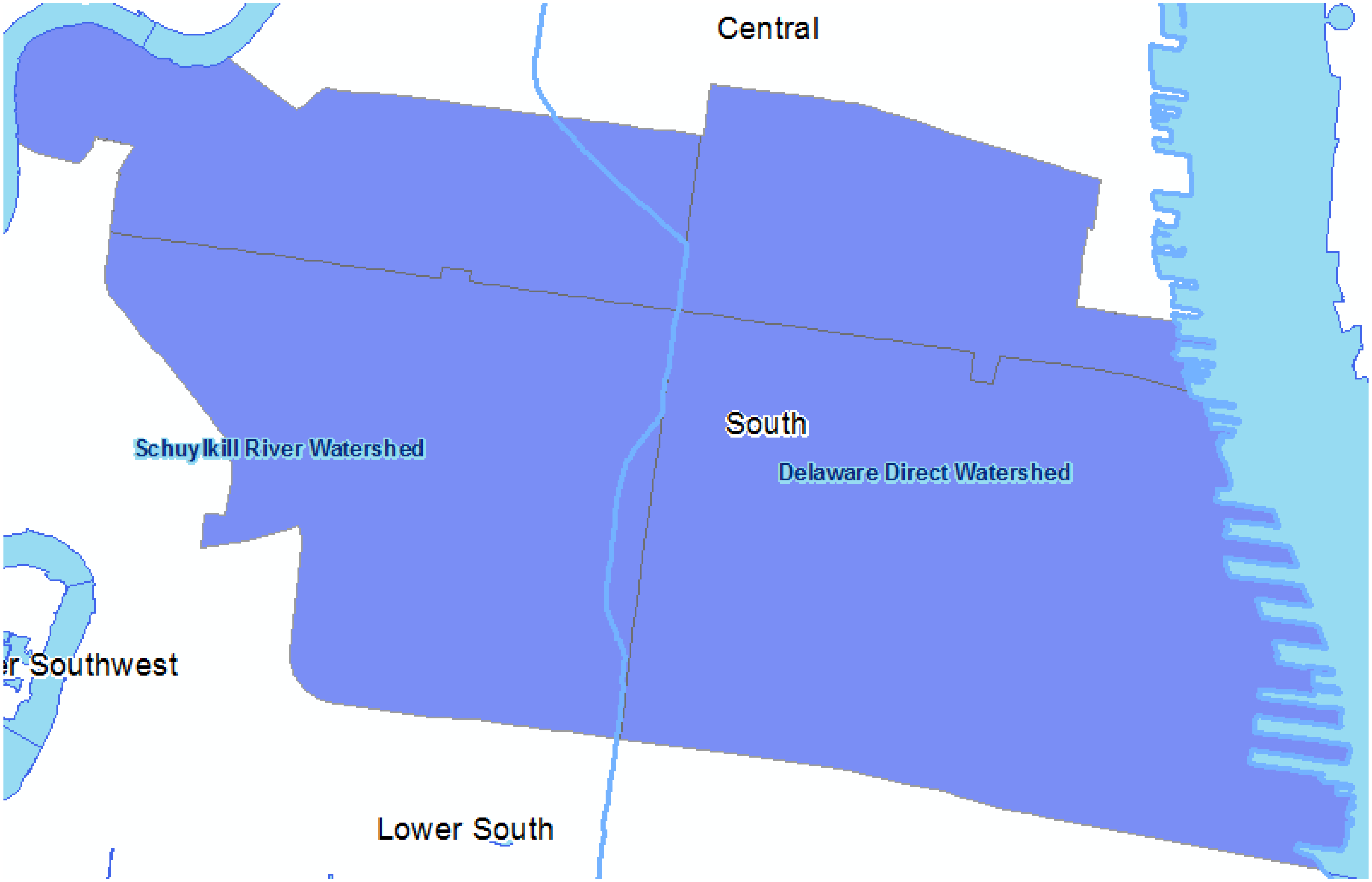
The South Planning District contains addresses in the zip codes 19146, 19147, 19145, and 19148.

Zip codes in the South Planning District



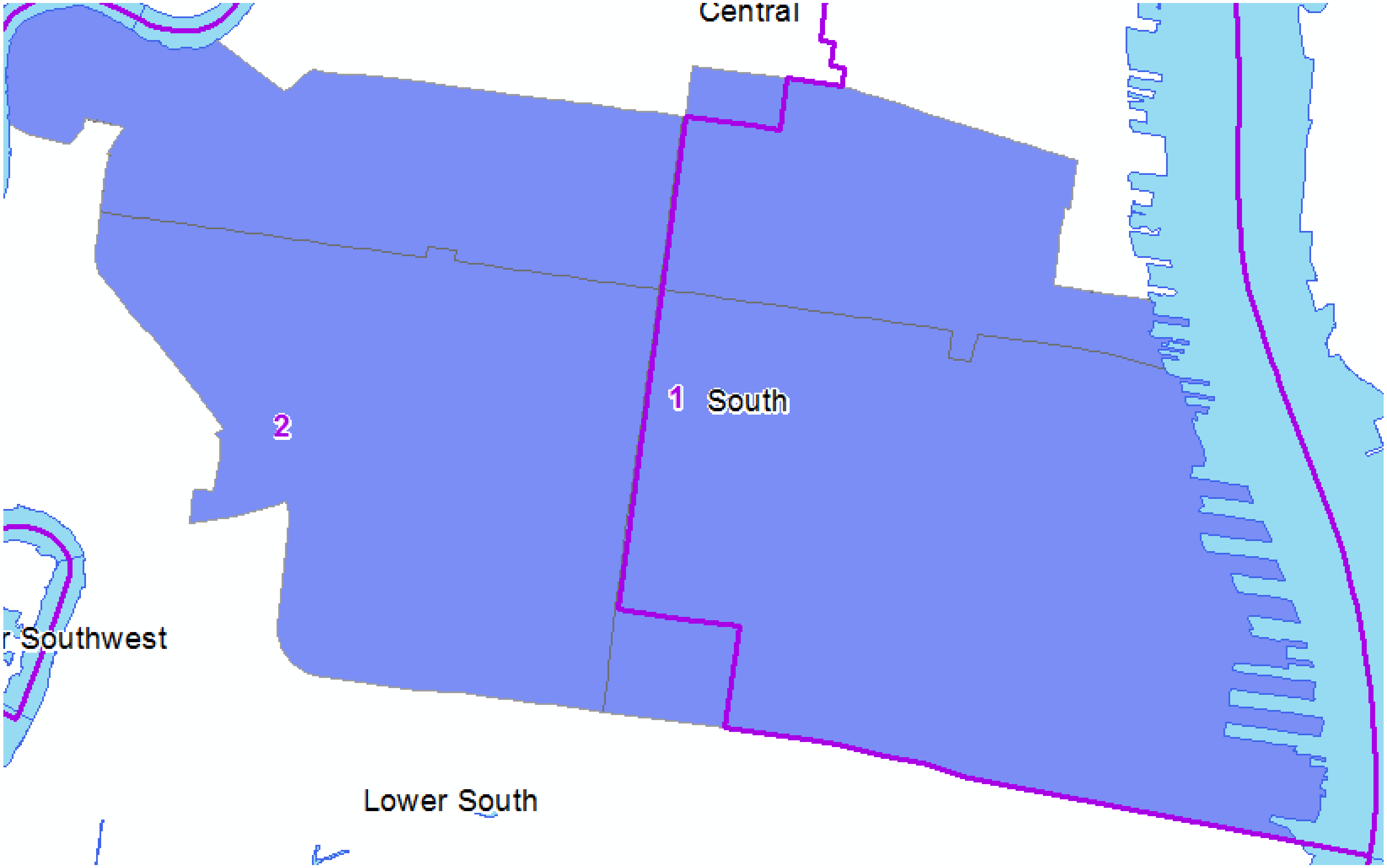
The South planning district falls partially in the Delaware Direct and Schuylkill River Watersheds.

Watersheds in the South Planning District



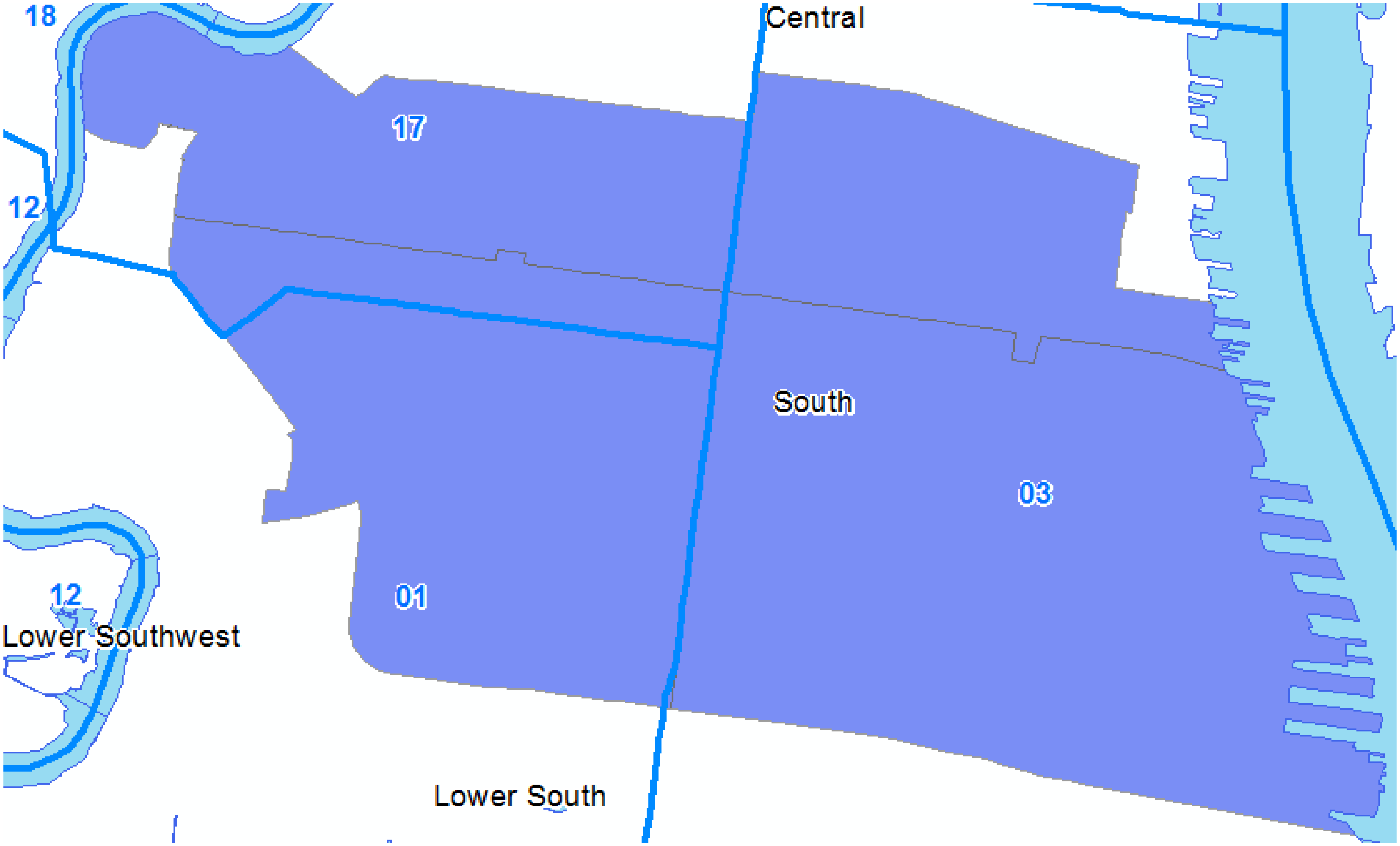
The South Planning District resides within the 2nd and 1st Council Districts of Philadelphia.

Council Districts in South Planning District



The South Planning District falls mostly within the 17th, 1st, and 3rd Police Districts.

Police Districts in the South Planning District



21.1.11.2 Current and Future Land Use

PCPC forecasts that the South District will see continued residential growth over the next ten years.[498] The proposed land use map provides a generalized road map for the appropriate densities of existing residential neighborhoods and boundaries/typologies for commercial and industrial areas.[499] [500]

Philadelphia South Planning District Existing Land Use

---

[498] City of Philadelphia, Philadelphia 2035. South District Plan. Retrieved November 20, 2015.

[499] Ibid.

[500] All graphics, charts, and recommendations come from the City of Philadelphia: Philadelphia 2035 South District Plan. Retrieved November 20, 2015.

Philadelphia South Planning District Future Land Use

21.1.11.3 Social Characteristics

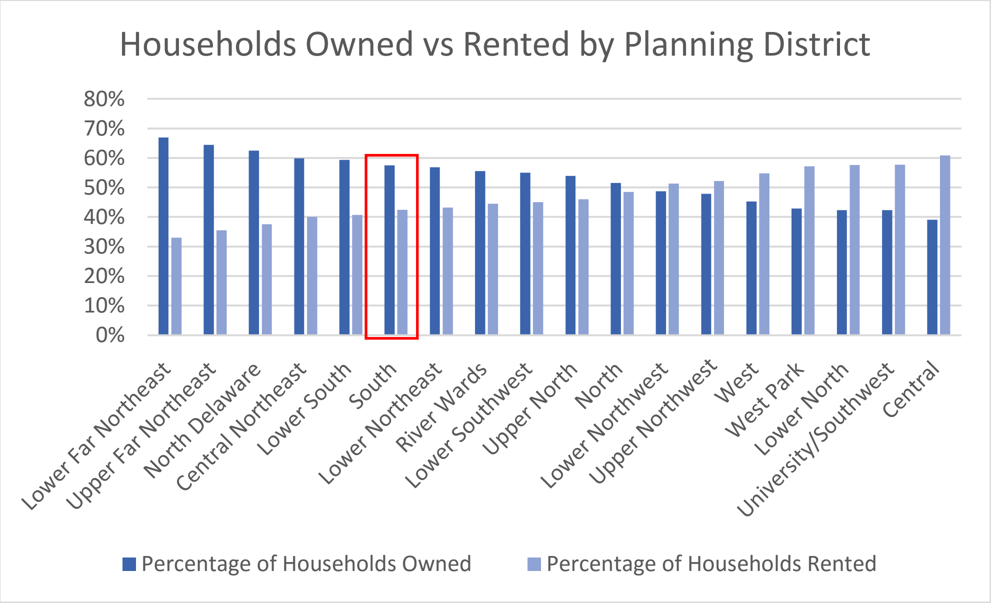
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

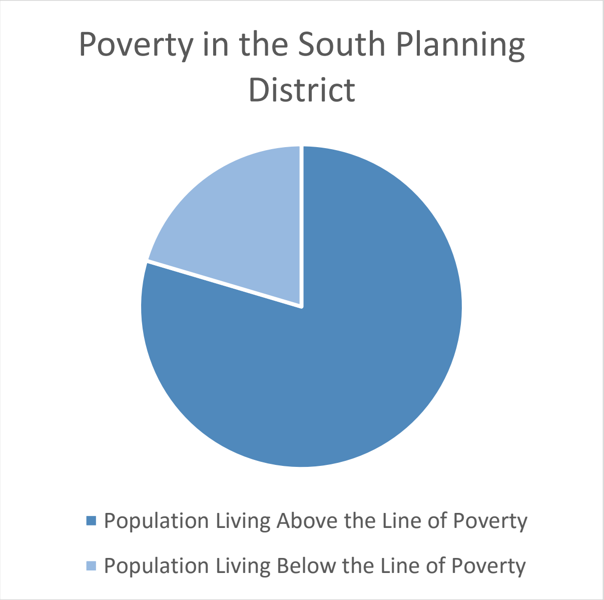
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	173,303
- Male population	82,732
- Female population	90,571
Median Age	34.6
- Age dependency ratio (the percentage of the population under 15 and over 64)	45.3%
- Population under 15	27.4%
- Population over 64	17.9%

21.1.11.4 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	69,299
- Households owned	39,855
- Households rented	29,444
No vehicle access	24,509
Population below the federal line of poverty	20.0%





21.1.11.5 Disability

Of those individuals residing within the South Planning District, 13.9 percent reported having a disability. Disabilities reported by individuals in the South Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	5.7%
Vision difficulty	6.1%
Cognitive difficulty	6.3%
Ambulatory Difficulty	6.0%
Self-care Difficulty	6.4%
Independent Living Difficulty	6.0%

21.1.11.6 South Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[501] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[502] [503] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the South Planning District.[504]

Structurally Deficient Bridges in the South Planning District

---

[501] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.
[502] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.
[503] Ibid.
[504] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the South Planning District		
Name	**Location**	**Year Built**
Walt Whitman Bridge	Delaware River	1957
CSX Transportation	Wharton St, west of 34th St	1918
CSX Railroad	Grays Ferry Ave at 34th St	1930
CSX Tunnels	Grays Ferry Ave at 34th St	1896

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. There are no dams in the South Planning District.

Dams in the South Planning District

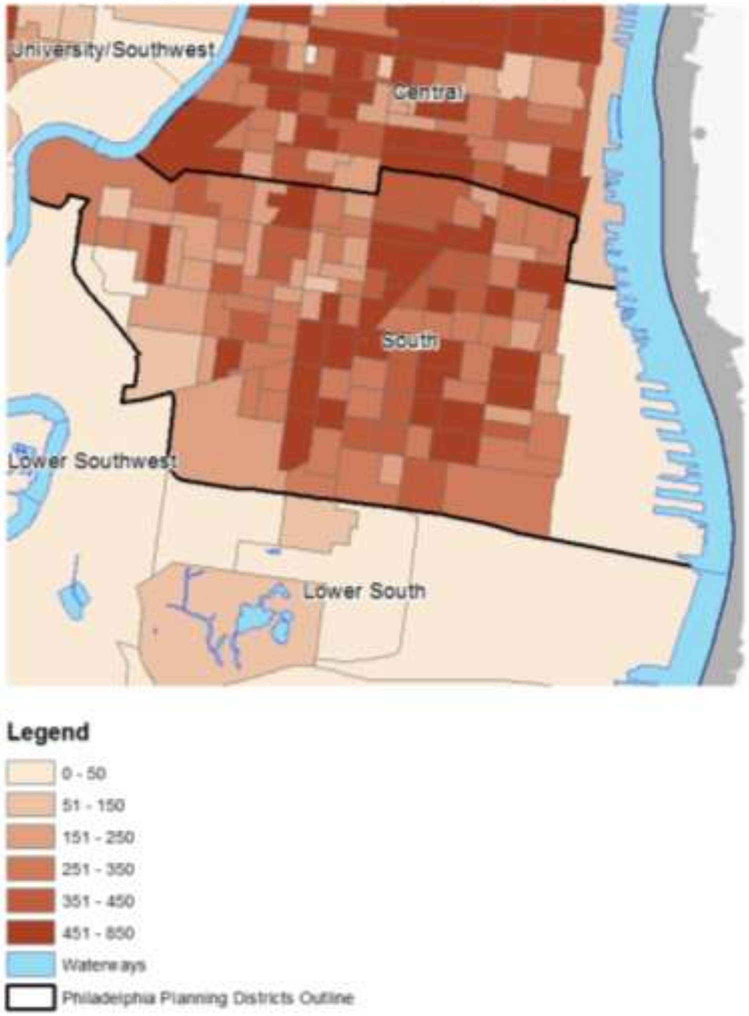
Building Collapse

Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance;
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

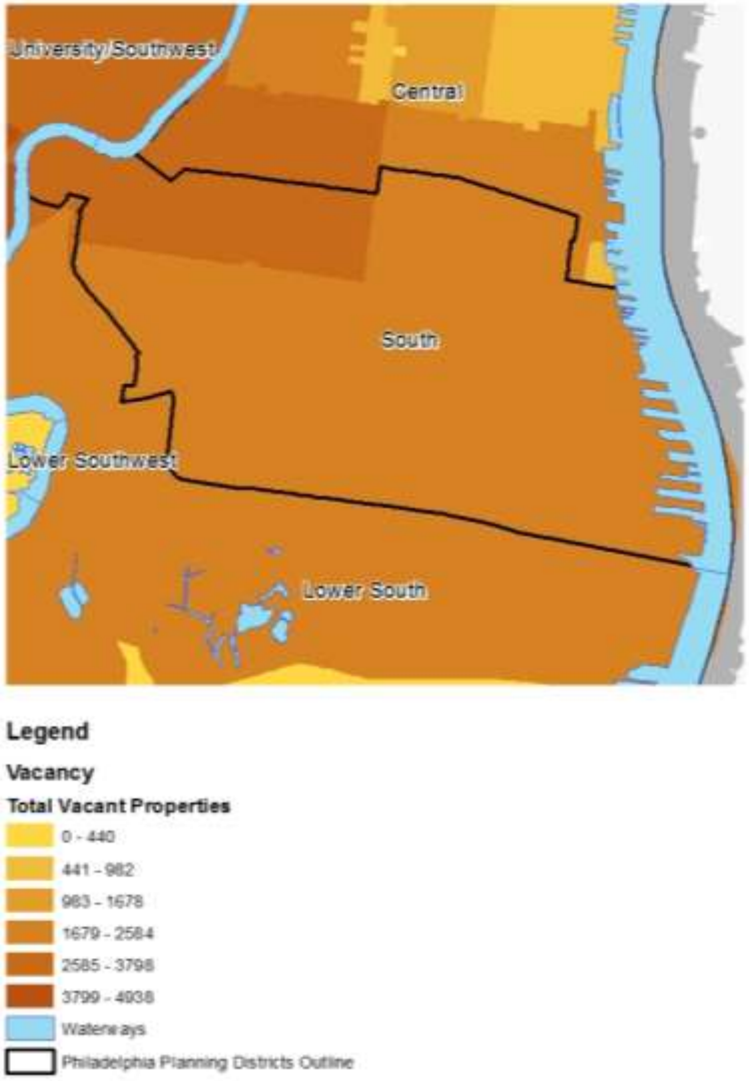
Building age increases the risk of collapse. The map to the right shows the number of properties built in the South Planning District built before 1939.

Structures Built Prior to 1939 in the South Planning District



Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the South Planning District. The South Planning District has several vacant properties throughout the district, with a slightly larger amount of vacant properties in the northwest.

Vacancy in the South Planning District



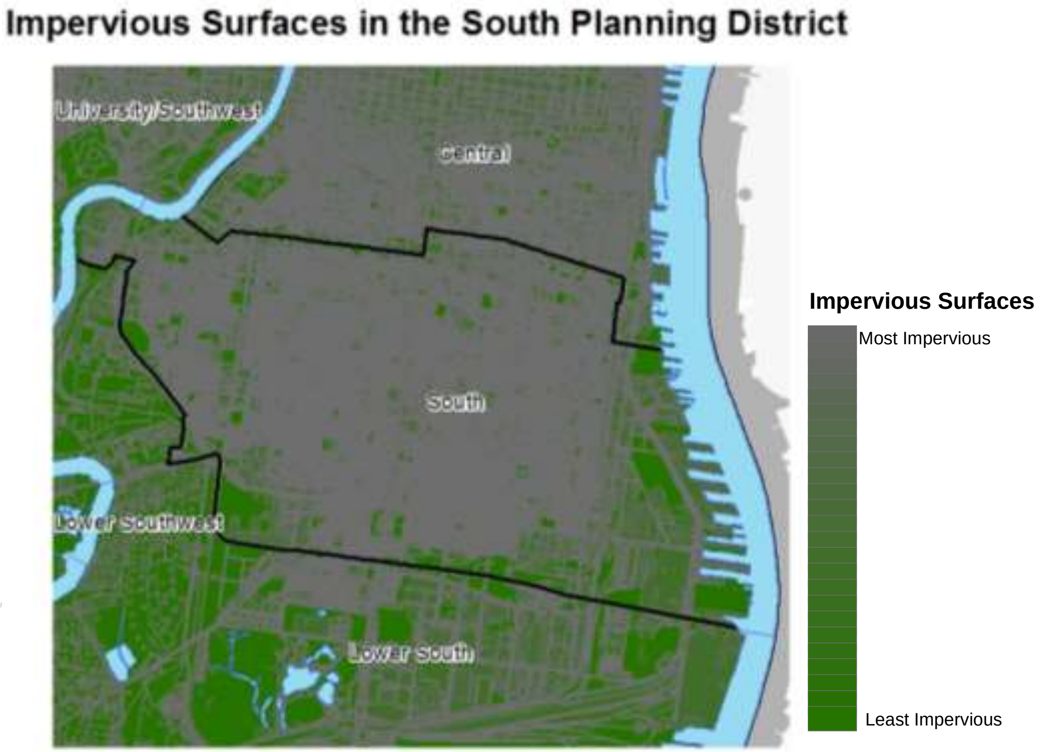
Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map to the right shows the location of imminently dangerous structures in the South Planning District.

Imminently Dangerous Structures in the South Planning District

Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[505] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[506] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the South Planning District.

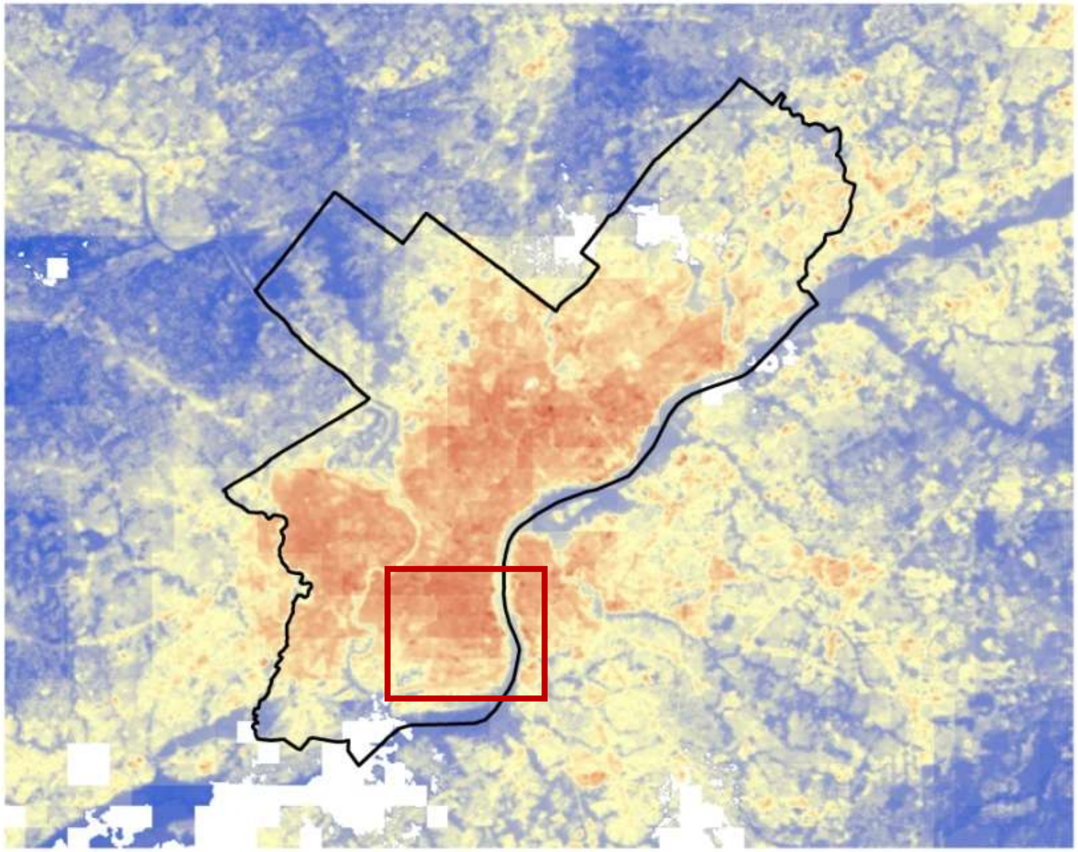


Impervious Surfaces in the South Planning District

---

[505] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[506] “Heat Island Effect”. US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[507] As the map shows, the South is located in an area which experiences higher heat island effects than other protions of the city. Impervious surfaces and housing density contribute to this effect.



---

[507] "Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002". URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[508]

Flood Hazard Areas in the South Planning District

Winter flooding includes 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. All forms of flooding can damage

---

[508] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

infrastructure.[509] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

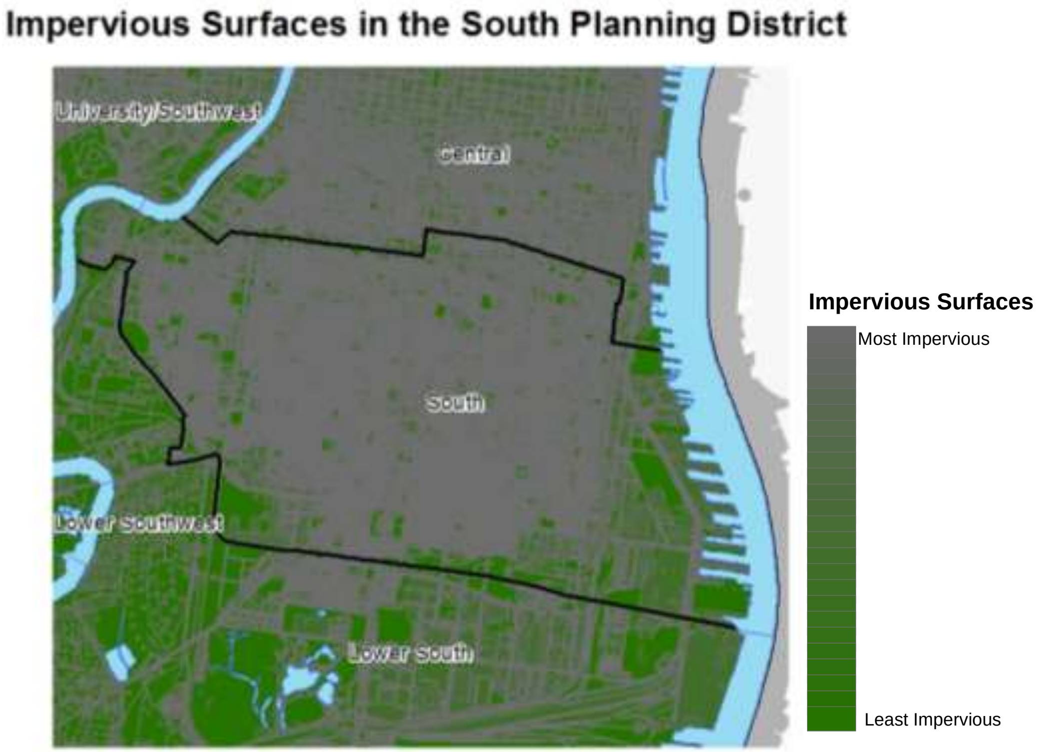
A small portion of the South Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the South Planning District there are 269 National Flood Insurance Program (NFIP) policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

---

[509] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Flash flooding is a concern for some areas of the South Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the South Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[510]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see [Hazardous Material Train Derailment]() under the [Risk Assessment]() section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the South Planning District

---

[510] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

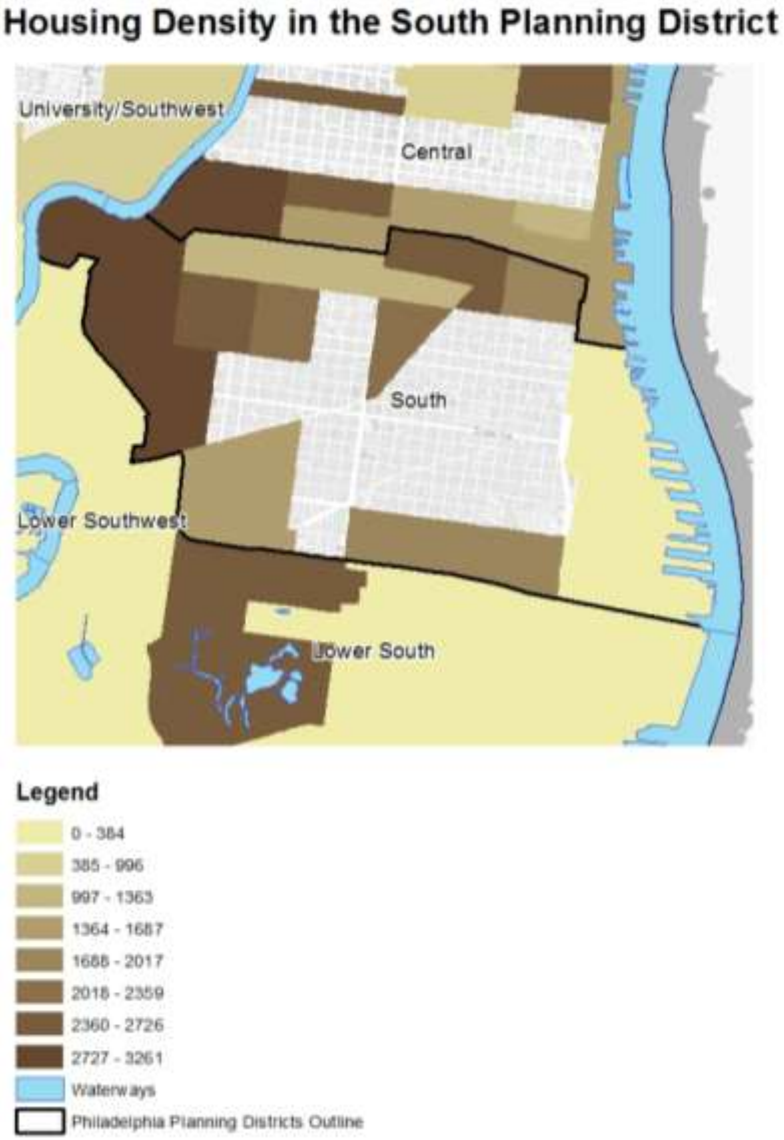
Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[511] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[512] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The South Planning District has several vacant properties throughout the district, with a slightly larger amount of vacant properties in the northwest.

---

[511] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.
[512] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the South Planning District's housing density. Data was unavailable for those portions of the map left uncolored. The available data shows housing density is greater in the western portion of the planning district.



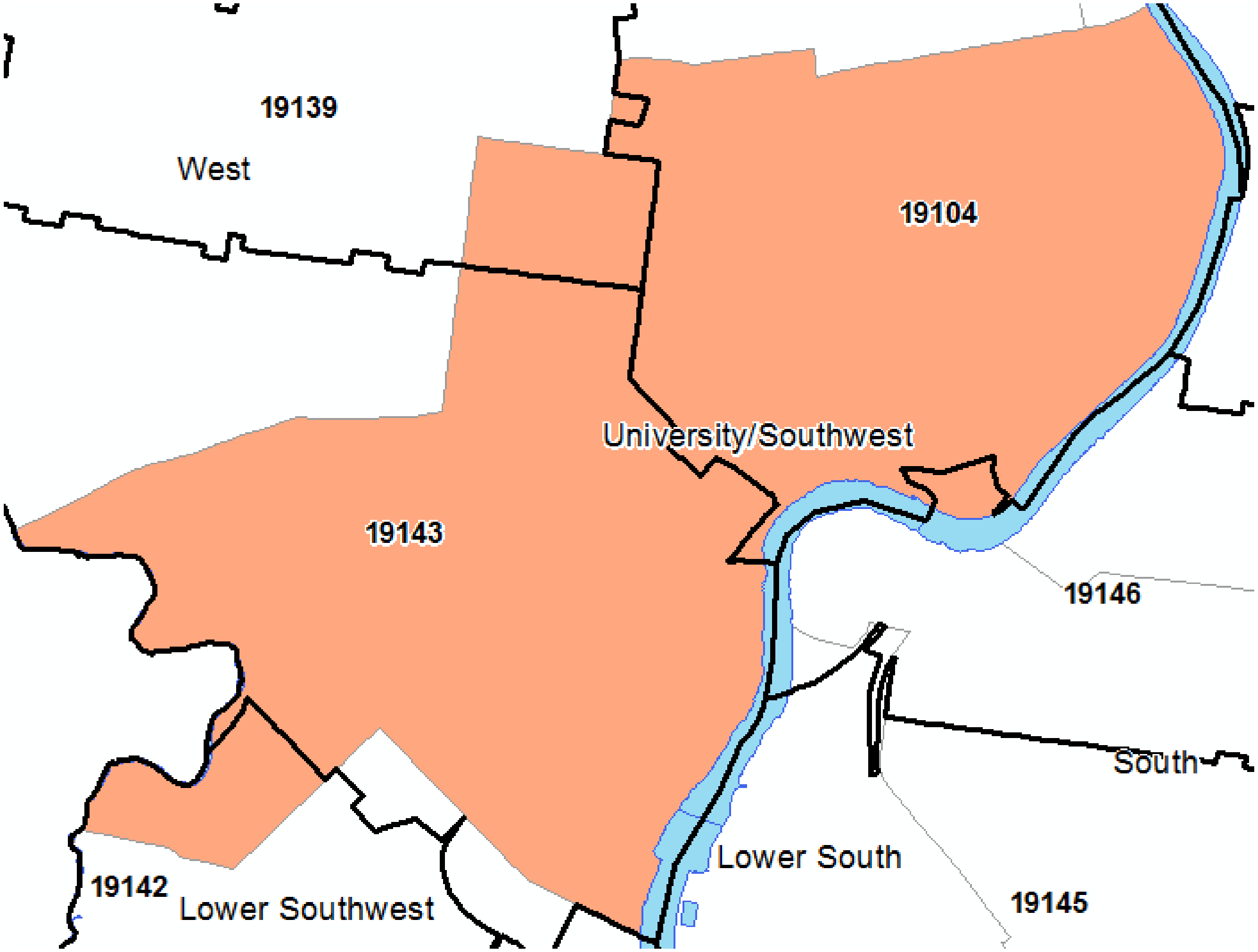
Housing Density in the South Planning District

21.1.12 University Southwest Planning District

21.1.12.1 Geography and Hydrology

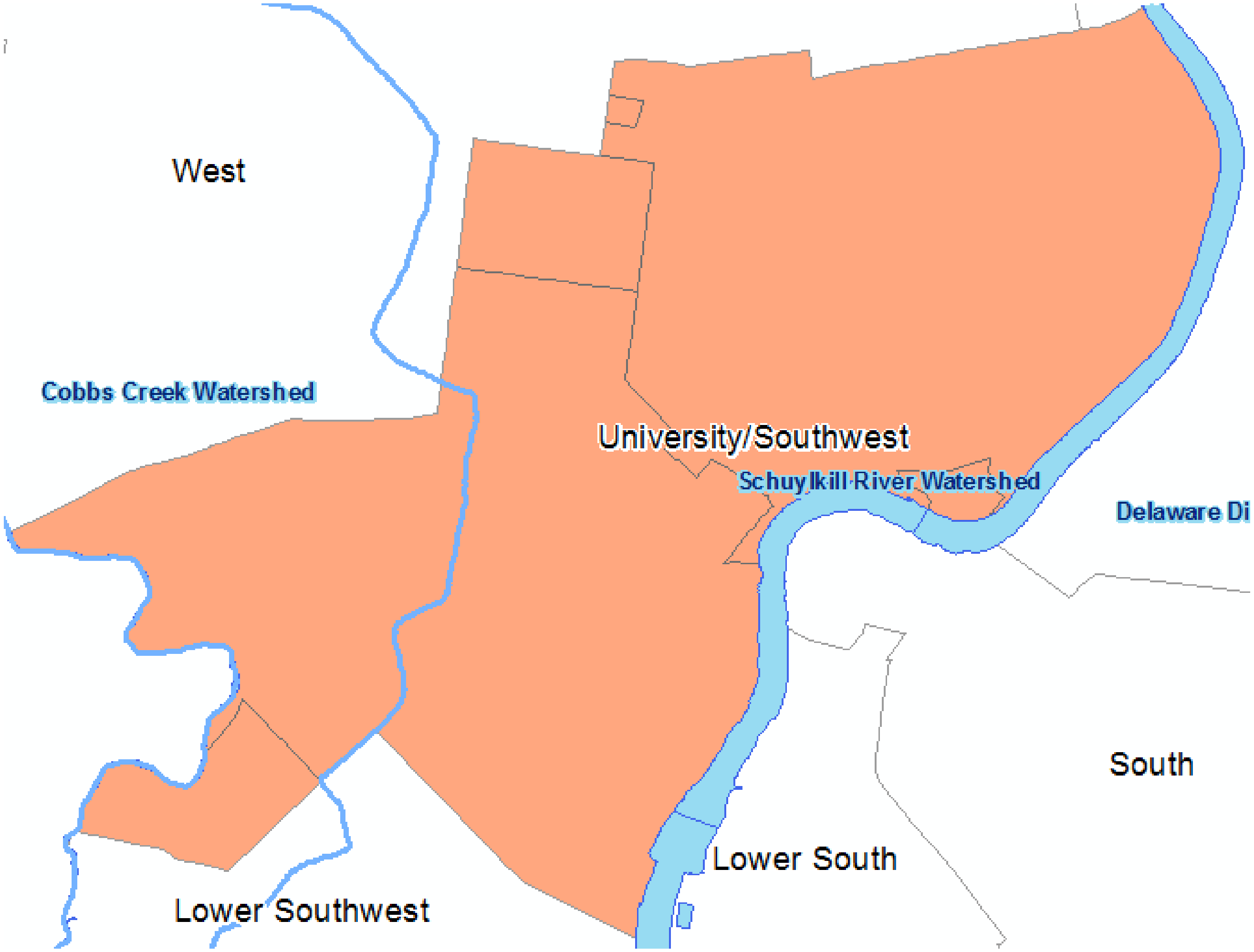
The University Southwest Planning District contains addresses in the zip codes 19104, 19143, and 19142.

Zip codes in the University Southwest Planning District



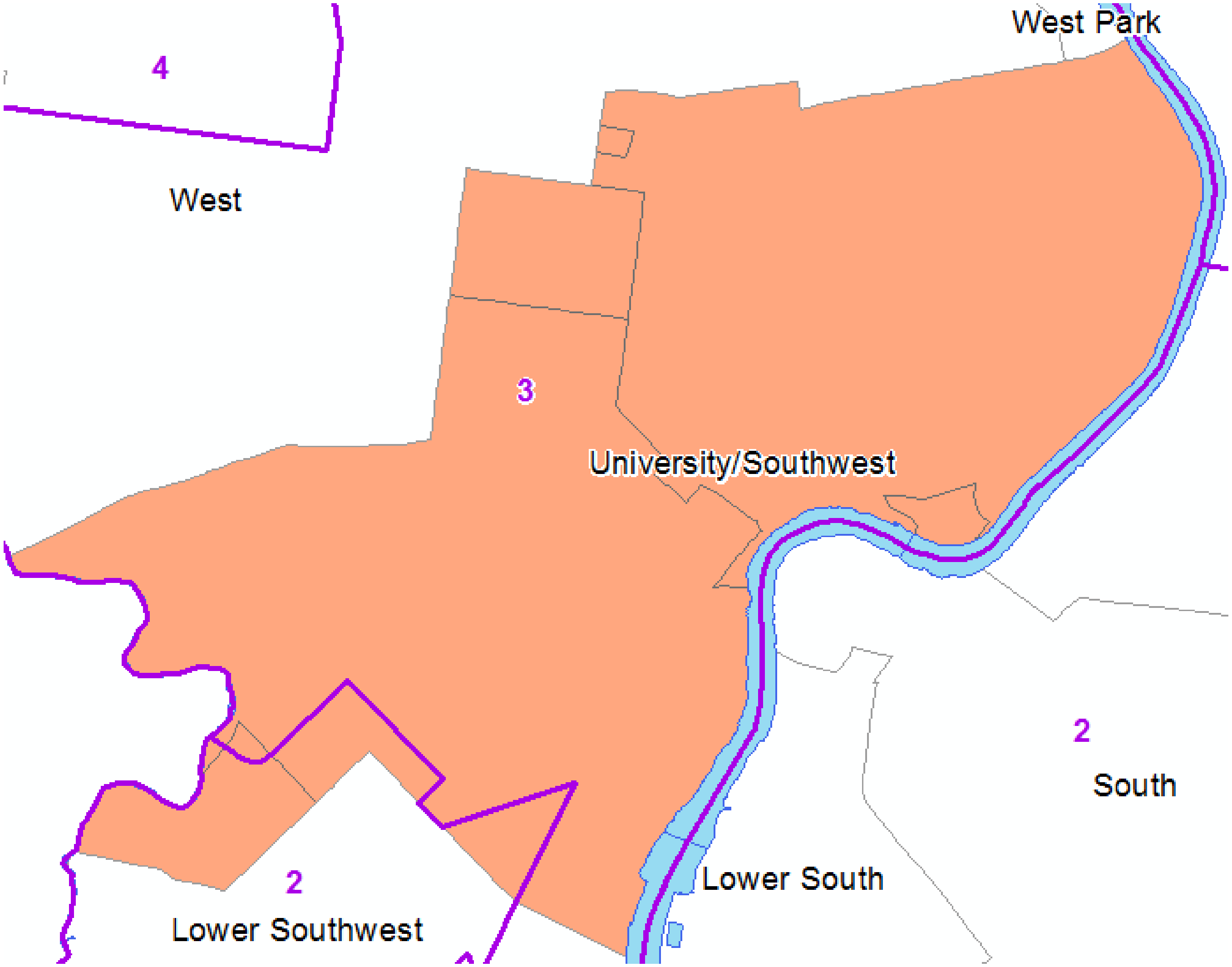
The University Southwest planning district falls partially in the Cobbs Creek and Schuylkill River Watersheds.

Watersheds in the University Southwest Planning District



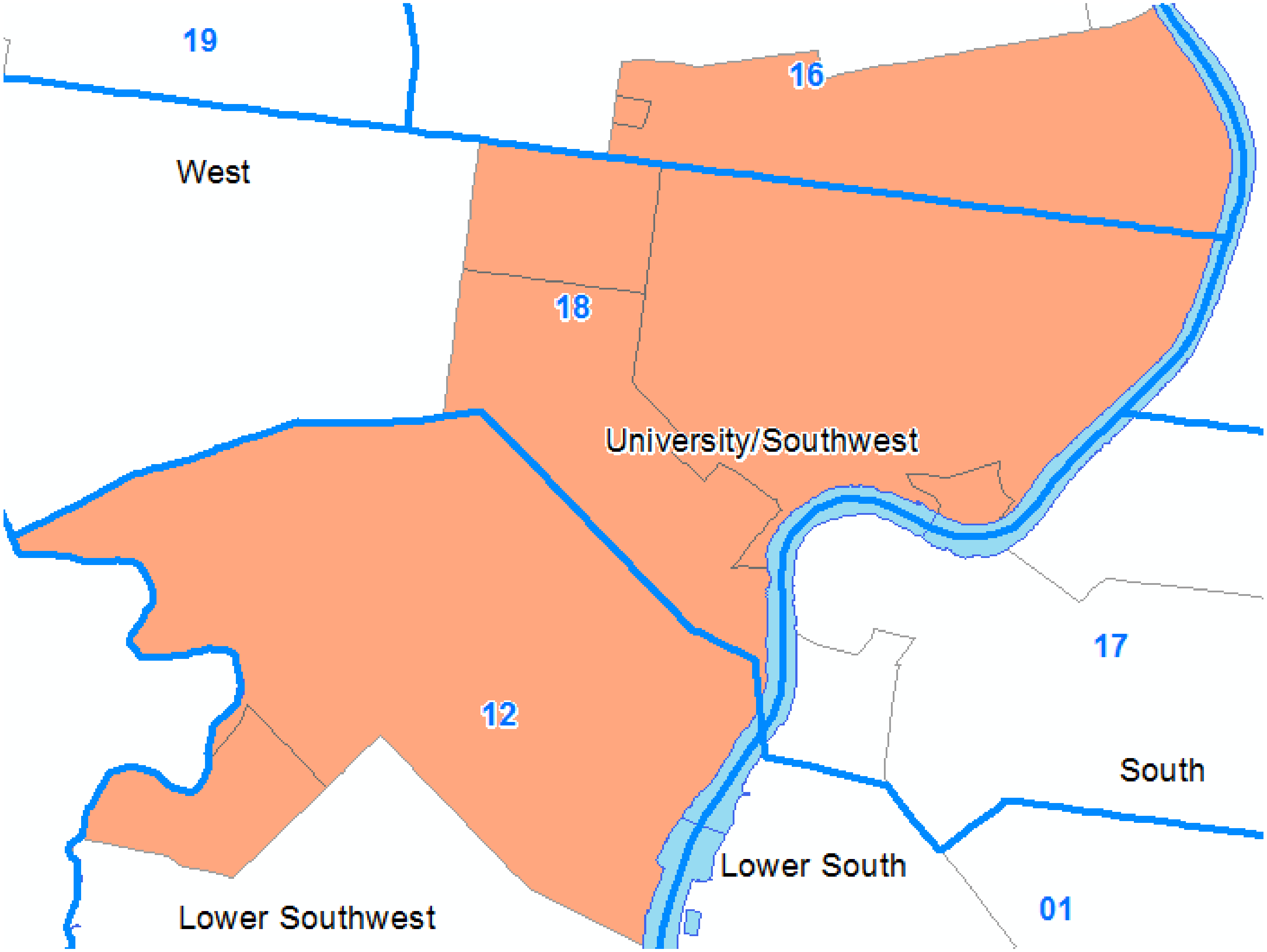
The University Southwest Planning District resides within the 3rd and 2nd Council Districts of Philadelphia.

Council Districts in University Southwest Planning District



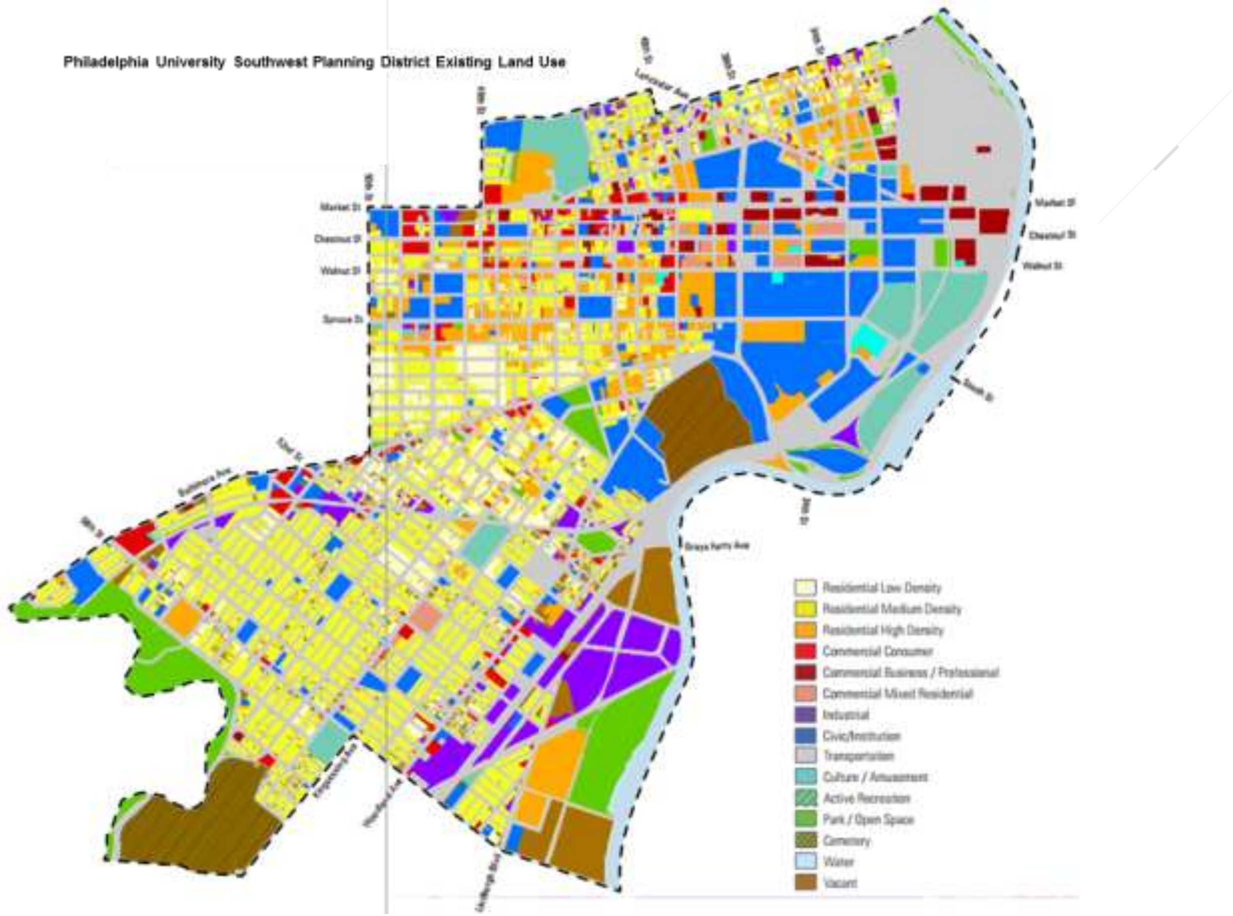
The University Southwest Planning District falls within 12th, 18th, and 16th Police Districts.

Police Districts in the University Southwest Planning District



21.1.12.2 *Current and Future Land Use*

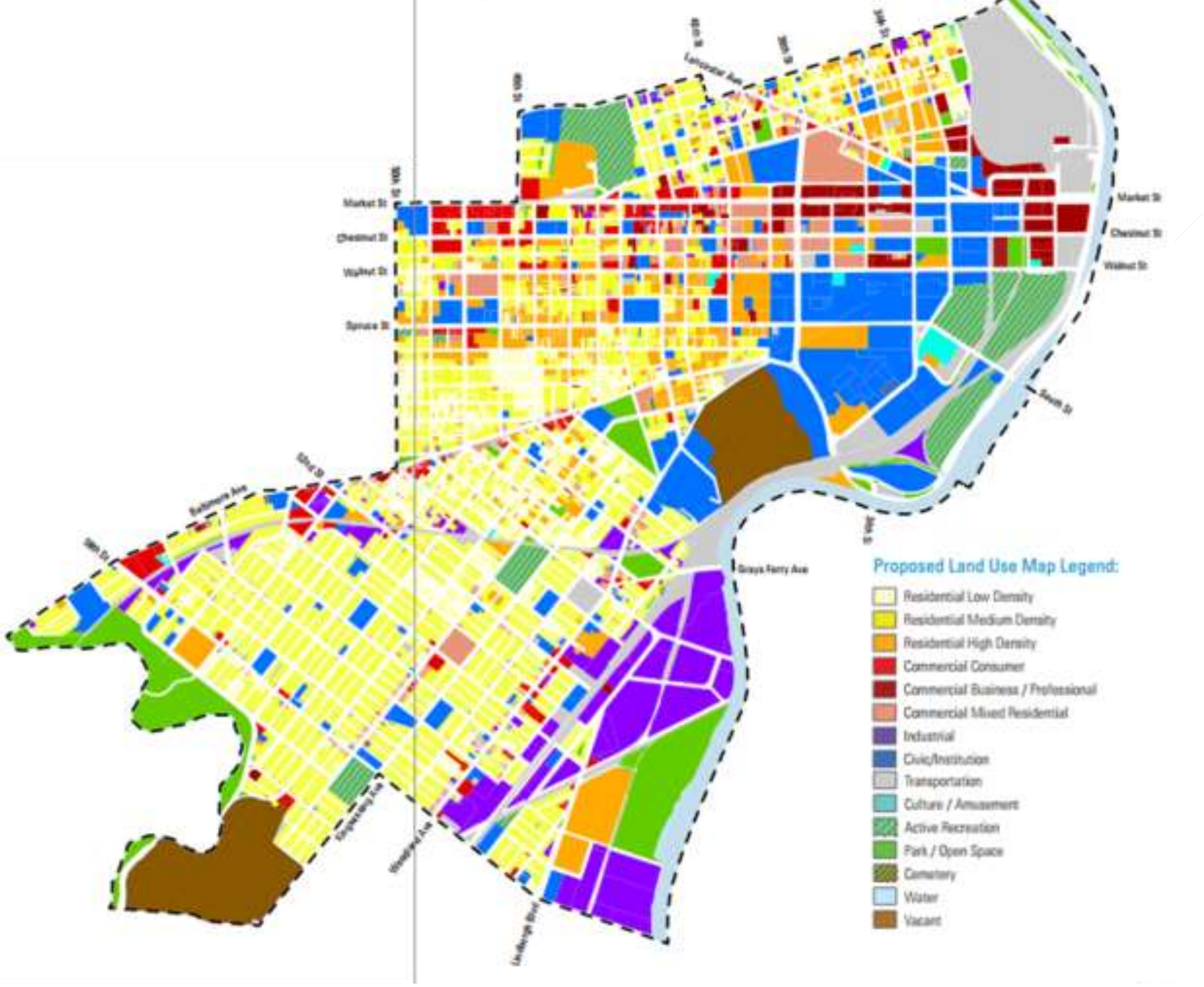
PCPC forecasts that the University Southwest District will see moderate growth over the next ten years, as well as continued job growth.[513] Future land use of the district takes into account those areas that are stable, such as the residential neighborhoods and some commercial areas, as well as where growth can and should be accommodated.[514] [515]



---

[513] City of Philadelphia, Philadelphia 2035. University South District Plan. Retrieved November 20, 2015.
[514] Ibid.

Philadelphia University Southwest Planning District Future Land Use



---

[515] All graphics, charts, and recommendations come from the City of Philadelphia: Philadelphia 2035 University South District Plan. Retrieved November 20, 2015.

21.1.12.3 Social Characteristics

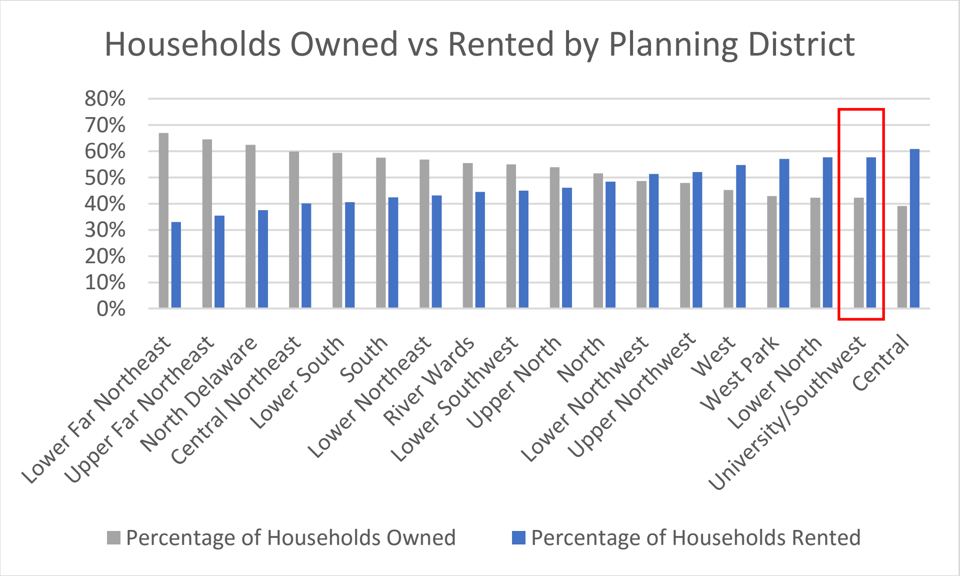
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

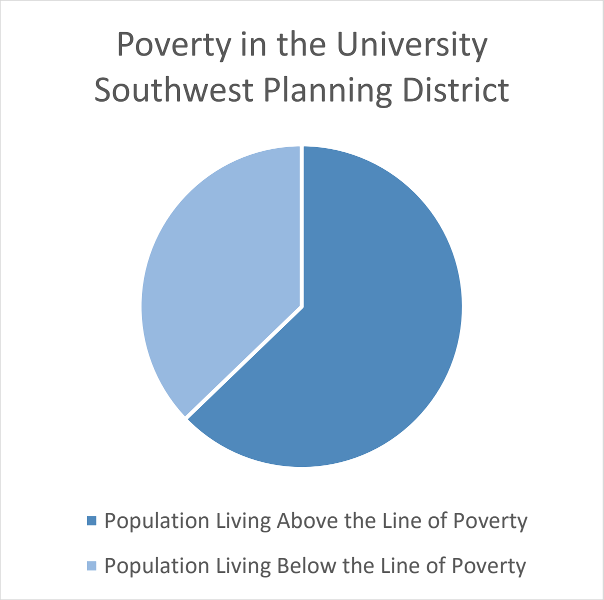
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	188,654
- Male population	88,547
- Female population	100,107
Median Age	29.7
- Age dependency ratio (the percentage of the population under 15 and over 64)	50.3%
- Population under 15	35.8%
- Population over 64	14.5%

21.1.12.4 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	66,136
- Households owned	28,001
- Households rented	38,135
No vehicle access	32,108
Population below the federal line of poverty	38.2%





21.1.12.5 Disability

Of those individuals residing within the University Southwest Planning District, 14.0 percent reported having a disability. Disabilities reported by individuals in the University Southwest Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	6.3%
Vision difficulty	6.5%
Cognitive difficulty	7.3%
Ambulatory Difficulty	7.8%
Self-care Difficulty	7.2%
Independent Living Difficulty	6.5%

21.1.12.6 University Southwest Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

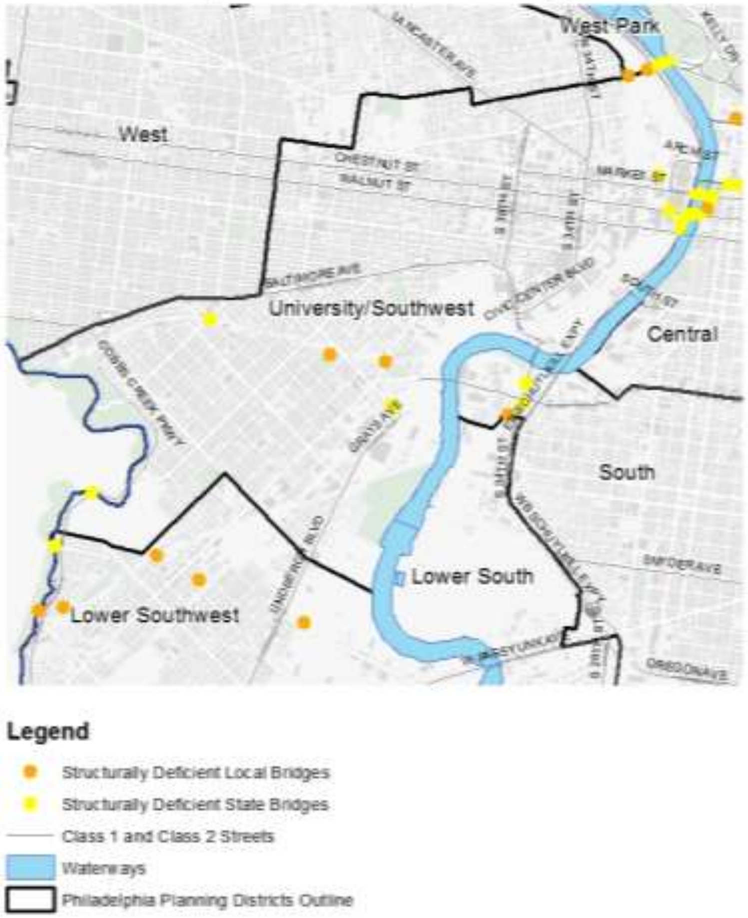
Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[516] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[517] [518] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the University Southwest Planning District.[519]

Structurally Deficient Bridges in the University Southwest Planning District



---

[516] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.
[517] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.
[518] Ibid.
[519] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the University Southwest Planning District		
Name	**Location**	**Year Built**
Amtrak & SEPTA, 32nd	Spring Garden St at 30th St Station	1964
Amtrak Northeast Corridor	Spring Garden St at 31st St	1964
SEPTA	Woodland Ave and W. 47th St	1920
SEPTA	49th St, south of Chester Ave	1942
CSX Railroad	Chestnut St	1901
Market St	Market St and Schuylkill River	1932
Cobbs Creek Parkway	Cobbs Creek	1924
SEPTA West Chester Bridge	Whitby Ave and South Baltimore Ave	1917
Amtrak, New York to Washington Branch	49th St	1923
SEPTA, West Branch	Kennedy Blvd, west of 30th St Station	1903
Schuylkill Expressway	Between Walnut and Chestnut	1959
West River Dr	Spring Garden St	1966

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. There are no dams within the University Southwest Planning District, with the closest dam located in the West Park Planning District to the northeast.

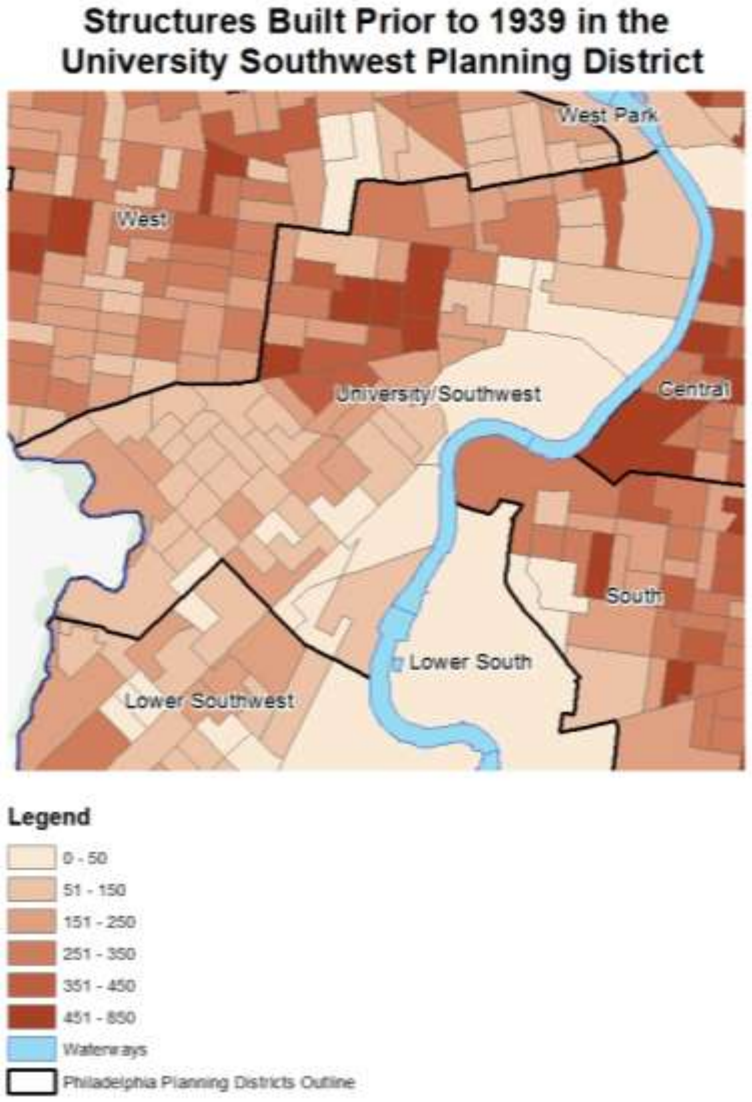
Dams in the University Southwest Planning District

Building Collapse

Buildings may collapse for a variety of reasons, including:

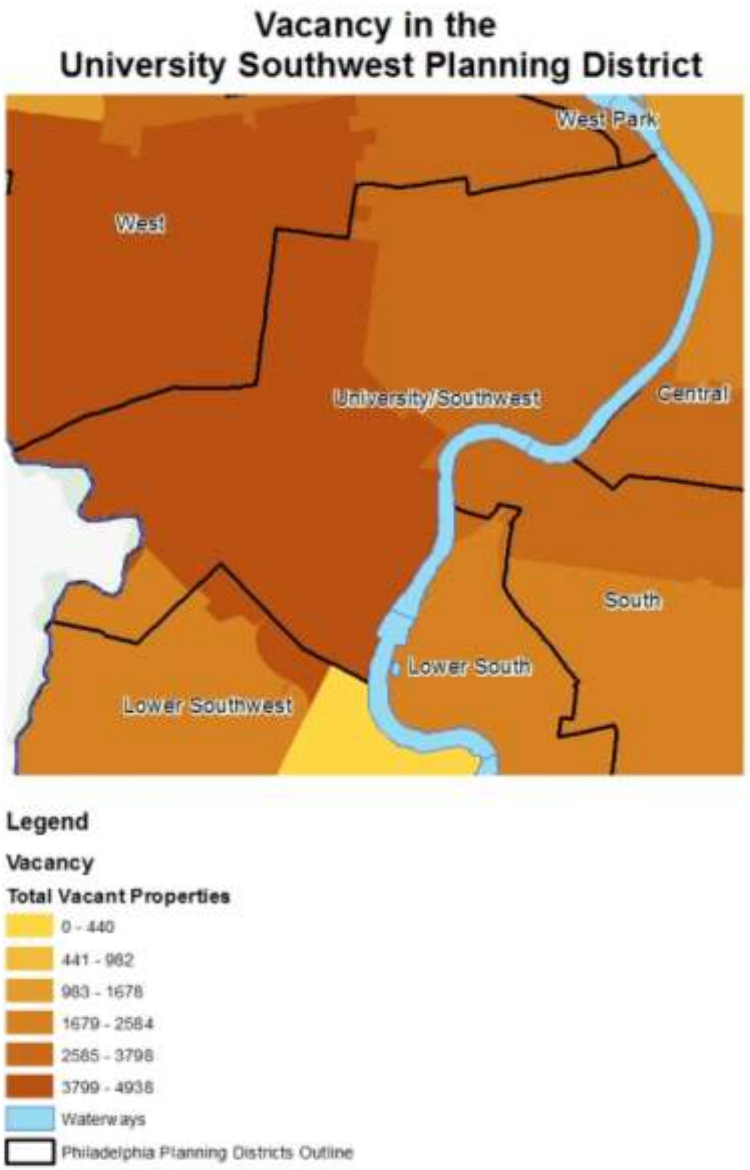
- Overall structural integrity;
- Poor construction or maintenance;
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the University Southwest Planning District built before 1939.



Structures Built Prior to 1939 in the University Southwest Planning District

Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the University Southwest Planning District. The University Southwest Planning District has a comparatively higher number of vacant properties than many other parts of Philadelphia.



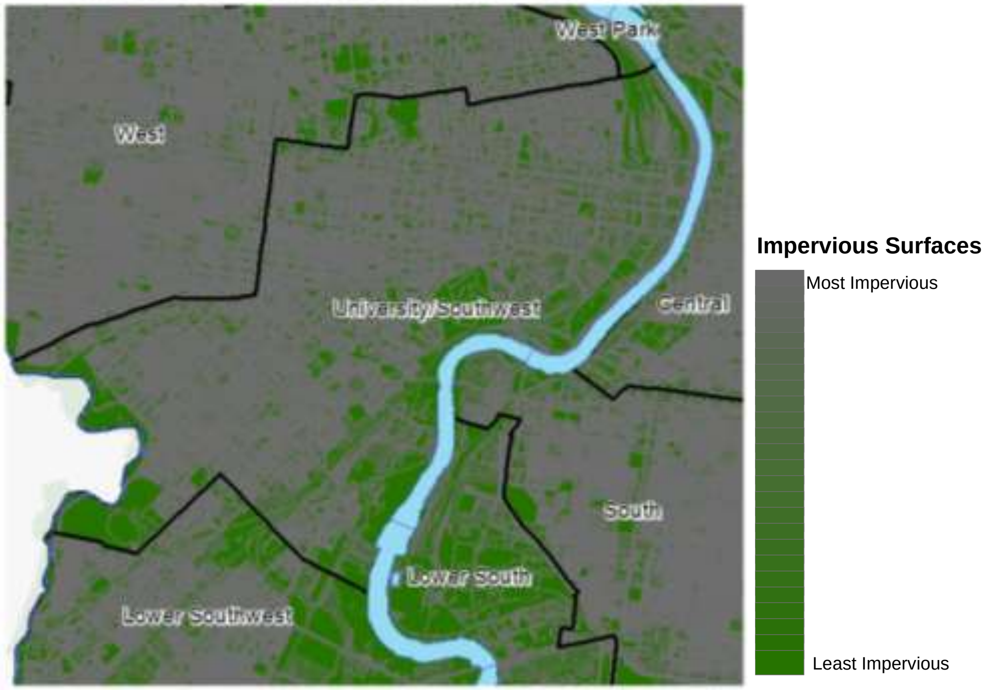
Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the University Southwest Planning District, most of which are located in the southwestern portion of the planning district.

Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[520] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[521] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the University Southwest Planning District.

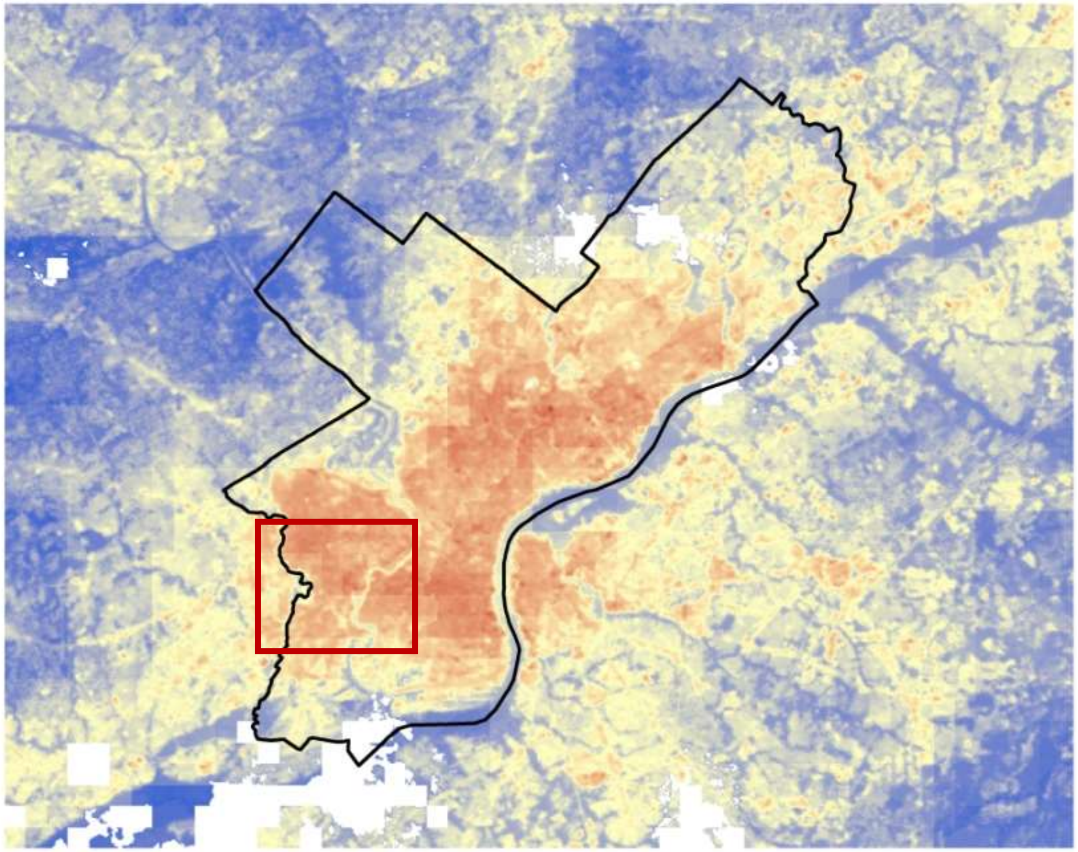
Impervious Surfaces in the University Southwest Planning District



---

[520] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[521] “Heat Island Effect”. US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[522] As the map shows, the University Southwest is located in an area which experiences higher heat island effects than other portions of the city and surrounding counties.



---

[522] “Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002”. URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.


Flood Hazard Areas in the University Southwest Planning District

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[523]

Winter flooding includes 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. All forms of flooding can damage infrastructure.[524] For more

---

[523] “Standard Operating Guide”. Commonwealth of Pennsylvania’s All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

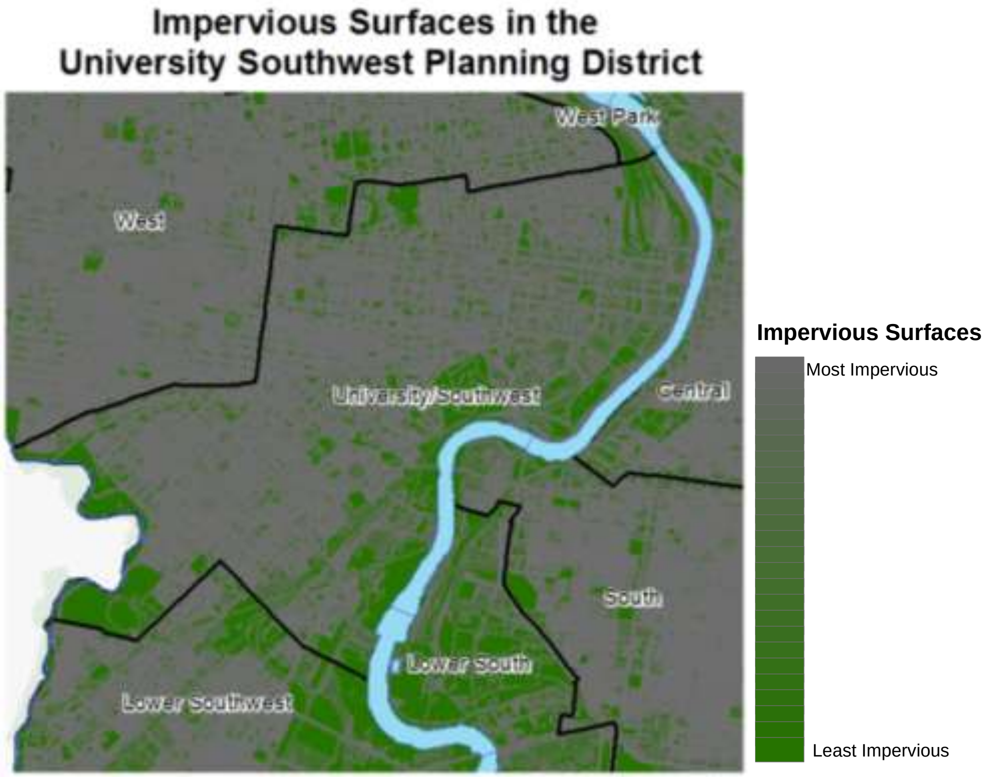
[524] “Standard Operating Guide”. Commonwealth of Pennsylvania’s All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

A small portion of the University Southwest Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the University Southwest Planning District there are 61 National Flood Insurance Program (NFIP) policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

Flash flooding is a concern for some areas of the University Southwest Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the University Southwest Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[525]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see [Hazardous Material Train Derailment](#) under the [Risk Assessment](#) section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the University Southwest Planning District

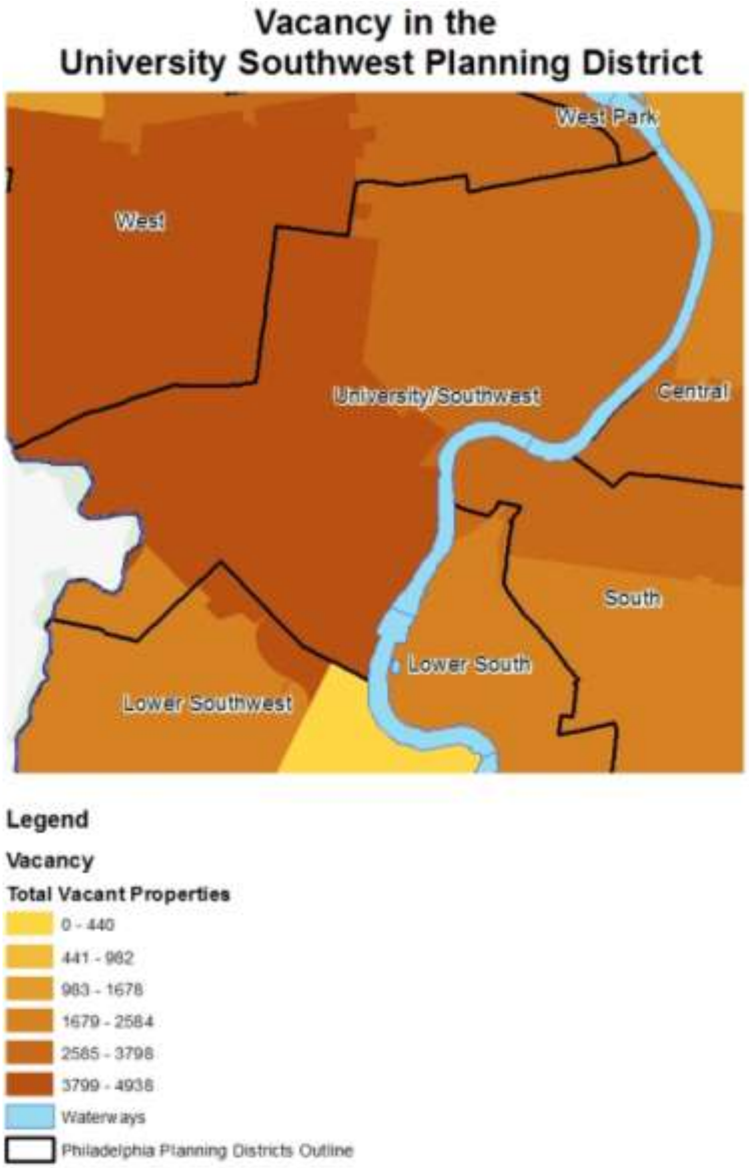
---

[525] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[526] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[527] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The University Southwest Planning District has a comparatively higher number of vacant properties than many other parts of Philadelphia.

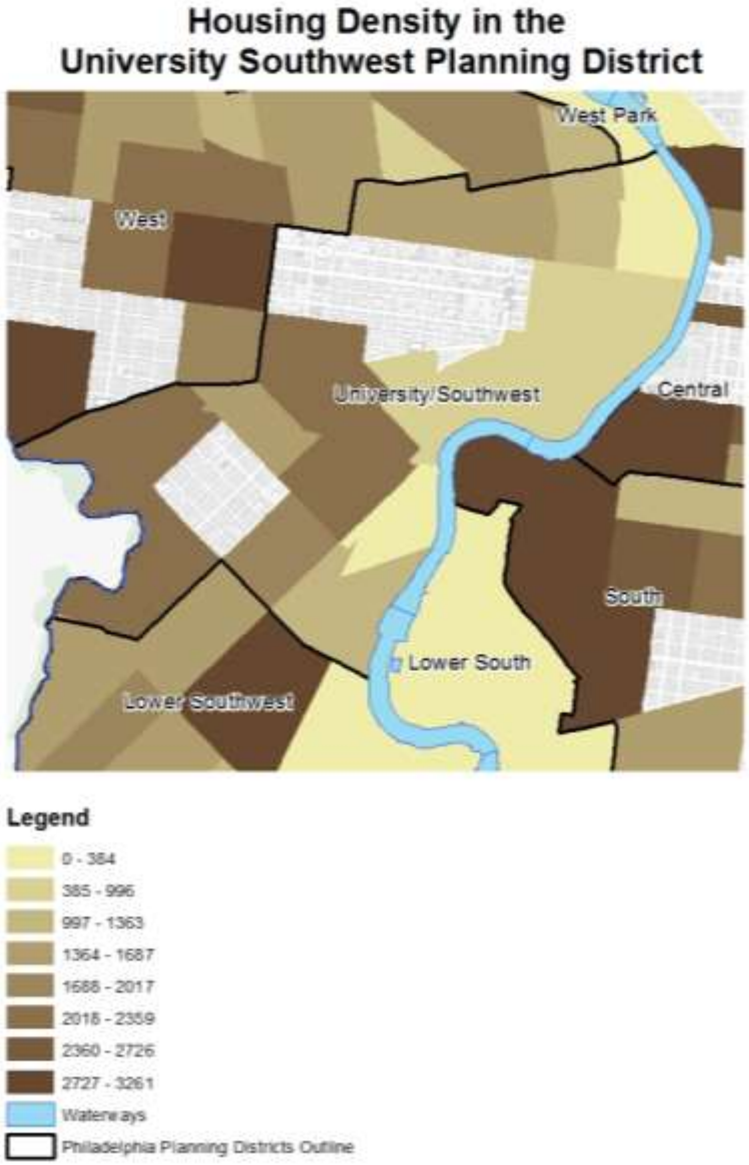


---

[526] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.

[527] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the University Southwest Planning District's housing density. Data was unavailable for those portions of the map left uncolored.

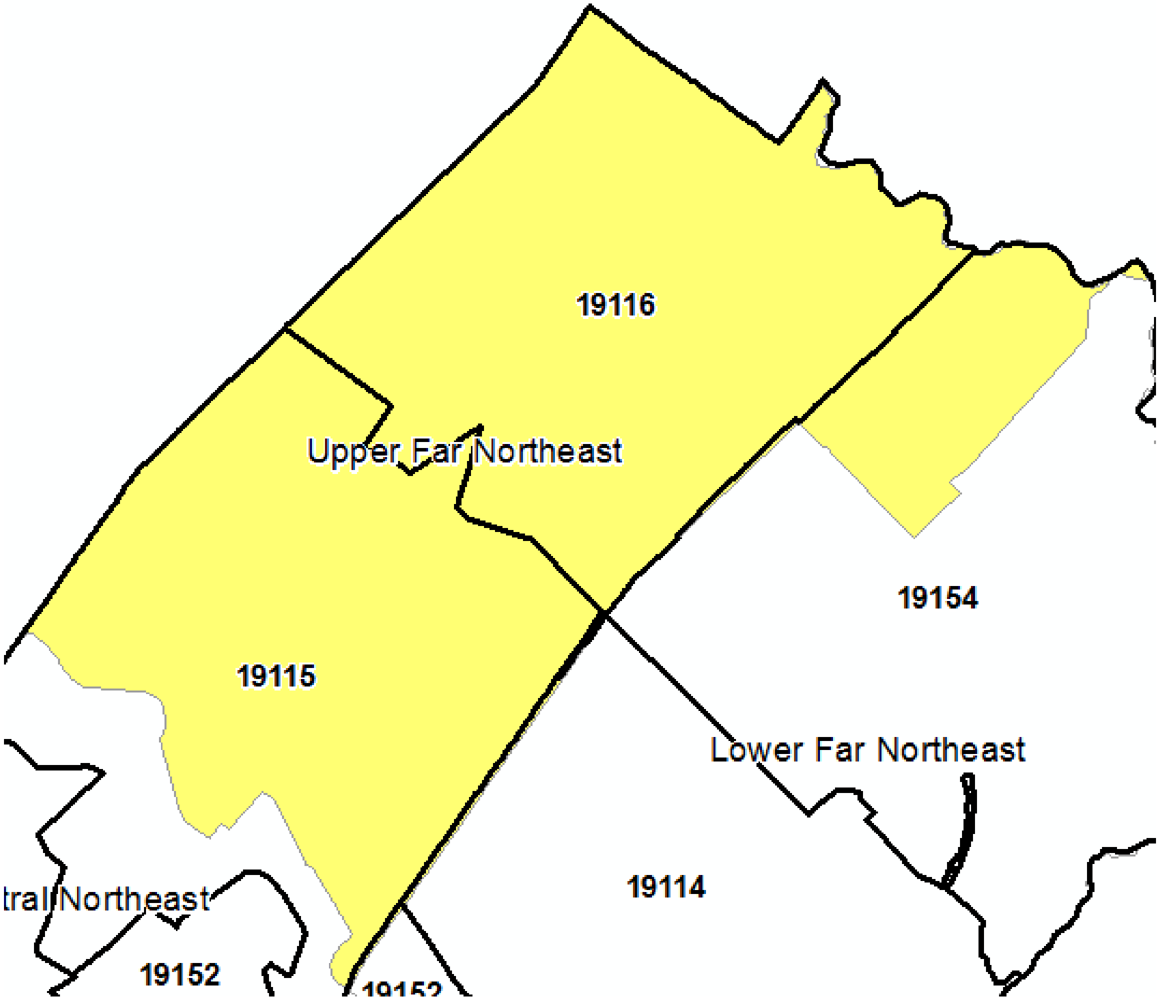


21.1.13 Upper Far Northeast

21.1.13.1 Geography and Hydrology

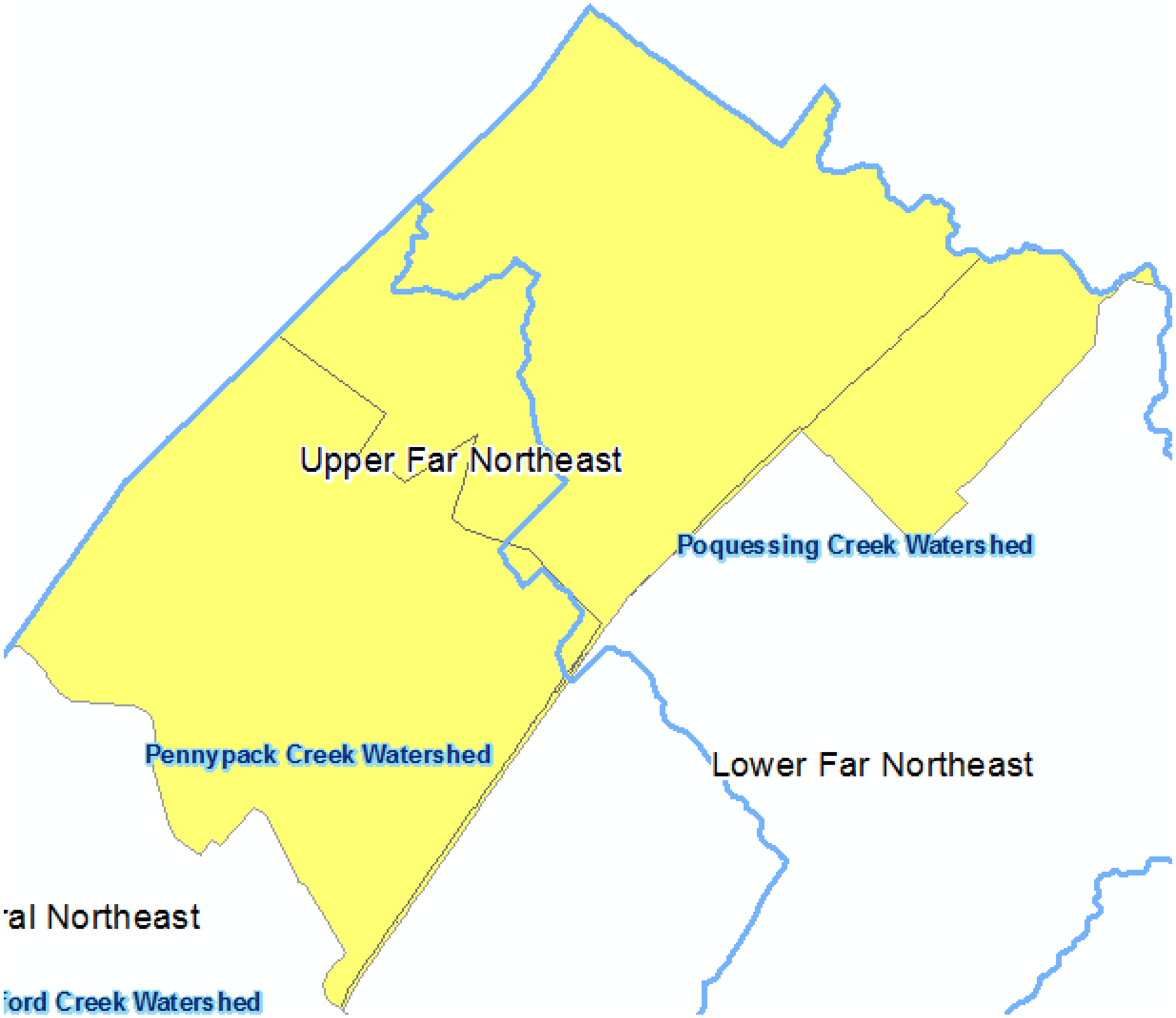
The Upper Far Northeast planning district contains addresses in the zip codes 19116, 19115, and 19154.

Zip codes in the Upper Far Northeast Planning District



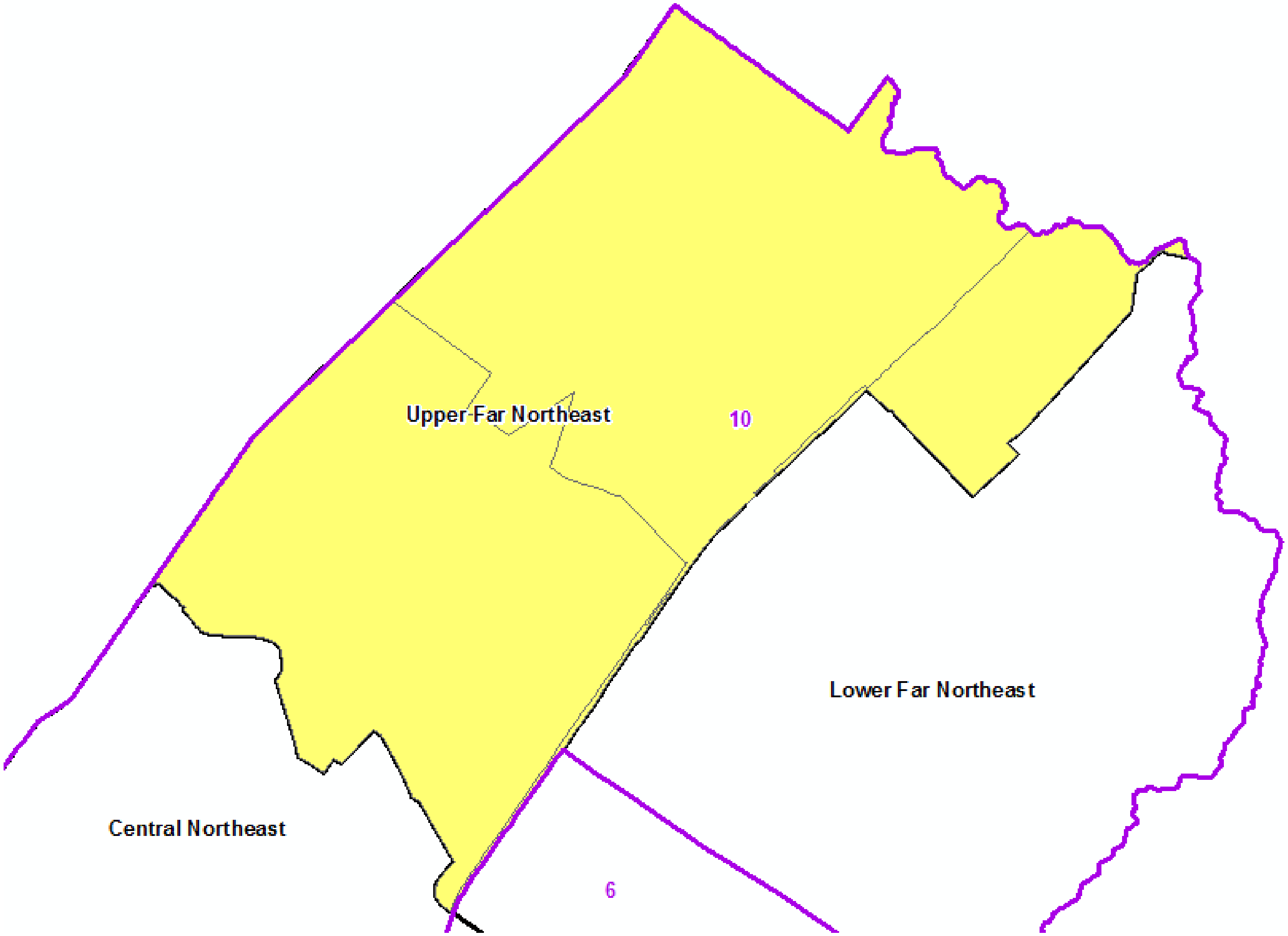
The Upper Far Northeast planning district fall partially in the Pennypack Creek and Poquessing Creek Watersheds.

Watersheds in the Upper Far Northeast Planning District



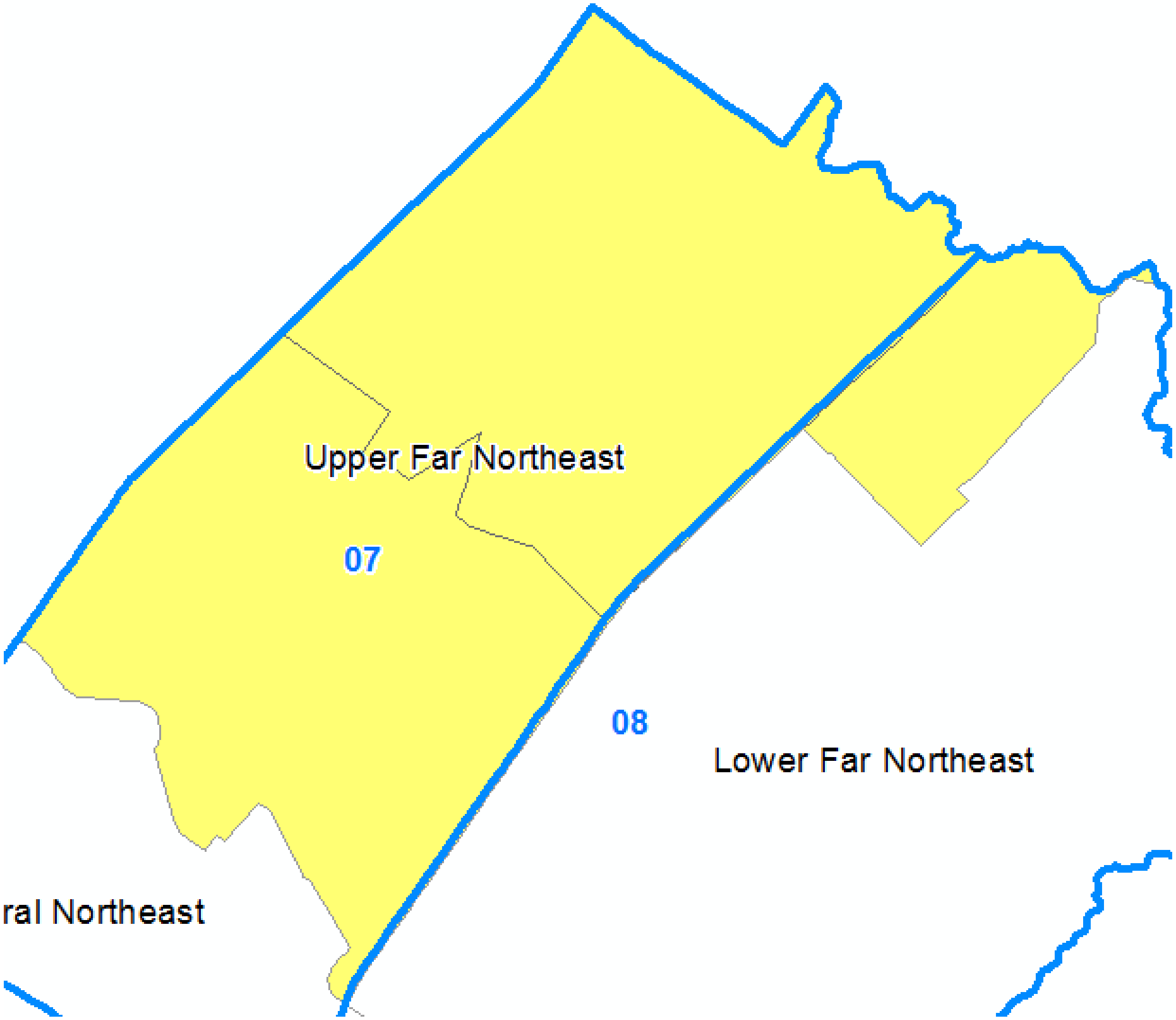
The Upper Far Northeast planning district resides within the 10th Council District of Philadelphia.

Council Districts in the Upper Far Northeast Planning District



The Upper Far Northeast planning district falls mostly within the 7th Police District, and also crosses into the 8th Police District.

Police Districts in the Upper Far Northeast Planning District



21.1.13.2 Social Characteristics

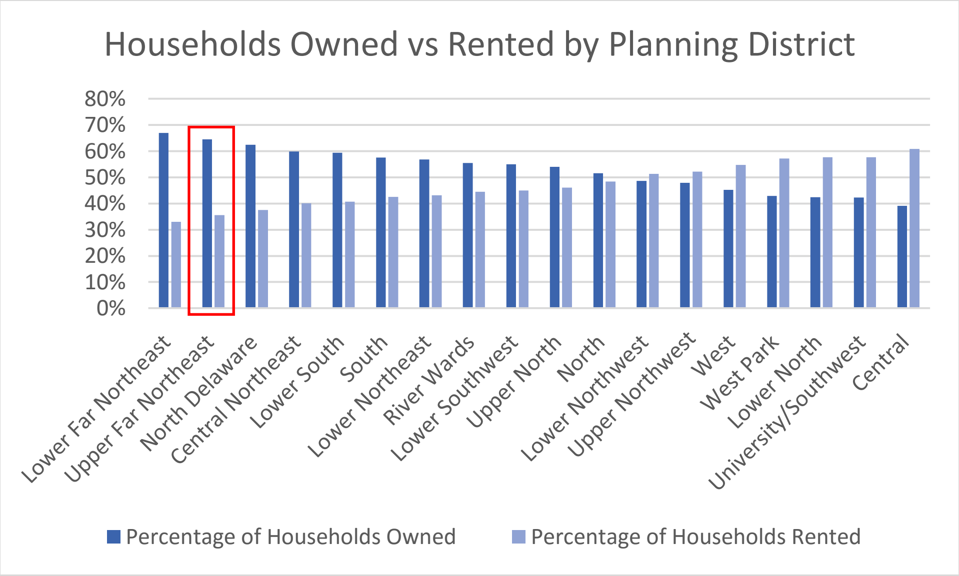
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

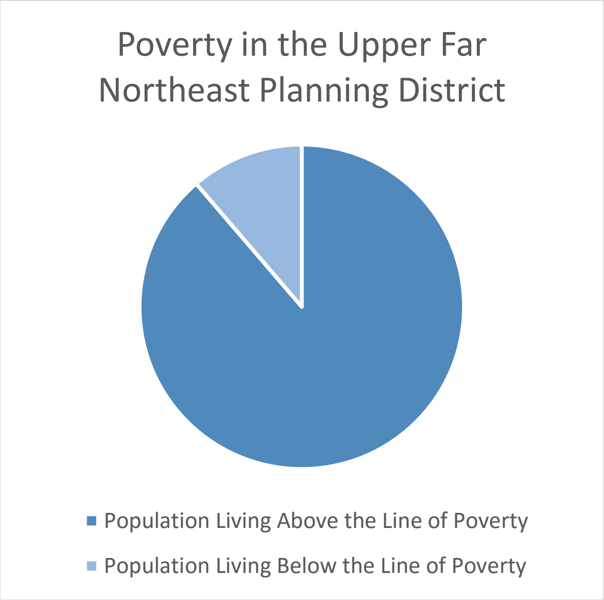
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	164,978
- Male population	76,657
- Female population	85,321
Median Age	42.44
- Age dependency ratio (the percentage of the population under 15 and over 64)	64.52%
- Population under 15	32.54%
- Population over 64	31.96%

21.1.13.3 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	63,744
- Households owned	41,099
- Households rented	22,645
No vehicle access	7,876
Population below the federal line of poverty	11.28%





21.1.13.4 Disability

Of those individuals residing within the Upper Far Northeast Planning District, 15.4 percent reported having a disability. The table below lists disabilities reported by individuals in the Upper Far Northeast Planning District by the percentage of the total population of the District. Disabilities are not exclusive, as some individuals may report having more than one disability type.

Disability Reported	Percentage of Population
Hearing difficulty	4.8%
Vision difficulty	5.3%
Cognitive difficulty	5.8%
Ambulatory Difficulty	5.6%
Self-care Difficulty	5.6%
Independent Living Difficulty	5.4%

21.1.13.5 Upper Far Northeast Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

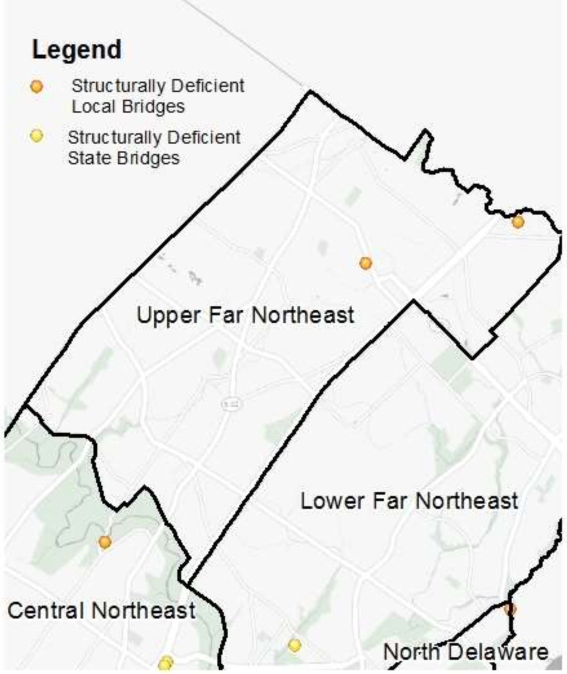
Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[528] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A “structurally deficient bridge” typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[529] [530] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the Upper Far Northeast Planning District.[531]

Structurally Deficient Bridges in the Upper Far Northeast Planning District



Structurally Deficient Bridges in the Upper Far Northeast Planning District

Name	Location	Year Built
CSX Transportation	Byberry Rd and NW Route 1	1996
Poquessing Creek	Old Lincoln and US 1	1805

---

[528] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[529] 2010 Status of the Nation’s Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[530] Ibid.

[531] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Dam Failure

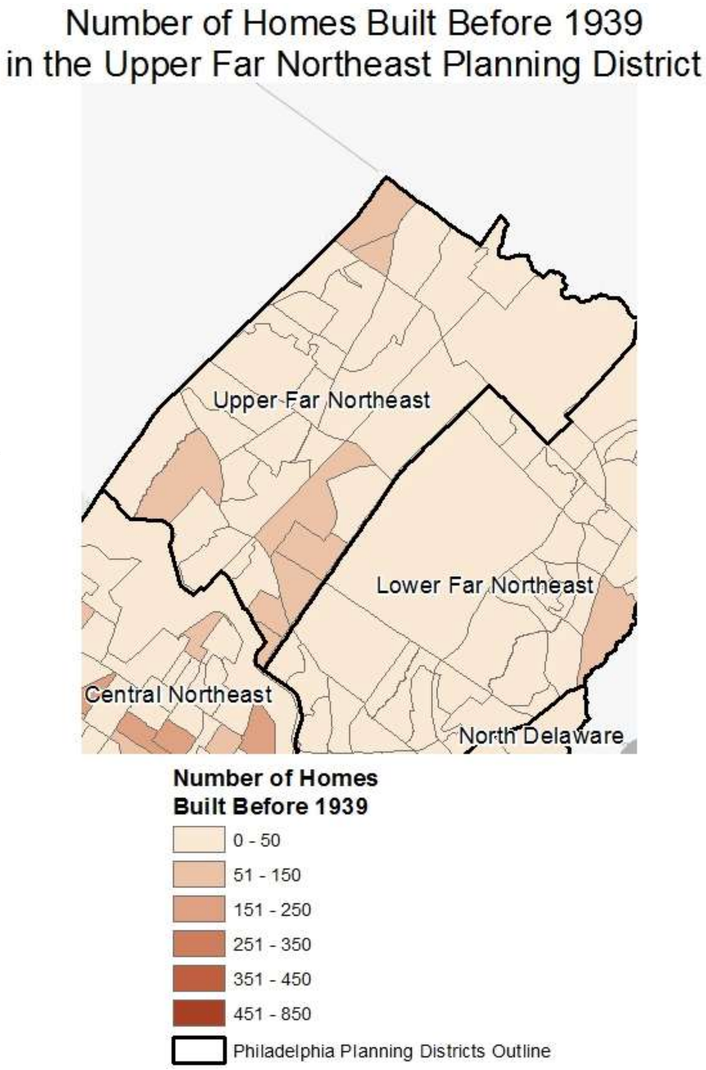
A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. There are no dams in the Upper Far Northeast Planning District.

Building Collapse

Buildings may collapse for a variety of reasons, including:

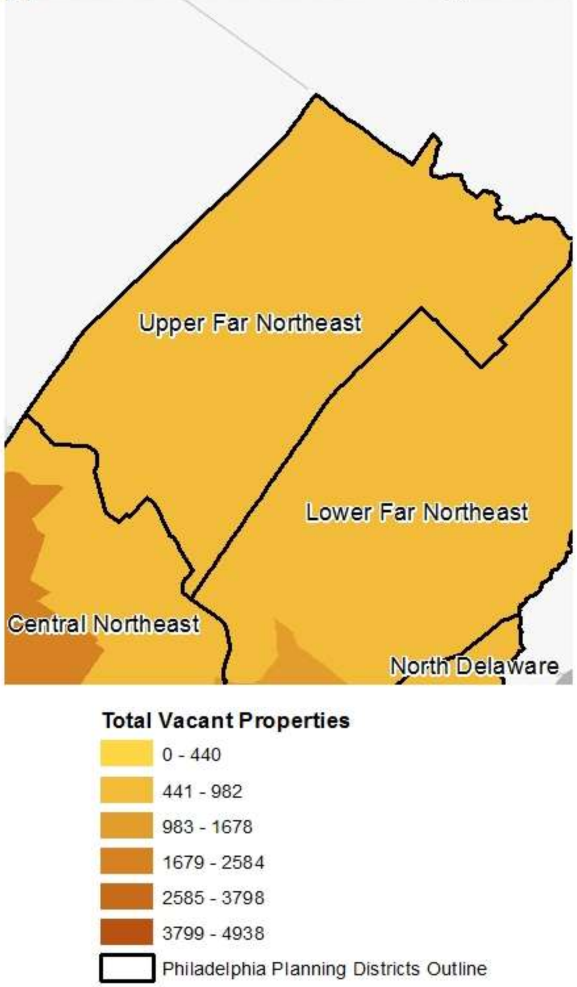
- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the Upper Far Northeast Planning District built before 1939.

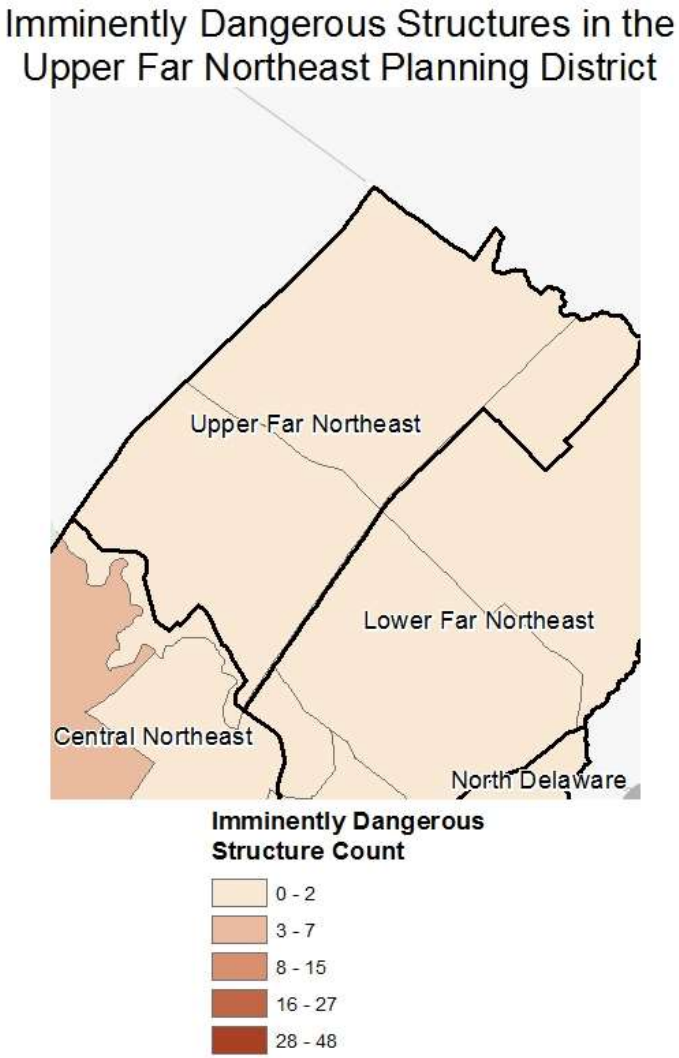


Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the Upper Far Northeast Planning District.

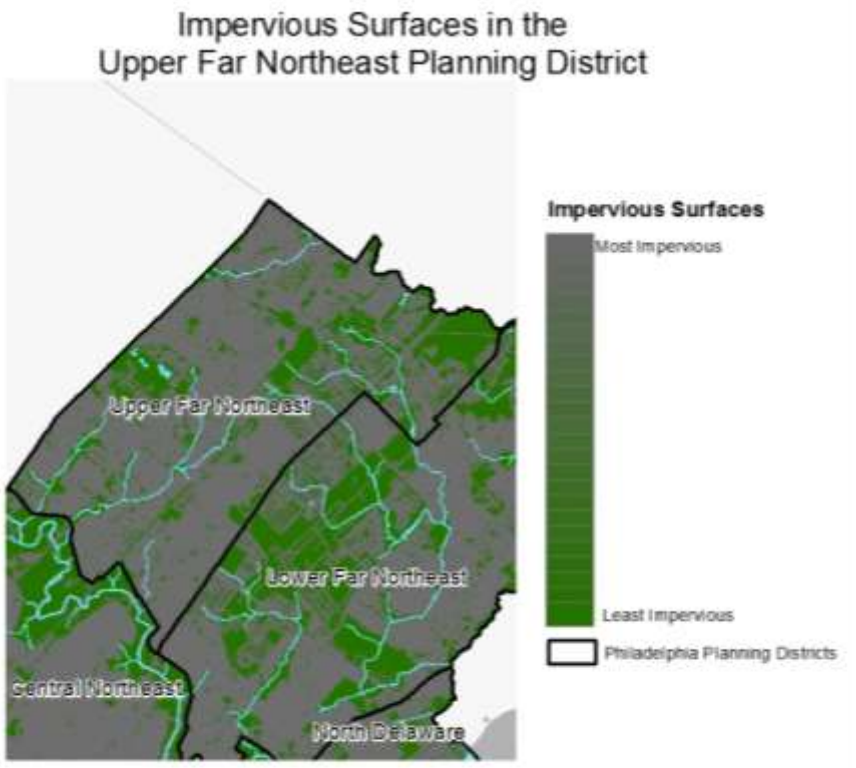
Vacant Homes in the
Upper Far Northeast Planning District



Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the Upper Far Northeast Planning District.



Extreme Heat



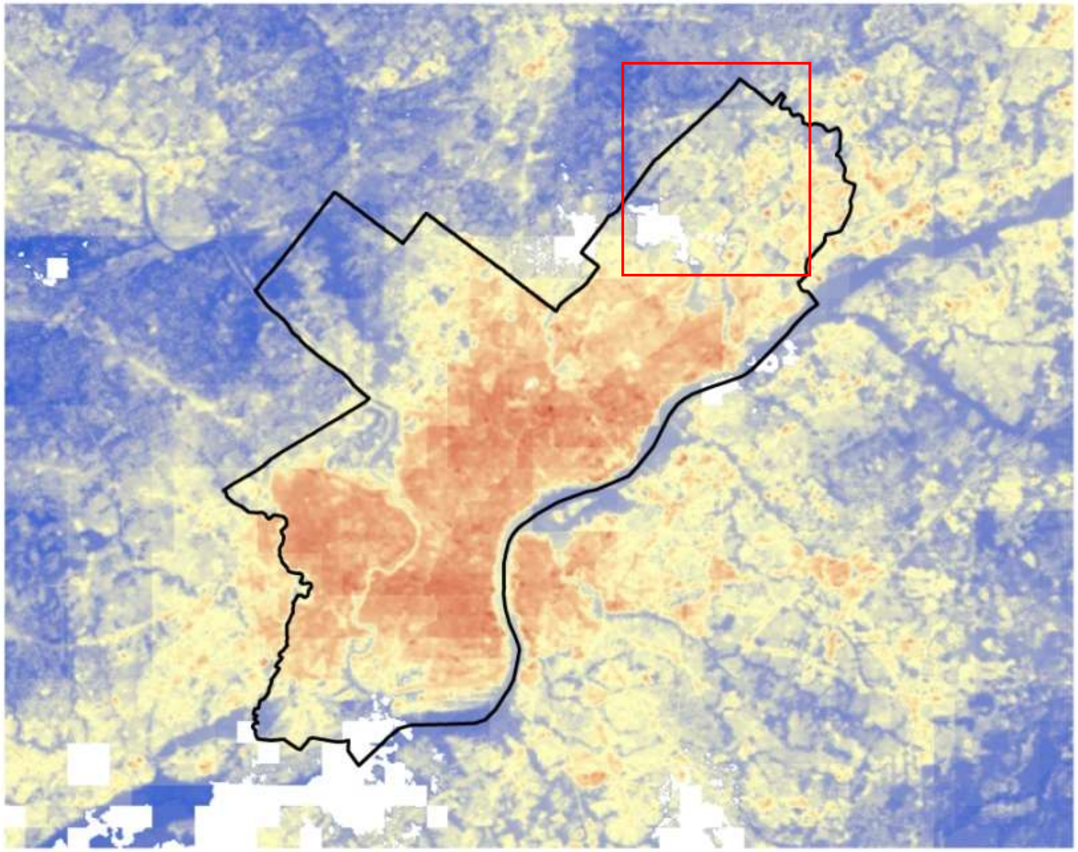
Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[532] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[533] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Upper Far Northeast Planning District.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[534] As the map shows, the Upper Far Northeast is not located in the areas which experience the highest heat island effects, but the Upper Far Northeast still feels some of the effects of such an event more than the surrounding counties.

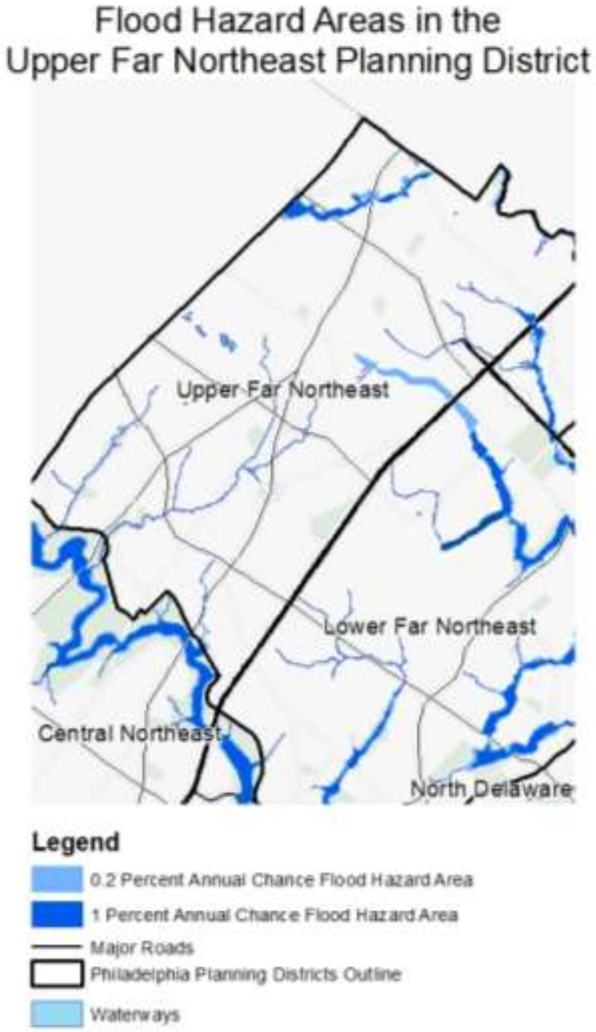
---

[532] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[533] “Heat Island Effect”. US EPA. Retrieved March 3, 2016.
[534] “Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002”. URSA. Retrieved March 7, 2016.



Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.



The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[535]

Winter flooding includes 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. All forms of flooding can damage infrastructure.[536] For more

---

[535] “Standard Operating Guide”. Commonwealth of Pennsylvania’s All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

[536] “Standard Operating Guide”. Commonwealth of Pennsylvania’s All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

A small portion of the Upper Far Northeast Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the Upper Far Northeast Planning District there are 281 of policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

Flash flooding is a concern for some areas of the Upper Far Northeast Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Upper Far Northeast Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.


Impervious Surfaces in the Upper Far Northeast Planning District

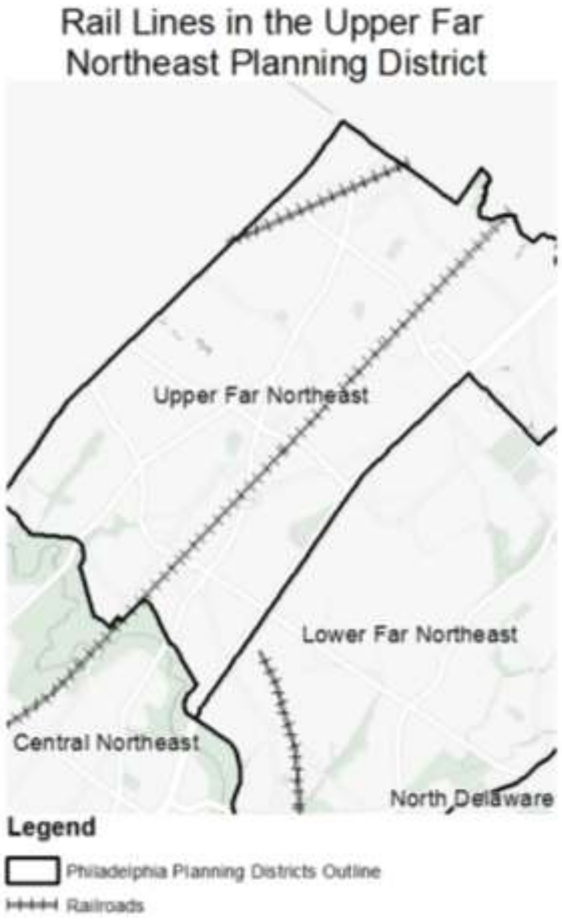
Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[537]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.



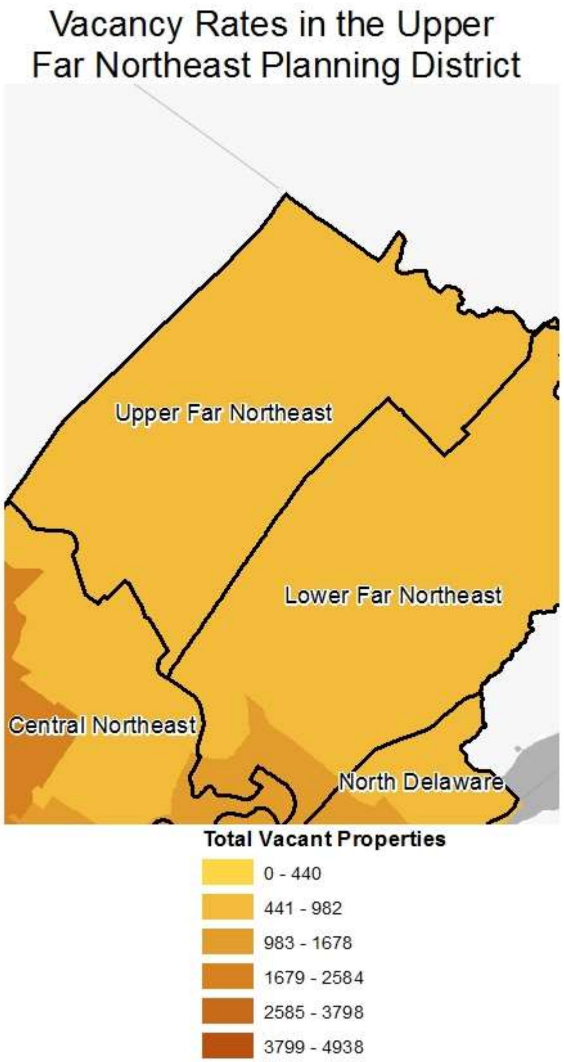
---

[537] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[538] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[539] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The Upper Far Northeast Planning District has comparatively fewer vacant properties than many other parts of Philadelphia, and therefore has a slightly lower risk for urban conflagration.

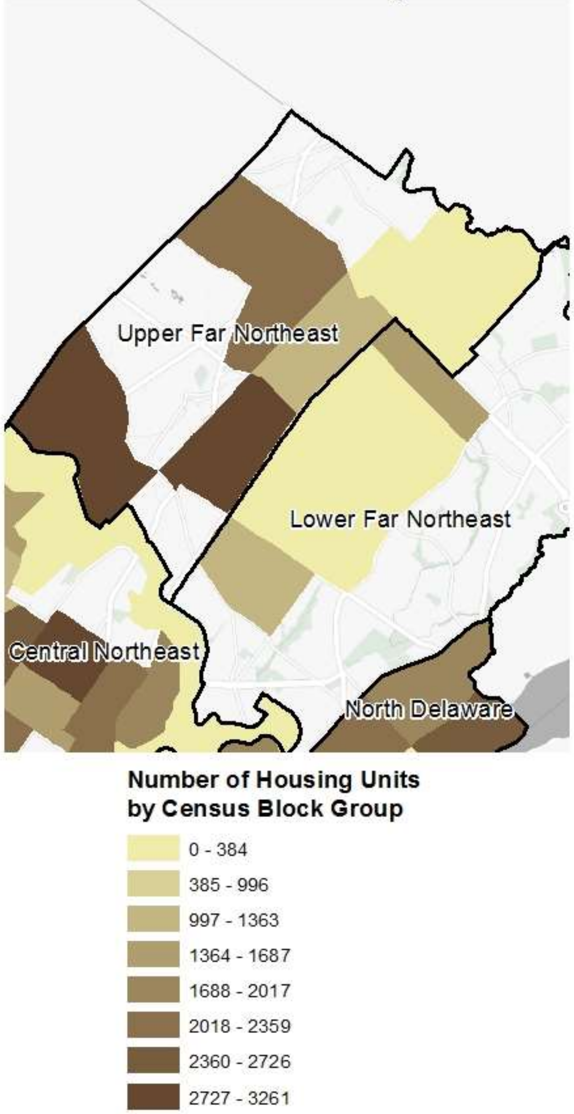


---

[538] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.
[539] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the Upper Far Northeast Planning District's housing density. The Upper Far Northeast has pockets of higher housing density in the northwest portion of the district. Data was unavailable for those portions of the map left uncolored.

Housing Density in the Upper Far Northeast Planning District

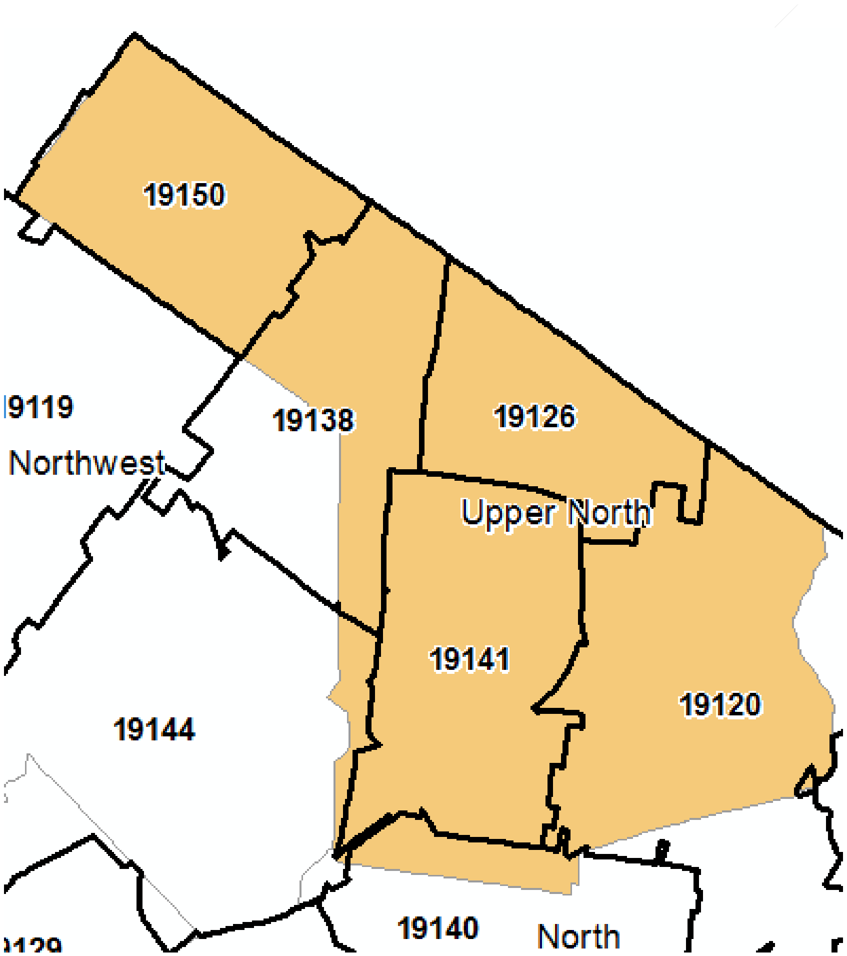


21.1.14 Upper North

21.1.14.1 Geography and Hydrology

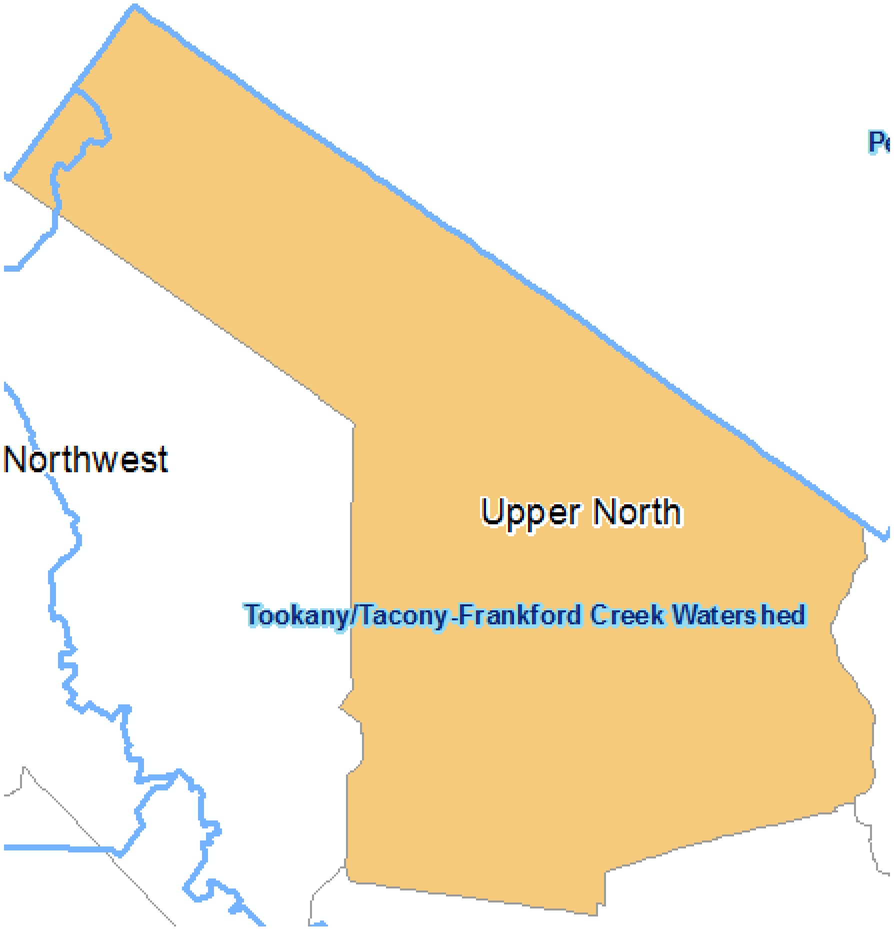
The Upper North Planning District contains addresses in the zip codes 19150, 19138, 19141, 19144, 19140, 19120, and 19126.

Zip codes in the Upper North Planning District



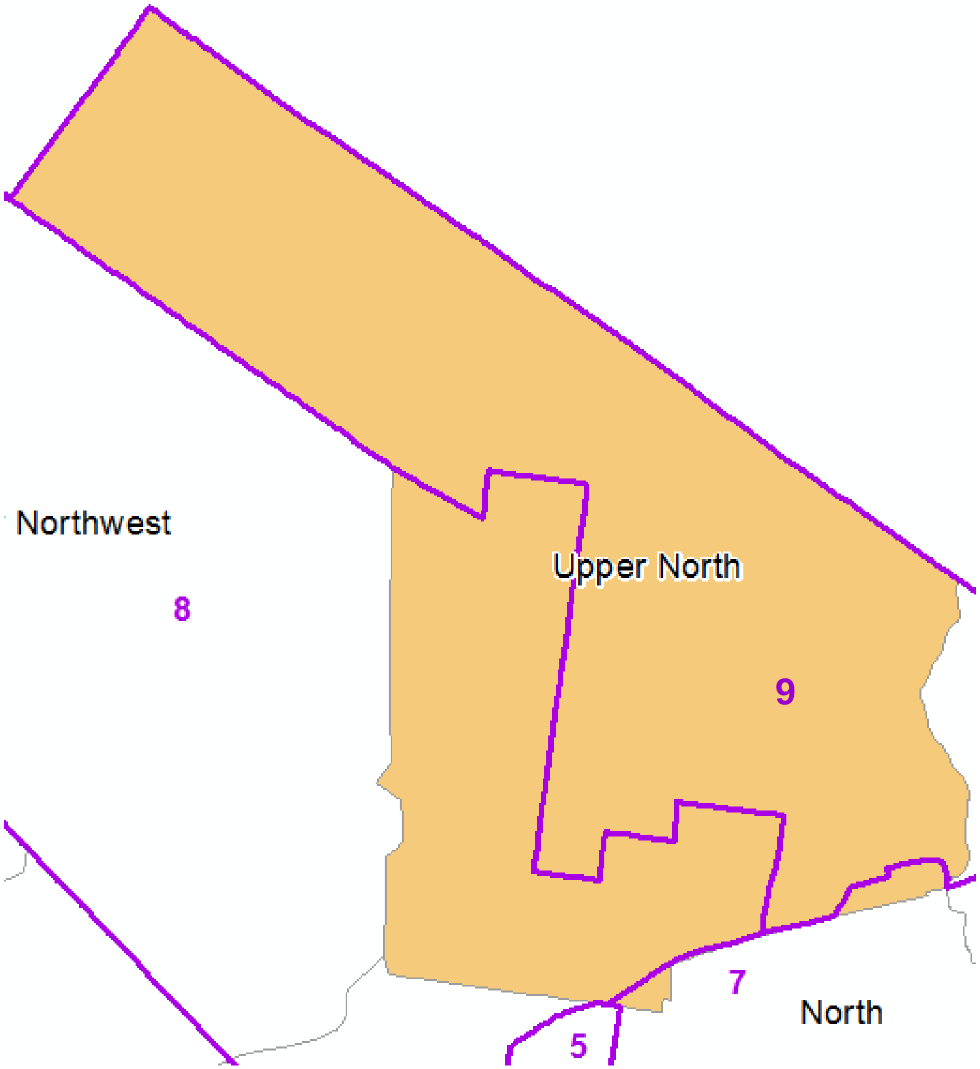
The Upper North planning district falls mostly in the Tookany/Tacony-Frankford Watershed, with only a small portion crossing into the Wissahickon Creek Watershed.

Watersheds in the Upper North Planning District



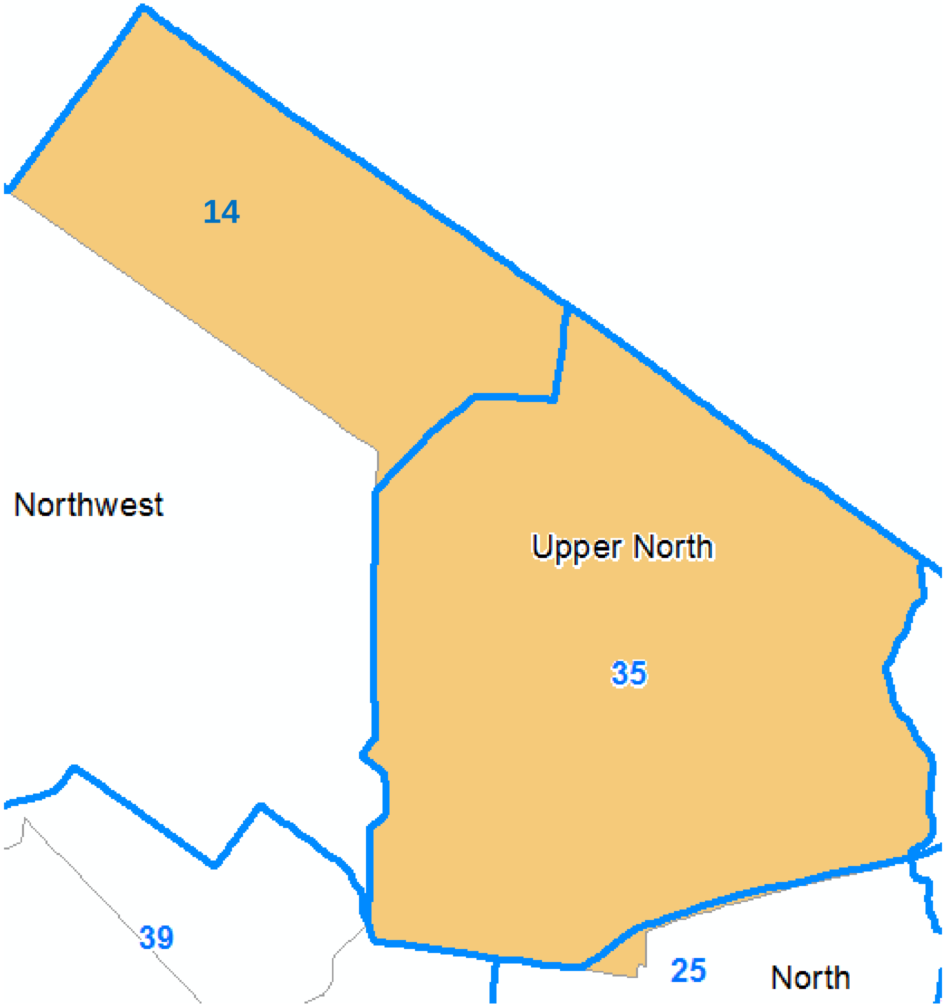
The Upper North Planning District resides within the 9th, 8th, and 7th Council Districts of Philadelphia.

Council Districts in Upper North Planning District



The Upper North Planning District falls mostly within the 35th and 14th Police Districts, and also crosses into the 25th Police District.

Police Districts in the Upper North Planning District



21.1.14.2 Social Characteristics

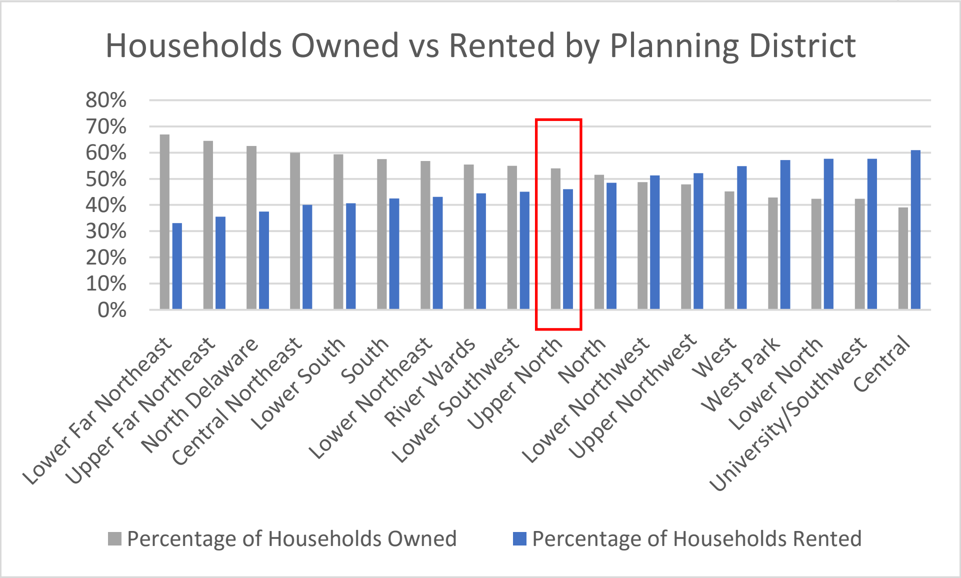
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	281,897
- Male population	129,175
- Female population	152,722
Median Age	35.4
- Age dependency ratio (the percentage of the population under 15 and over 64)	61.9%
- Population under 15	40.4%
- Population over 64	21.5%

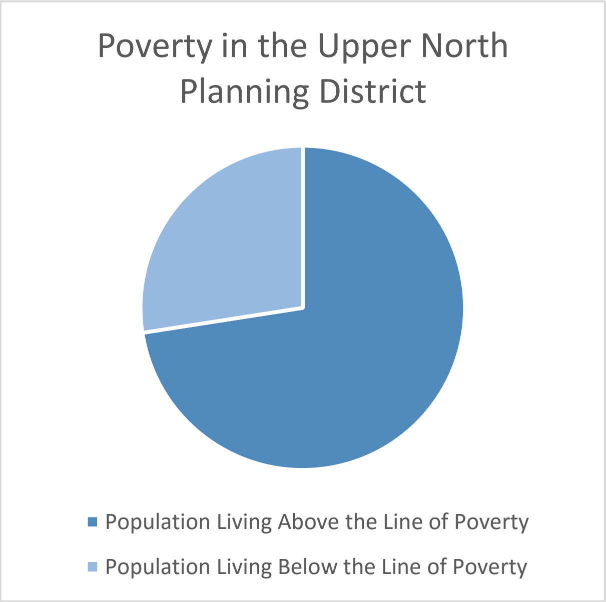
21.1.14.3 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	68,116
- Households owned	36,755
- Households rented	31,361
No vehicle access	22,730
Population below the federal line of poverty	27.5%



Households Owned vs Rented by Planning District



Poverty in the Upper North Planning District

21.1.14.4 Disability

Of those individuals residing within the Upper North Planning District, 16.1 percent reported having a disability. Disabilities reported by individuals in the Upper North Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	7.5%
Vision difficulty	7.8%
Cognitive difficulty	8.6%
Ambulatory Difficulty	8.2%
Self-care Difficulty	8.2%
Independent Living Difficulty	8.6%

21.1.14.5 Upper North Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessmentsection in the main body of the plan.

Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[540] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A “structurally deficient bridge” typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[541] [542] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the Upper North Planning District.[543]


Structurally Deficient Bridges in the Upper North Planning District

---

[540] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[541] 2010 Status of the Nation’s Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

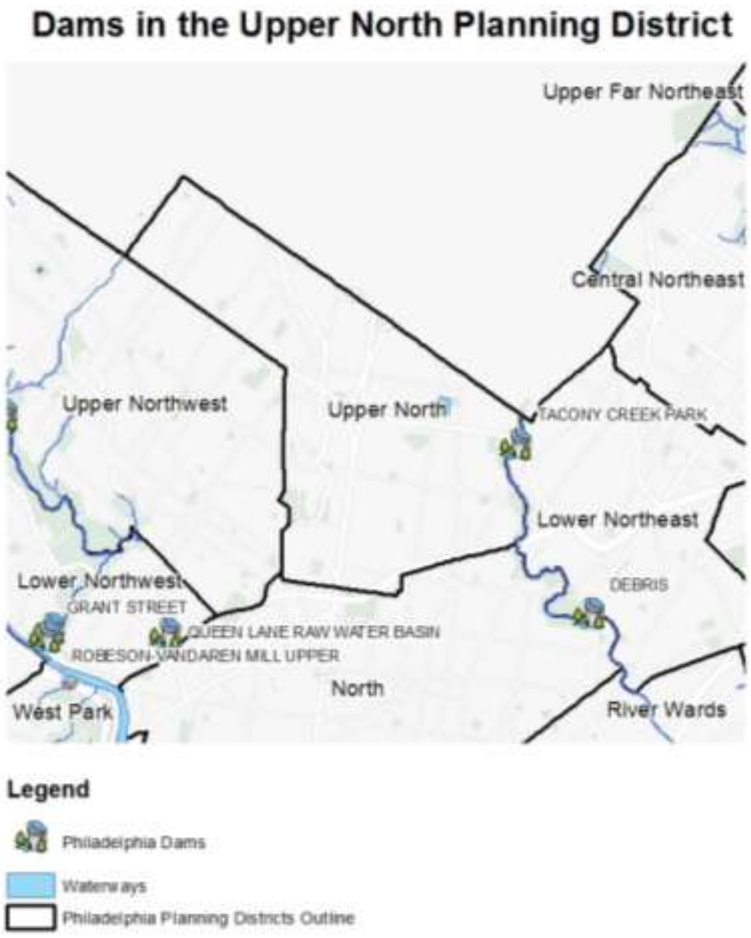
[542] Ibid.

[543] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the Upper North Planning District		
Name	**Location**	**Year Built**
Tacony Creek	Tabor Road	1957
SEPTA	Olney Ave by W. Rising Sun	1929
Tacony Creek	Adams Ave by West Train Station	1901

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. The table below shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.



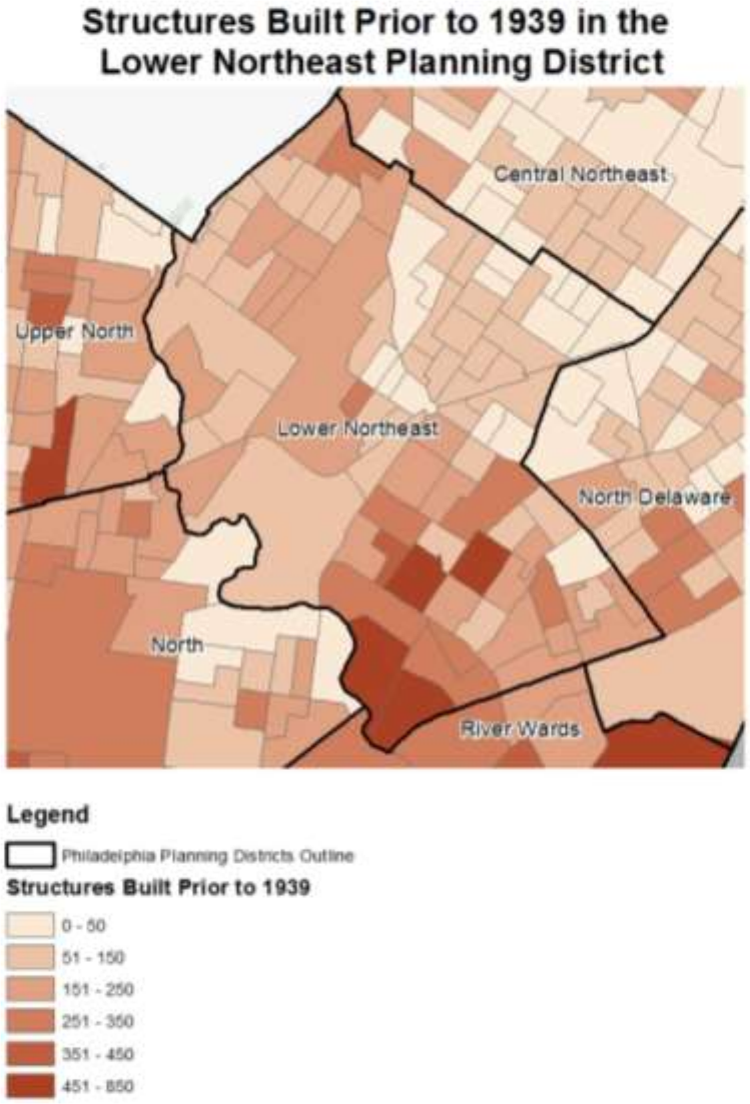
Dam Name	Waterway	High Hazard?	Permitted Owner
Tacony Creek Park	Tacony Creek	No	City of Philadelphia

Building Collapse

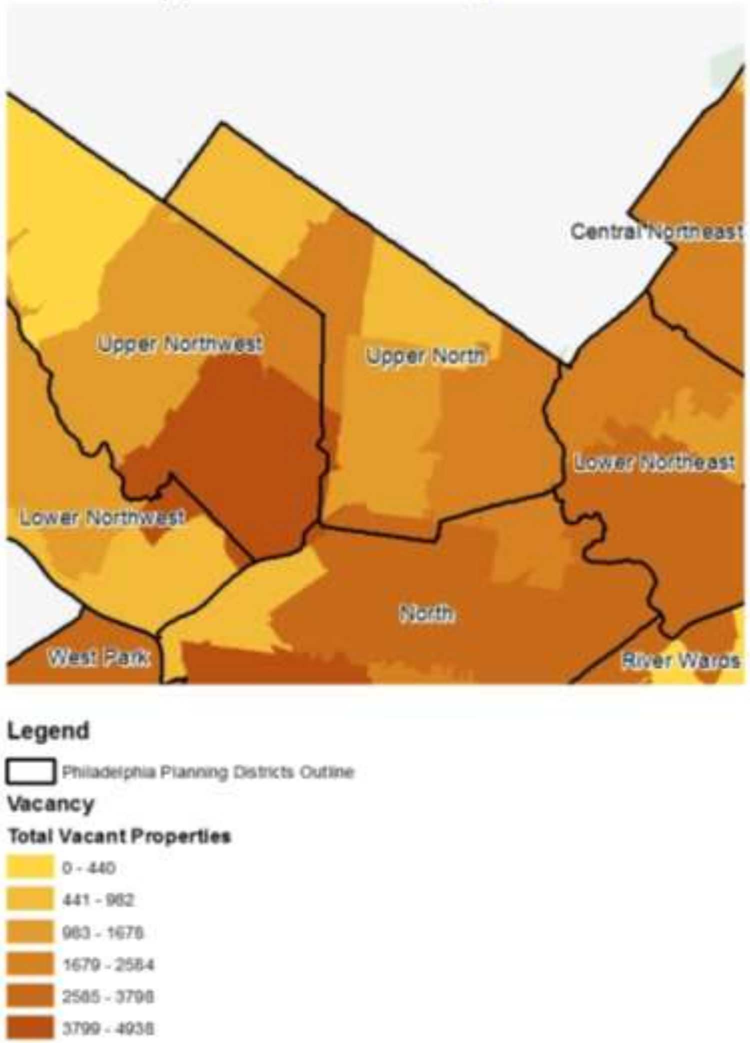
Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance;
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the Upper North Planning District built before 1939.

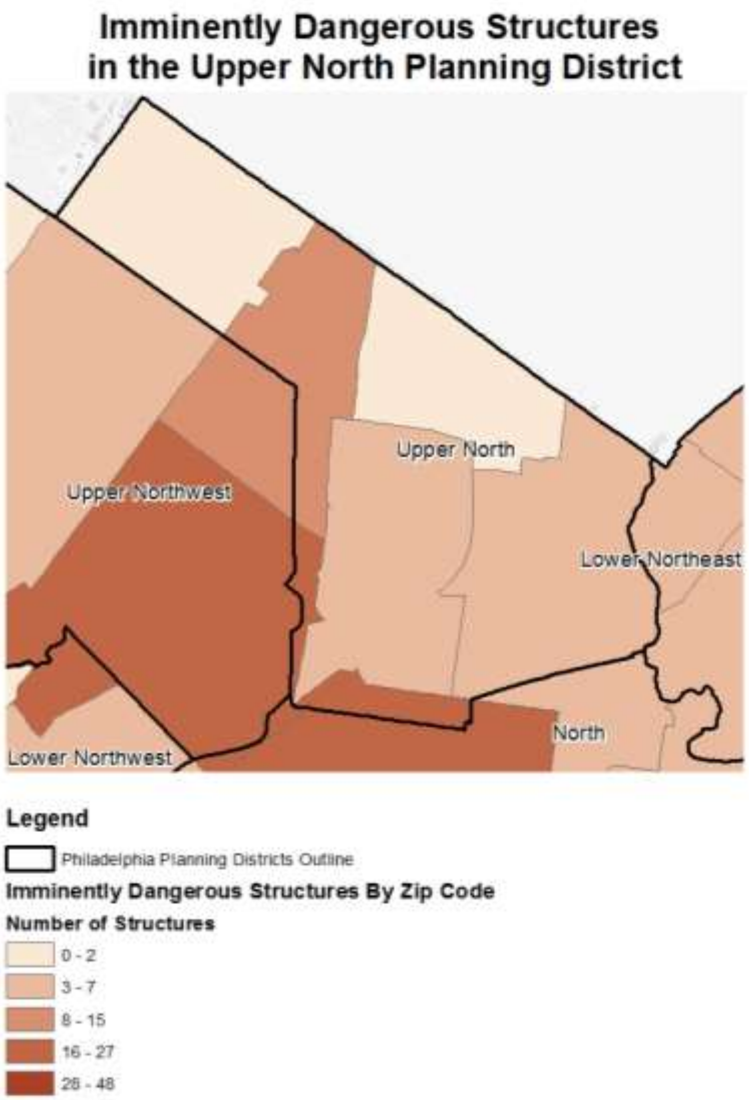


Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the Upper North Planning District.



Vacant Properties in the Upper North Planning District

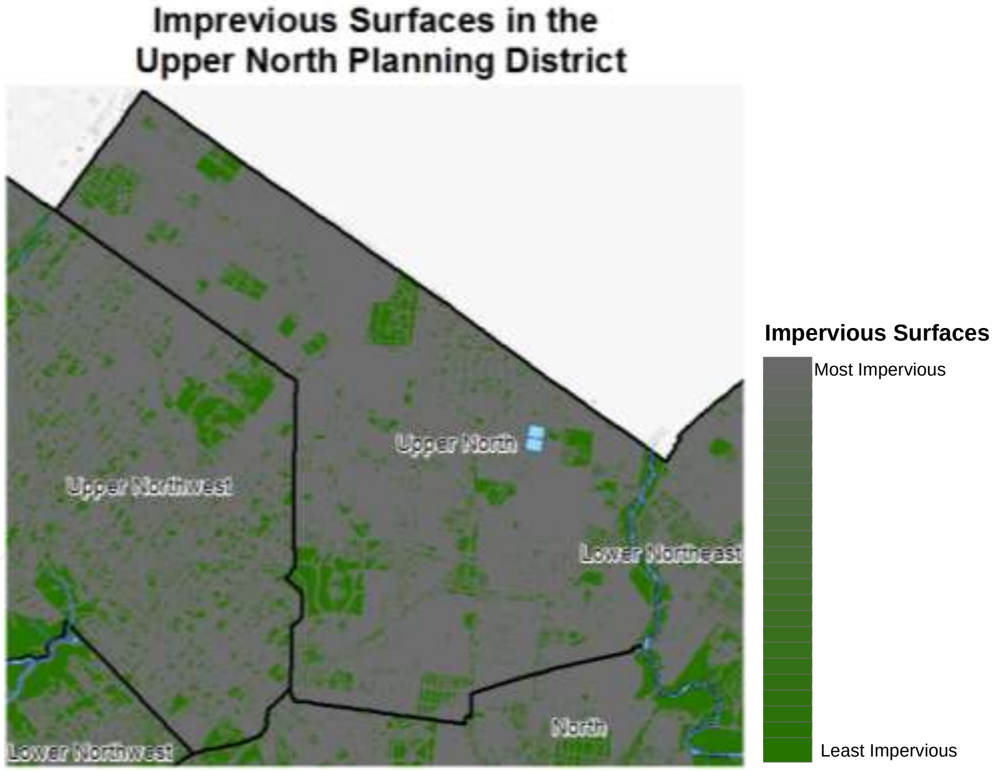
Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the Upper North Planning District.



Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[544] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

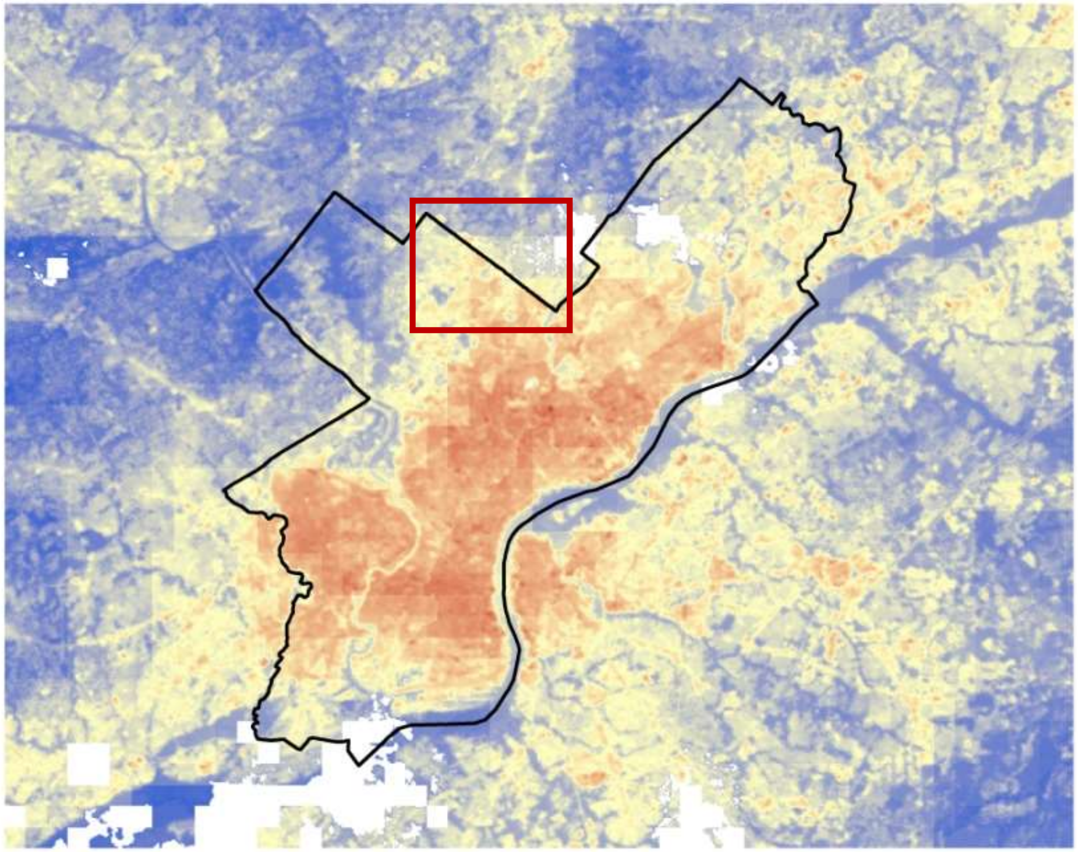
Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[545] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Upper North Planning District.



---

[544] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[545] "Heat Island Effect". US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[546] As the map shows, the Upper North is located in an area which experience higher heat island effects, and feels some of the effects of such an event more than the bordering counties.



---

[546] "Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002". URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[547]

Winter flooding includes 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. All forms of flooding can damage infrastructure.[548]

---

[547] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

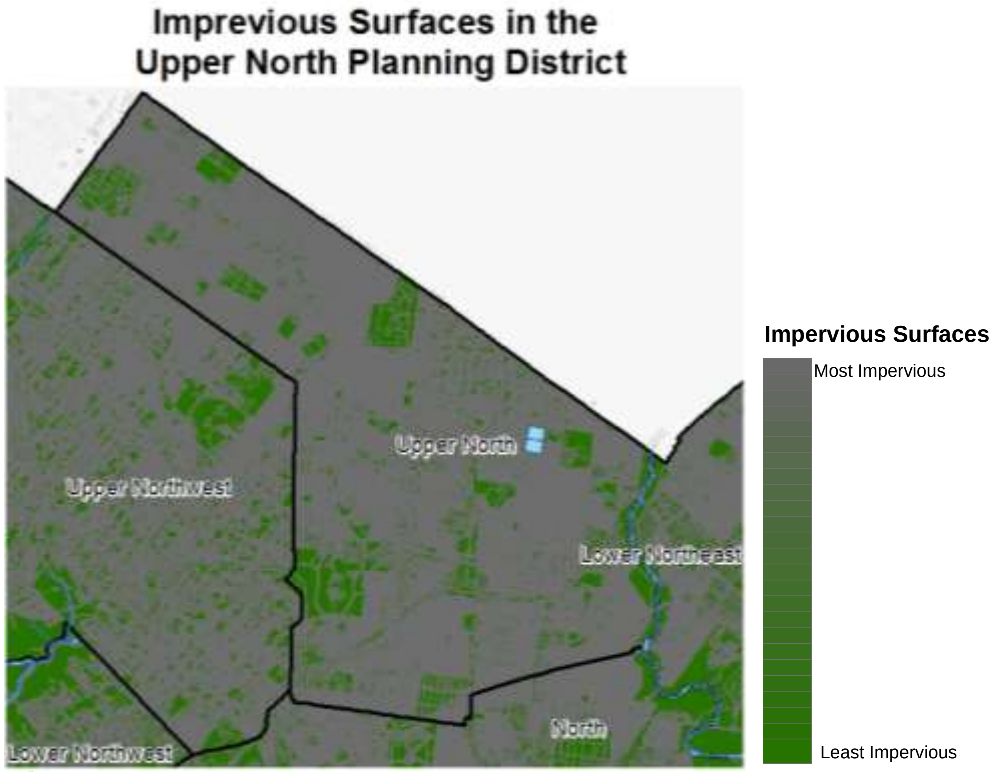
[548] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

For more information on flooding and its impacts, please see Flooding under the Risk Assessmentsection of the 2017 Hazard Mitigation Plan.

A small portion of the Upper North Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner’s insurance policy and must be purchased separately. Within the Upper North Planning District there are 45 of policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

Flash flooding is a concern for some areas of the Upper North Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Upper North Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[549]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the Upper North Planning District

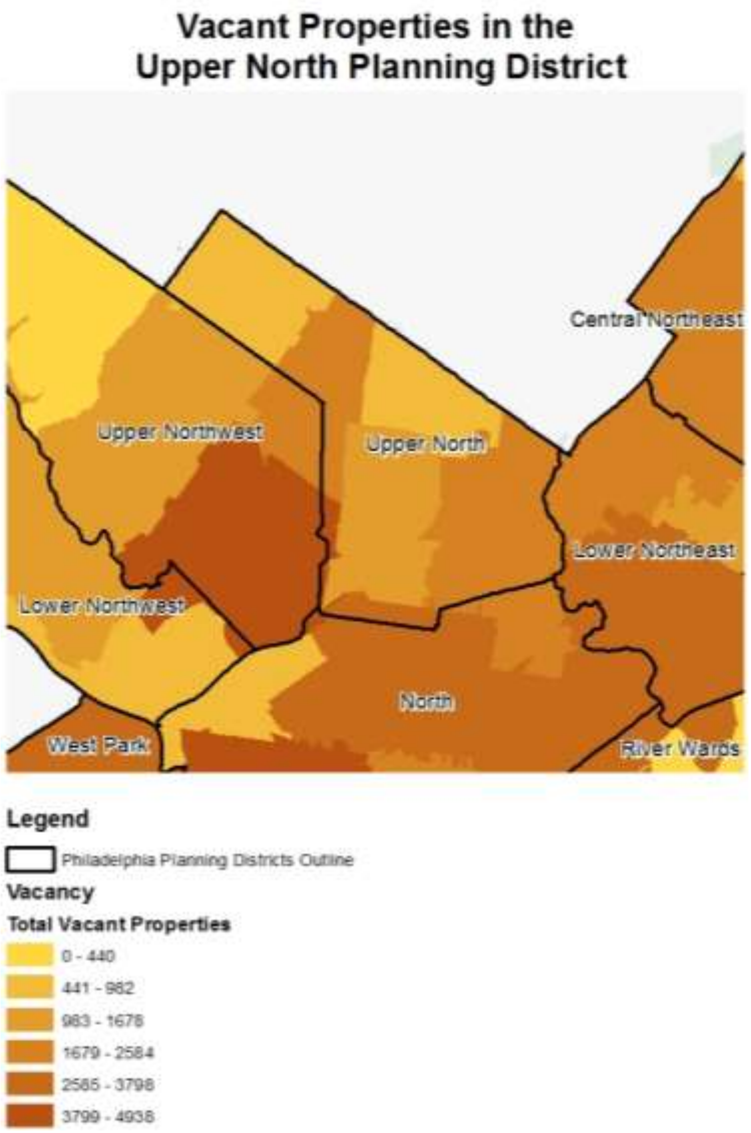
---

[549] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[550] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

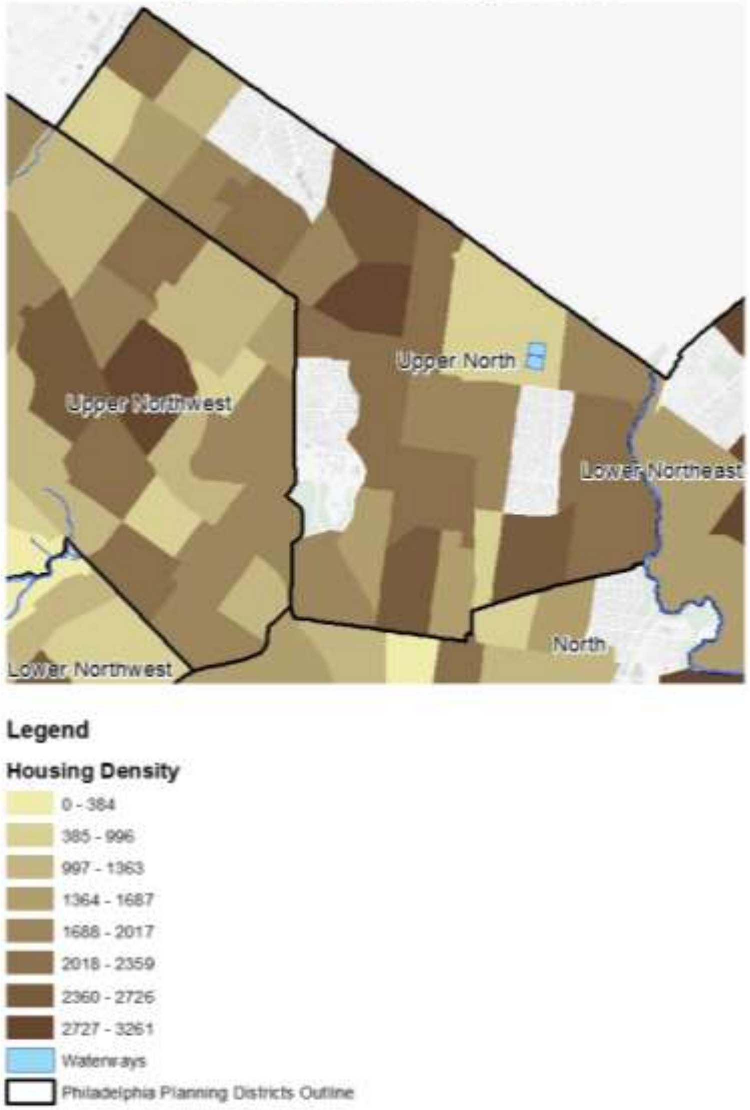
Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[551] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The Upper North Planning District has comparatively fewer vacant properties than many other parts of Philadelphia, and therefore has a slightly lower risk for urban conflagration.


Vacant Properties in the Upper North Planning District

---

[550] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.
[551] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the Upper North Planning District's housing density. Data was unavailable for those portions of the map left uncolored.



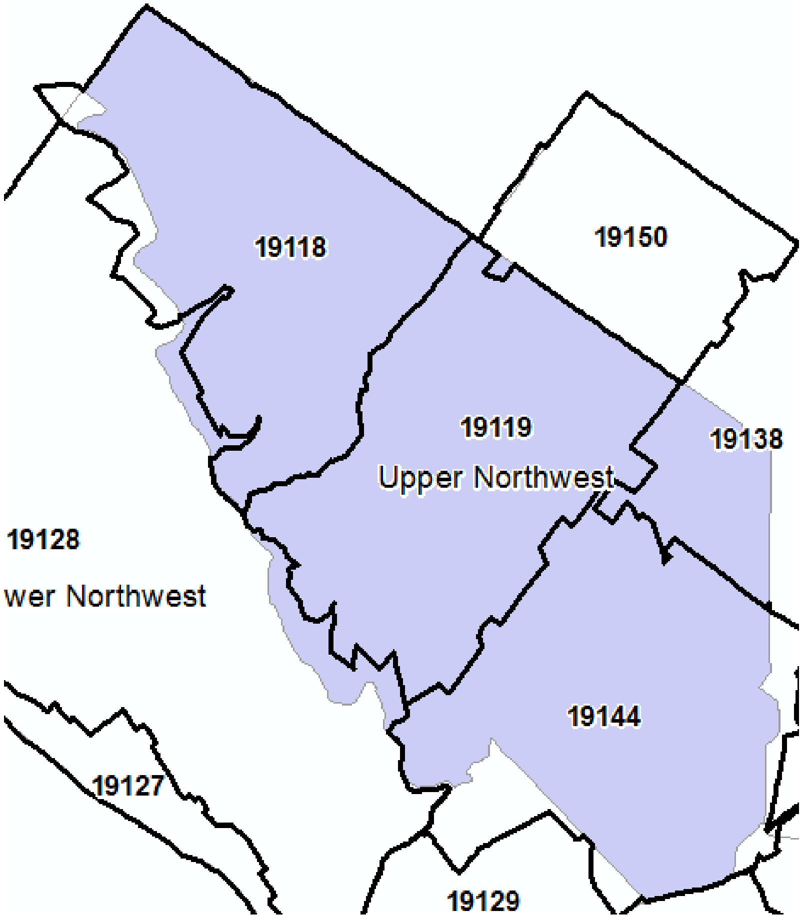
Housing Density in the Upper North Planning District

21.1.15 Upper Northwest

21.1.15.1 Geography and Hydrology

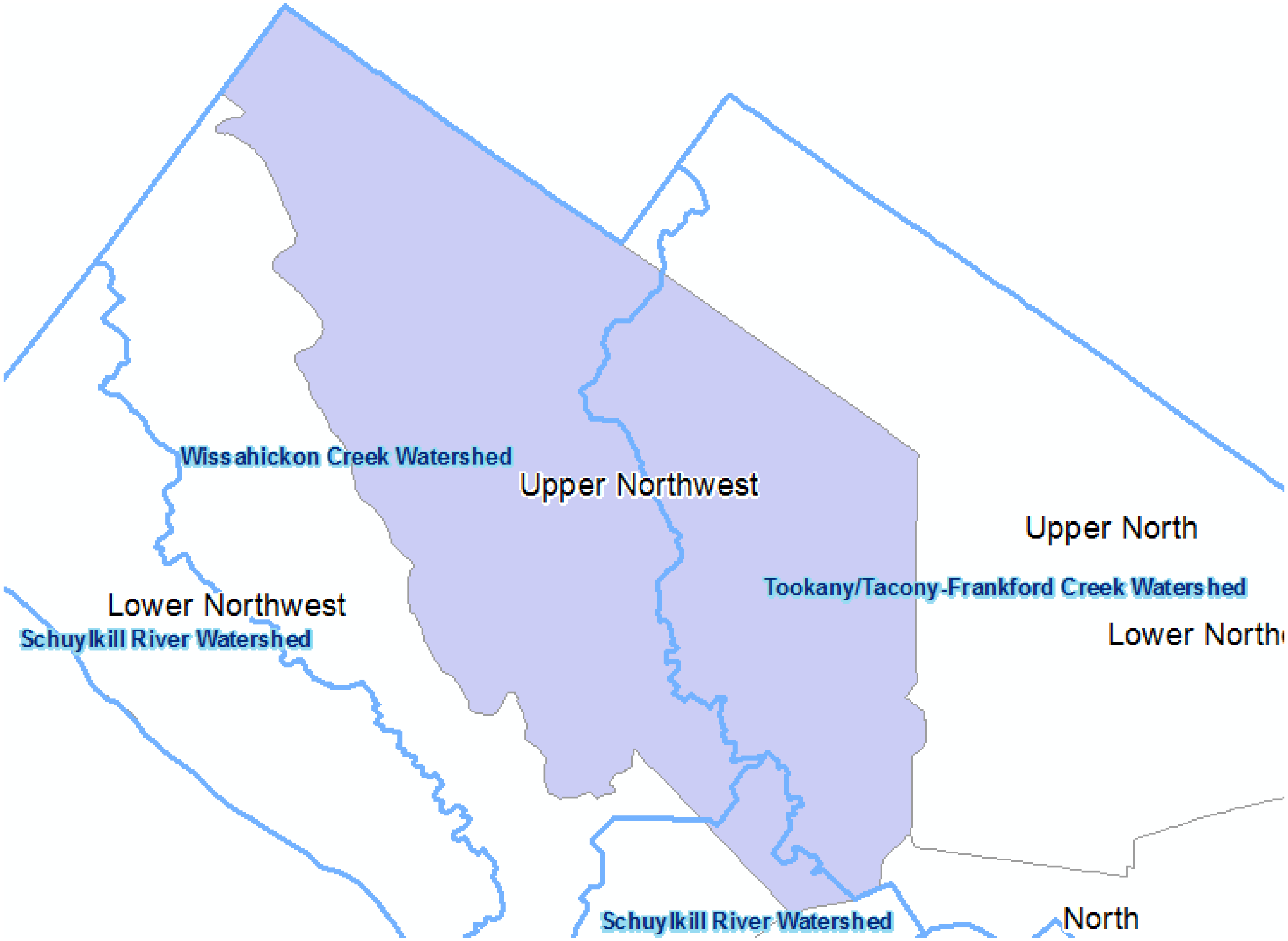
The Upper Northwest Planning District contains addresses in the zip codes 19118, 19119, 19138, 19144, and 19128.

Zip codes in the Upper Northwest Planning District



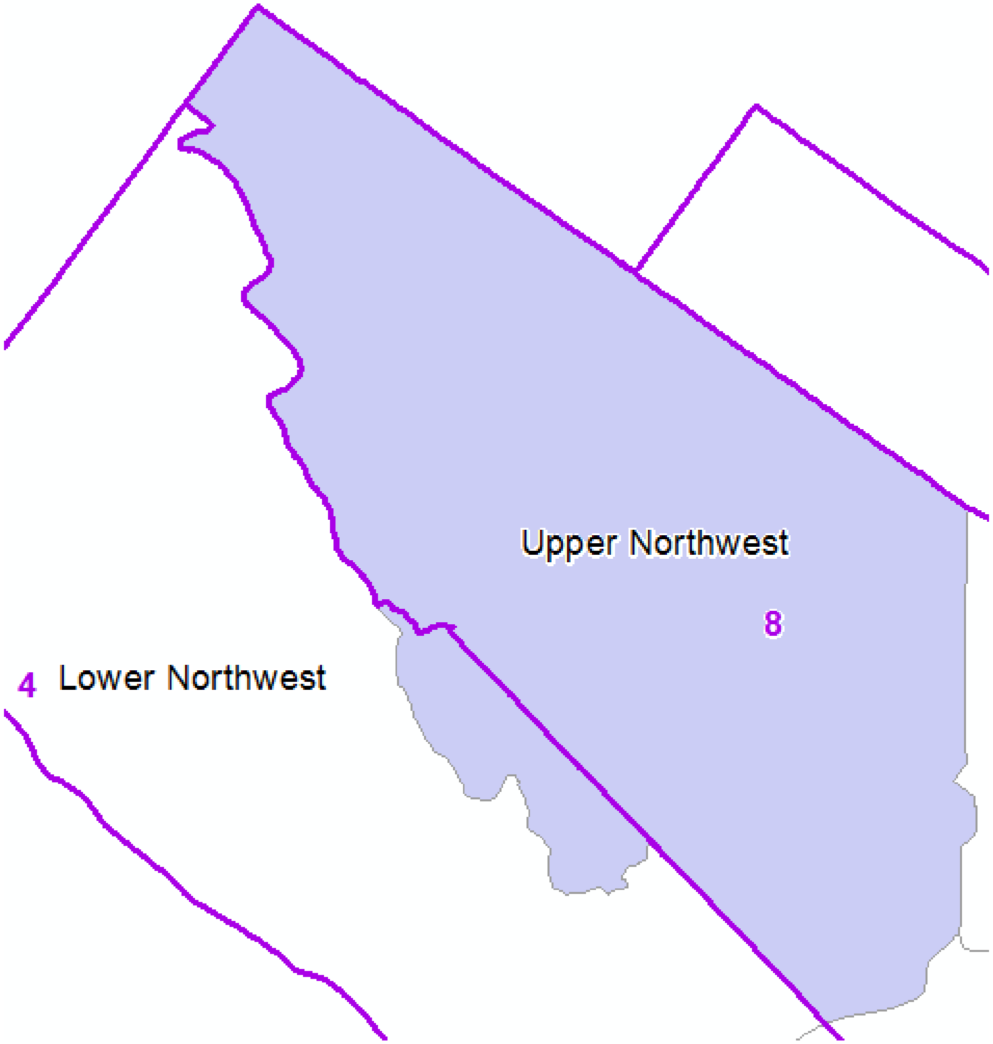
The Upper Northwest planning district falls partially in the Wissahickon, Tookany/Tacony-Frankford Creek, and Schuylkill River Watersheds.

Watersheds in the Upper Northwest Planning District



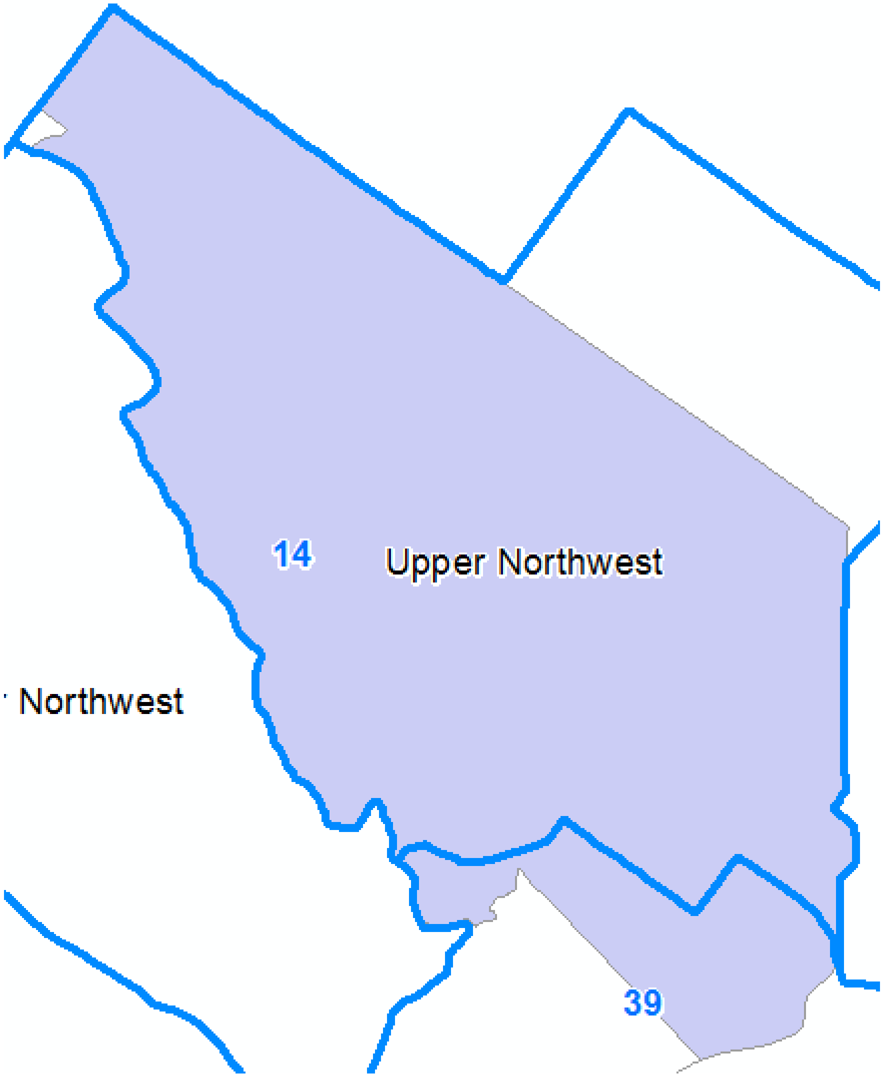
The Upper Northwest Planning District resides within the 8th and 4th Council Districts of Philadelphia.

Council Districts in Upper Northwest Planning District



The Upper Northwest Planning District falls within the 14th and 39th Police Districts.

Police Districts in the Upper Northwest Planning District



21.1.15.2 Social Characteristics

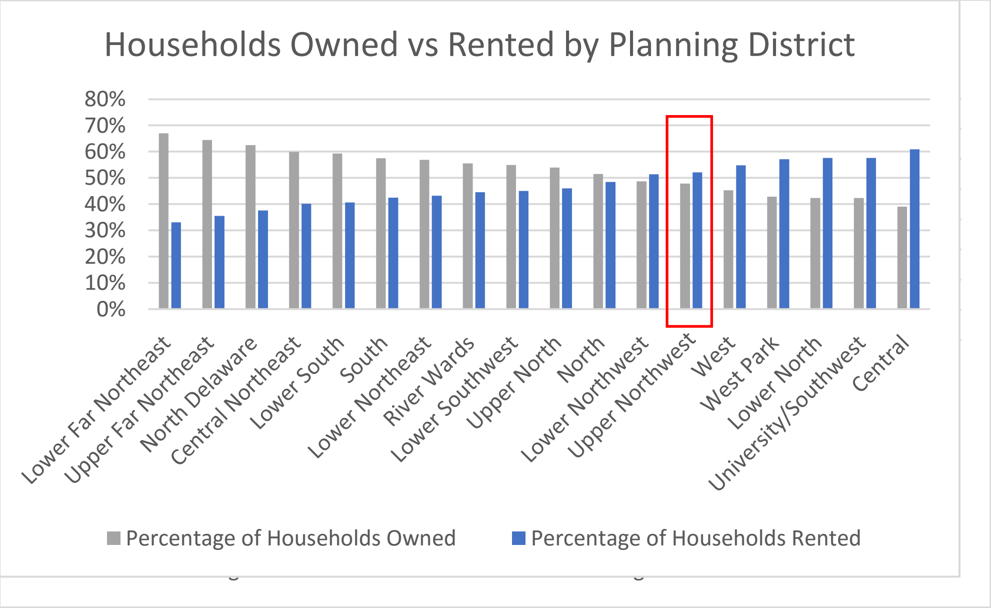
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

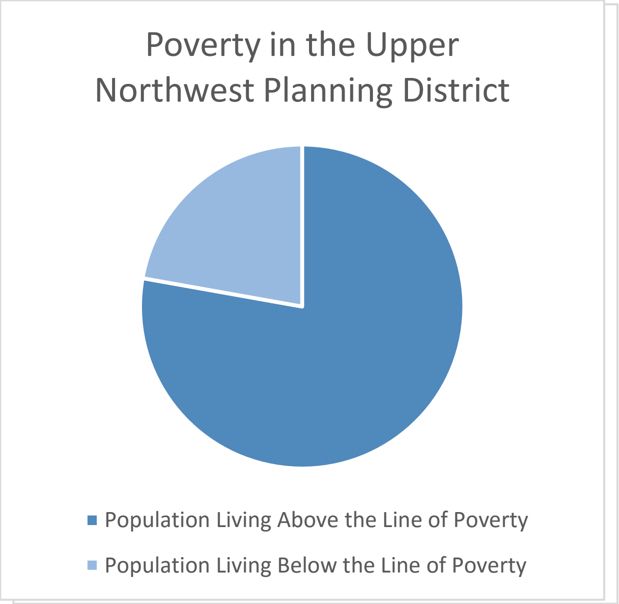
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	114,894
- Male population	51,525
- Female population	63,369
Median Age	38.6
- Age dependency ratio (the percentage of the population under 15 and over 64)	60.2%
- Population under 15	33.8%
- Population over 64	26.4%

21.1.15.3 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	33,431
- Households owned	16,003
- Households rented	17,428
No vehicle access	9,906
Population below the federal line of poverty	22.2%





21.1.15.4 Disability

Of those individuals residing within the Upper Northwest Planning District, 12.5 percent reported having a disability. Disabilities reported by individuals in the Upper Northwest Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	6.5%
Vision difficulty	6.9%
Cognitive difficulty	6.7%
Ambulatory Difficulty	6.7%
Self-care Difficulty	6.8%
Independent Living Difficulty	6.5%

21.1.15.5 Upper Northwest Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

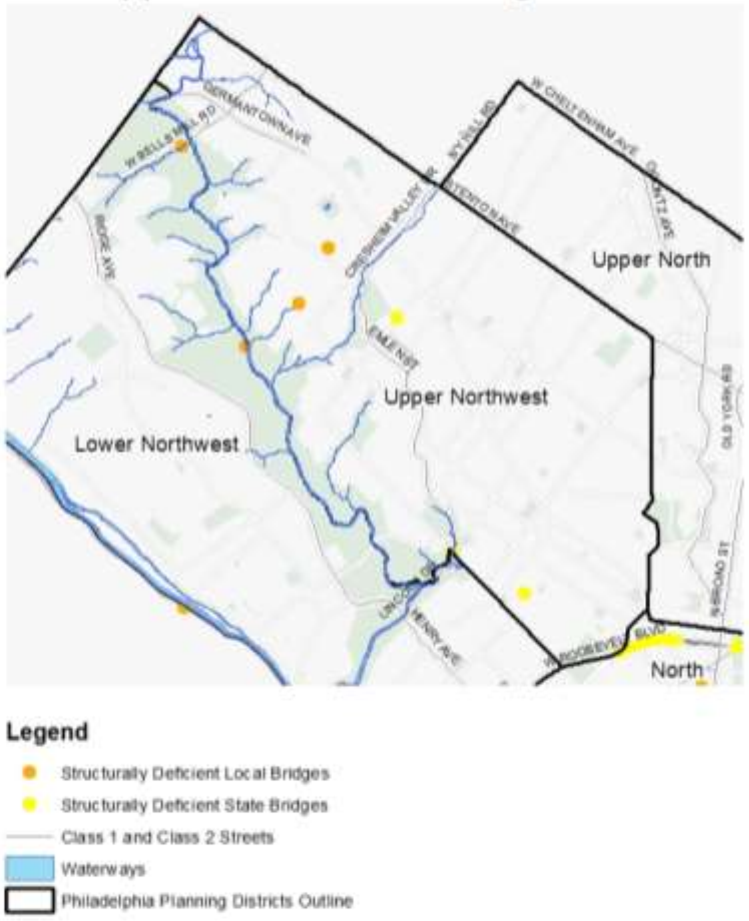
Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[552] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A “structurally deficient bridge” typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[553] [554] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the Upper Northwest Planning District.[555]

Structurally Deficient Bridges in the Upper Northwest Planning District



---

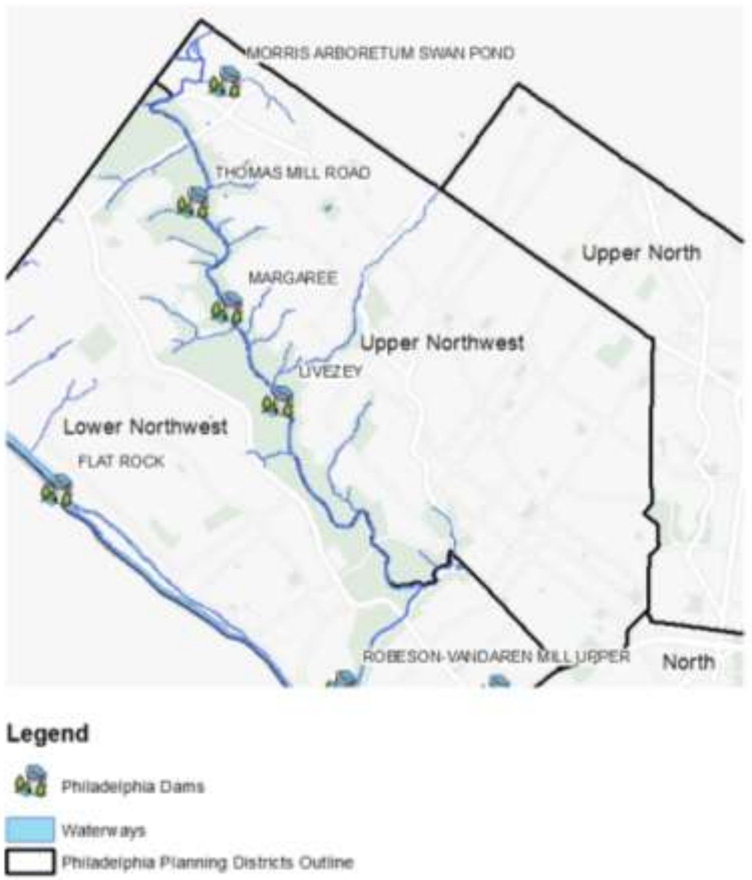
[552] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.
[553] 2010 Status of the Nation’s Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.
[554] Ibid.
[555] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the Upper Northwest Planning District		
Name	**Location**	**Year Built**
Valley Green Road	Cherokee Street and W. Springfield Ave	1960
SEPTA	Willow Grove Ave, north of St. Martins Ln	1883
Wissahickon Creek	Valley Green Rd	1915
SEPTA Chestnut Hill West	Coulter Ave	1901
SEPTA Chestnut Hill	Allens Lane	1908

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. The table below shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.

Dams in the Upper Northwest Planning District



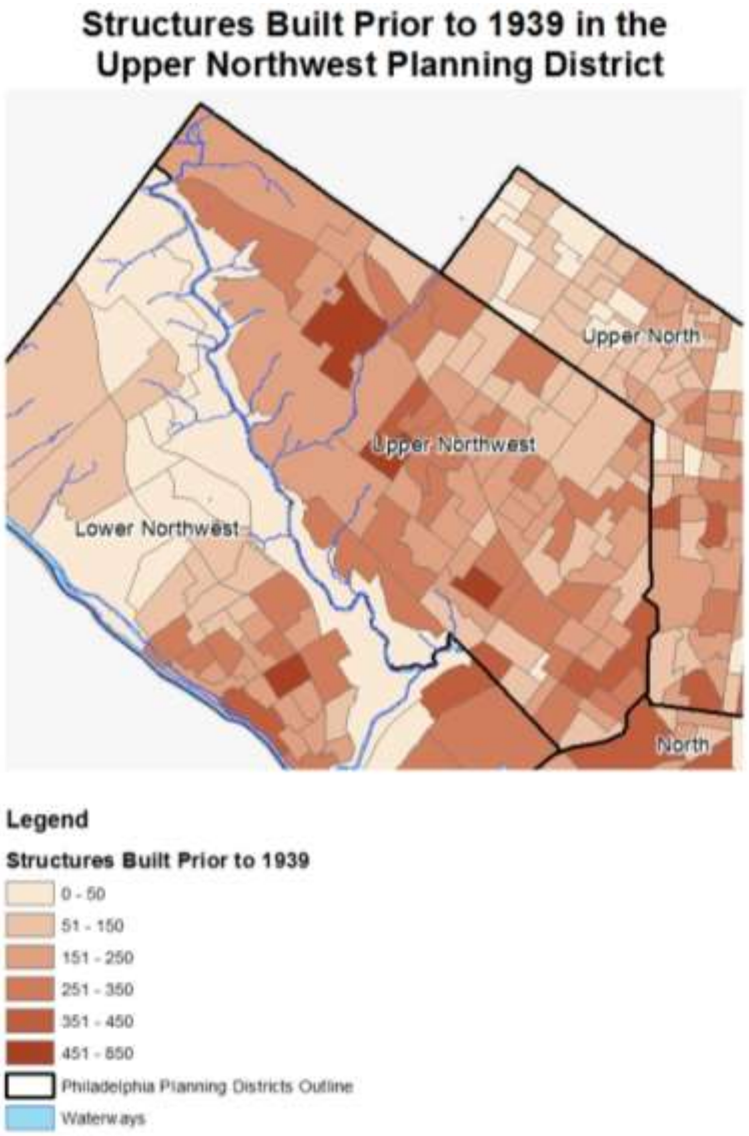
Dam Name	Waterway	High Hazard?	Permitted Owner
Margaree	Wissahickon Creek	No	City of Philadelphia
Thomas Mill Rd	Wissahickon Creek	No	City of Philadelphia
Livezey	Wissahickon Creek	No	City of Philadelphia
Morris Arboretum Swan Pond	Wissahickon Creek	No	Morris Arboretum

Building Collapse

Buildings may collapse for a variety of reasons, including:

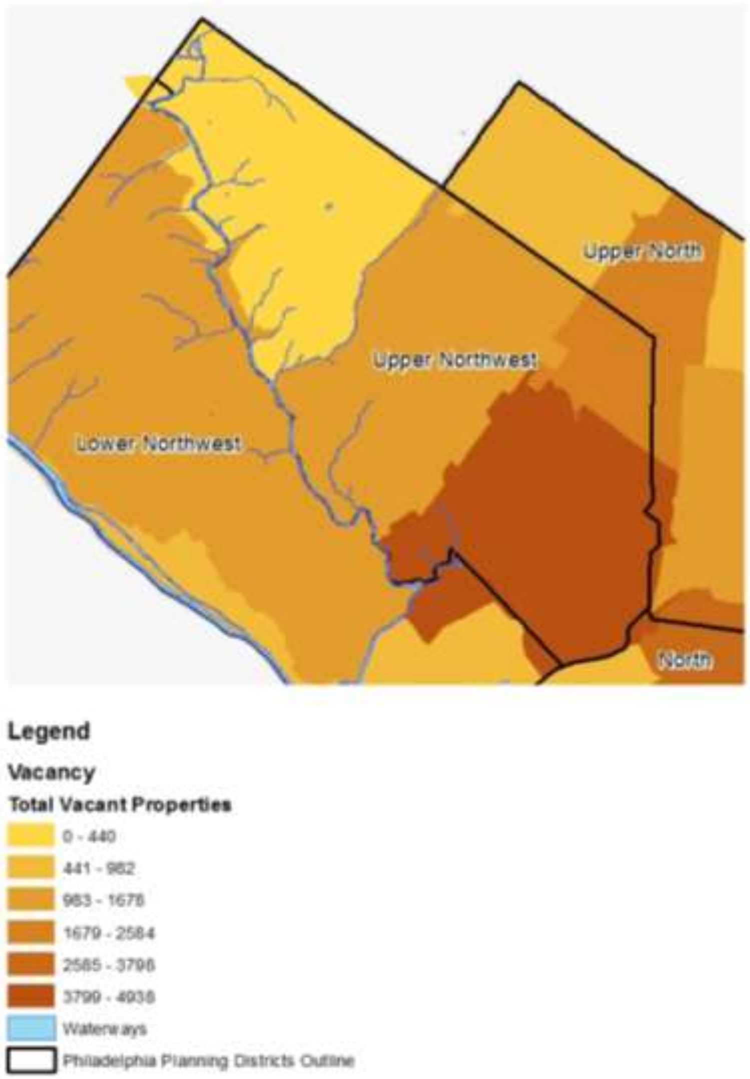
- Overall structural integrity;
- Poor construction or maintenance
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the Upper Northwest Planning District built before 1939.



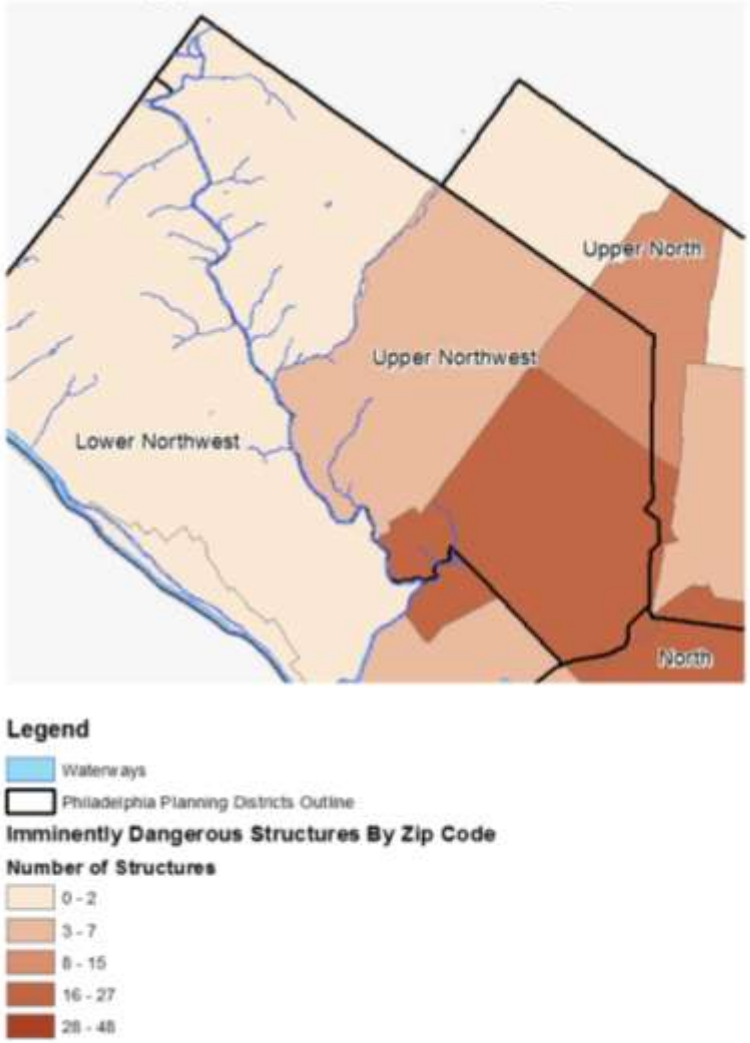
Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the Upper Northwest Planning District.

Vacancy in the Upper Northwest Planning District



Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the Upper Northwest Planning District.

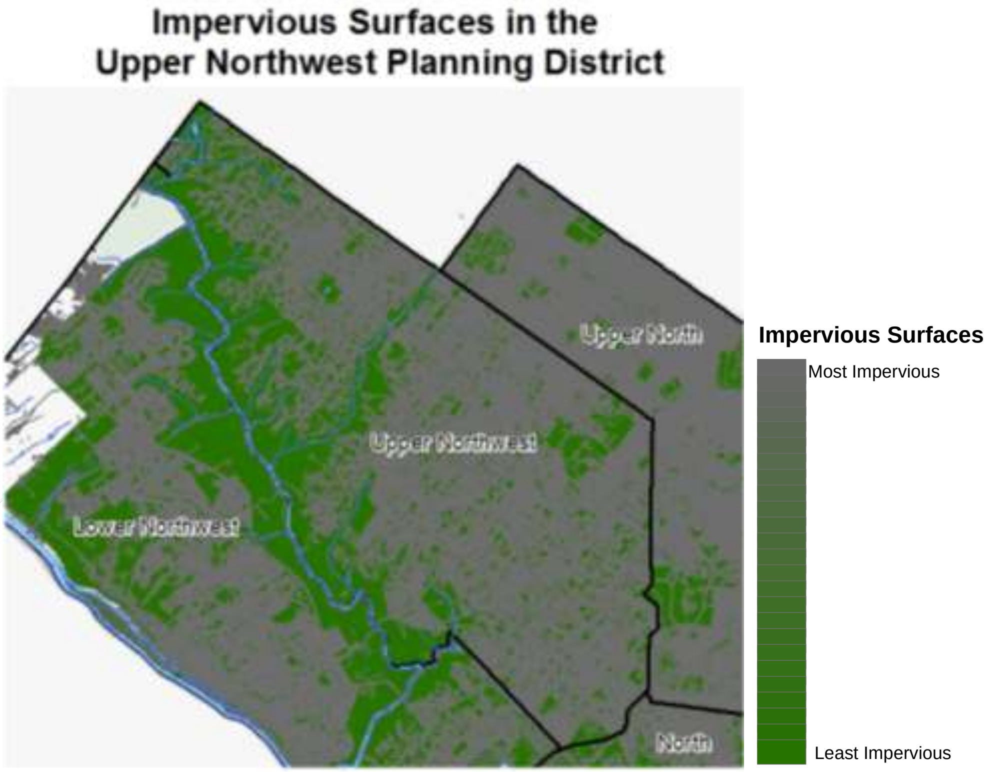
Imminently Dangerous Structures in the Upper Northwest Planning District



Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[556] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

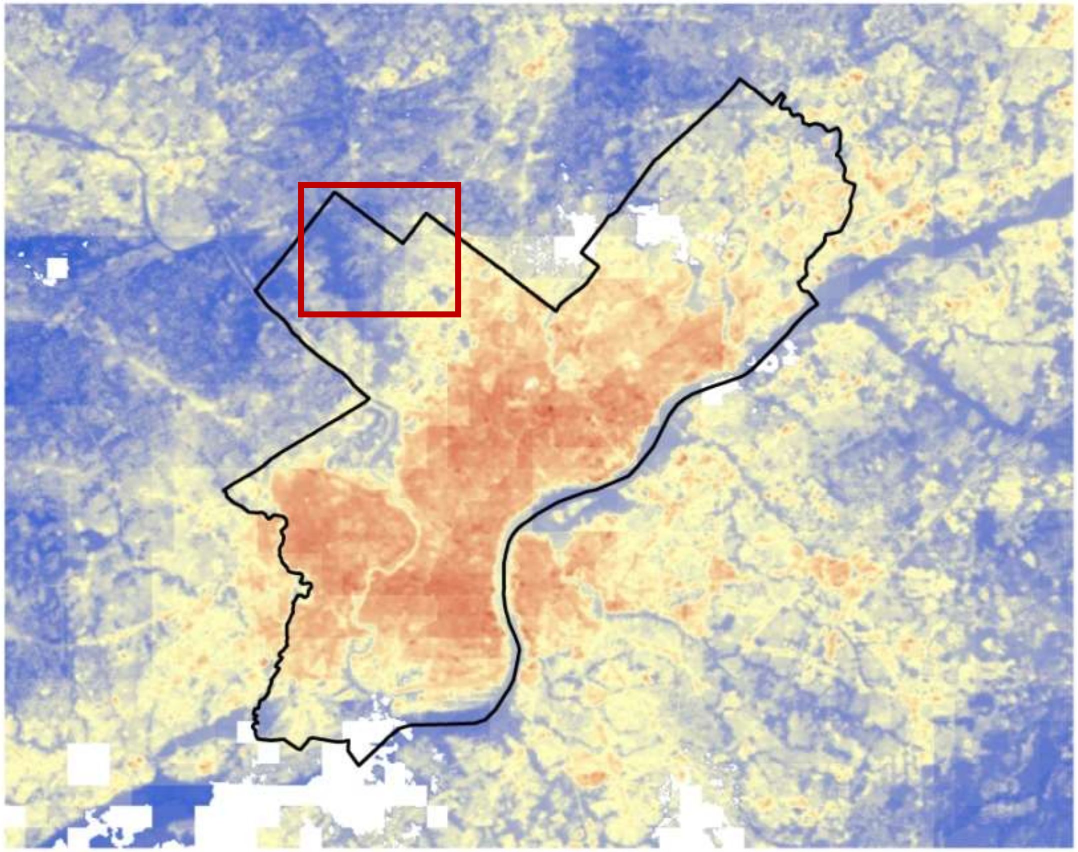
Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[557] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Upper Northwest Planning District.



---

[556] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[557] “Heat Island Effect”. US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[558] As the map shows, the Upper Northwest is located in an area which experiences very limitedlimited higher heat island effects.



---

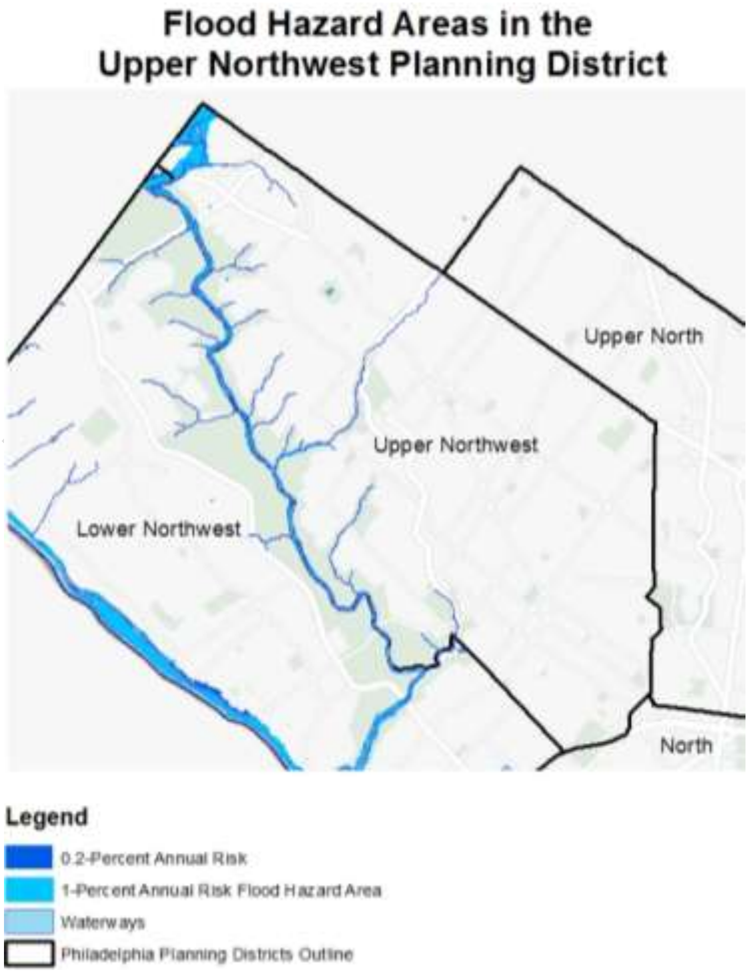
[558] “Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002”. URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[559]


Flood Hazard Areas in the Upper Northwest Planning District

Winter flooding includes 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. All forms of flooding can damage infrastructure.[560] For more

---

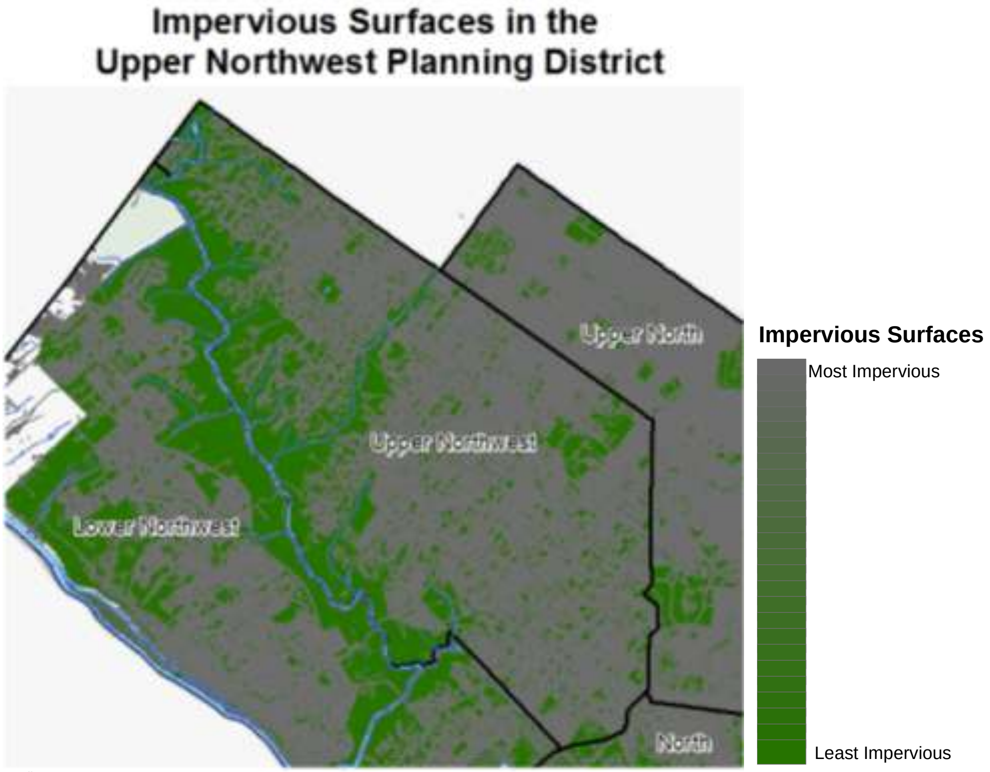
[559] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.
[560] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

A small portion of the Upper Northwest Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the Upper Northwest Planning District there are 69 National Flood Insurance Program (NFIP) policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

Flash flooding is a concern for some areas of the Upper Northwest Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the Upper Northwest Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Hazardous Material Train Derailment

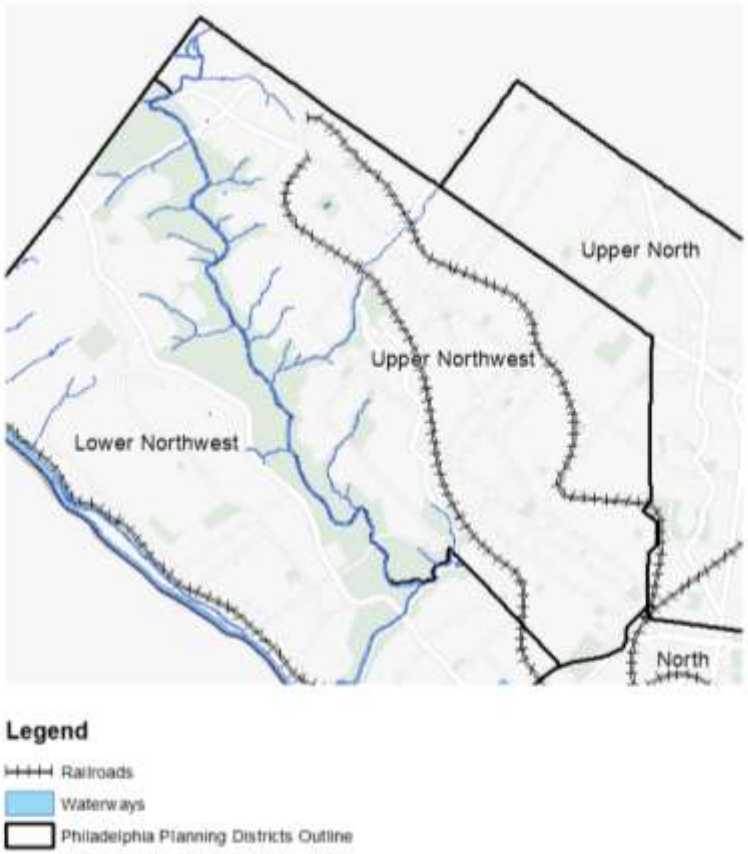
Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[561]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the Upper Northwest Planning District



---

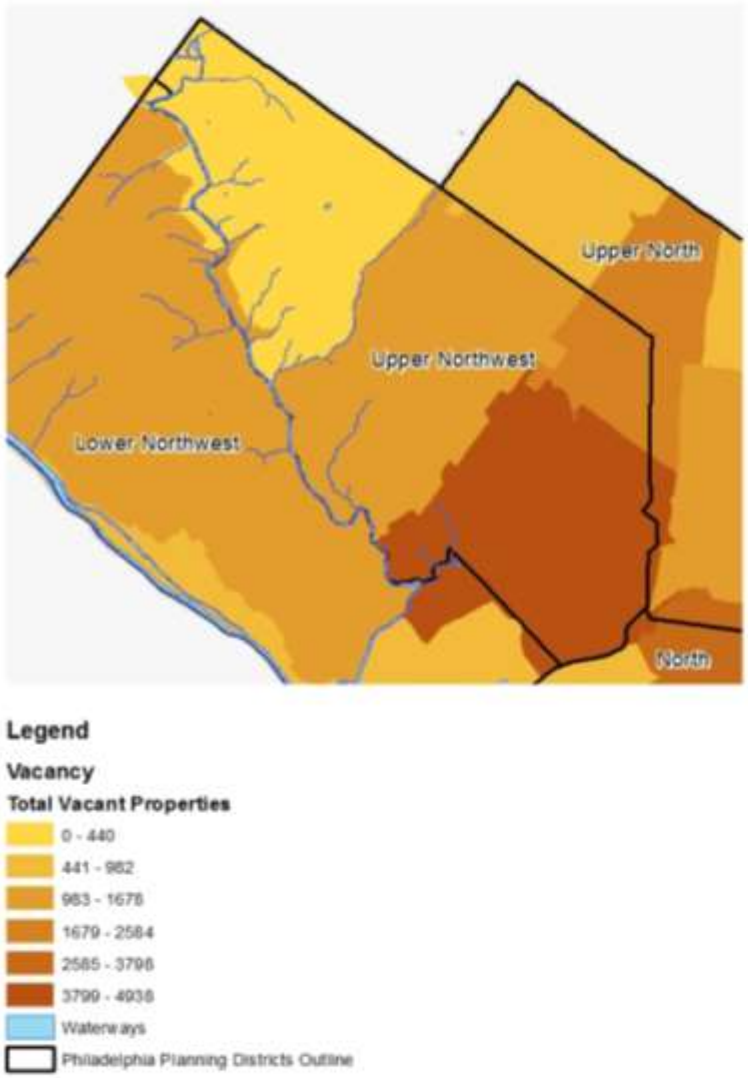
[561] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[562] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[563] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The Upper Northwest Planning District has some vacant properties with a concentration of vacant properties in the south eastern portion of the planning district.

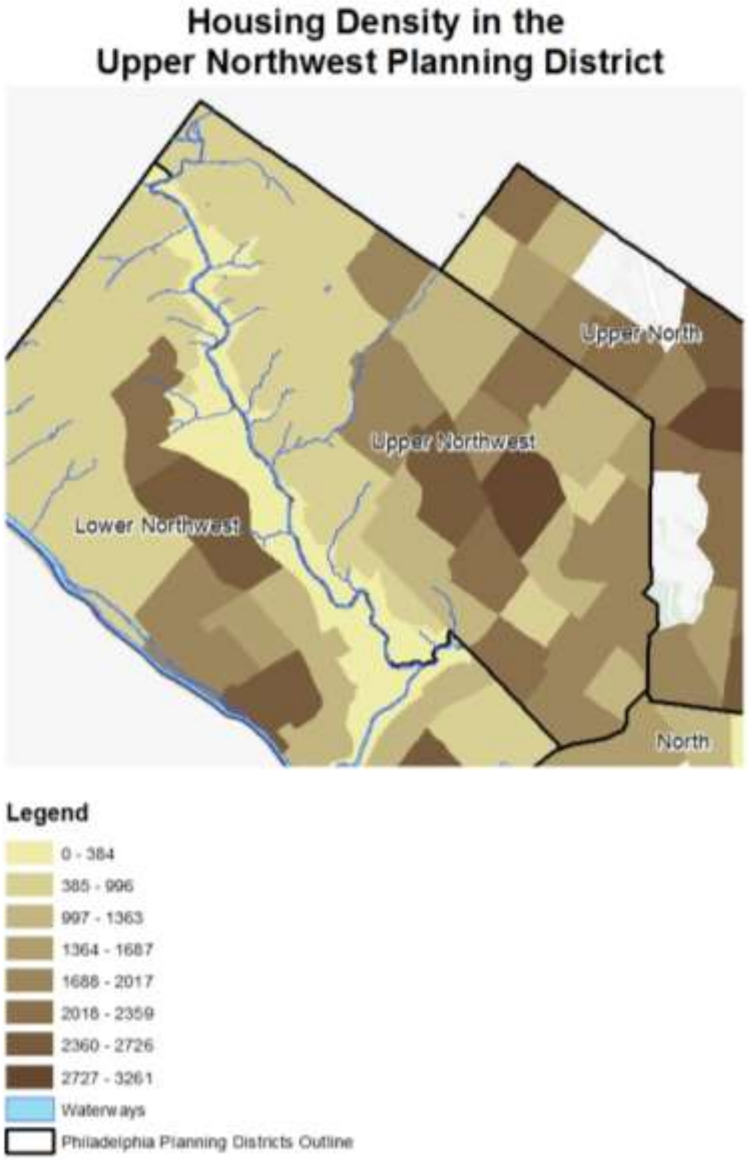
Vacancy in the Upper Northwest Planning District



---

[562] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.
[563] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the Upper Northwest Planning District's housing density. Data was unavailable for those portions of the map left uncolored.

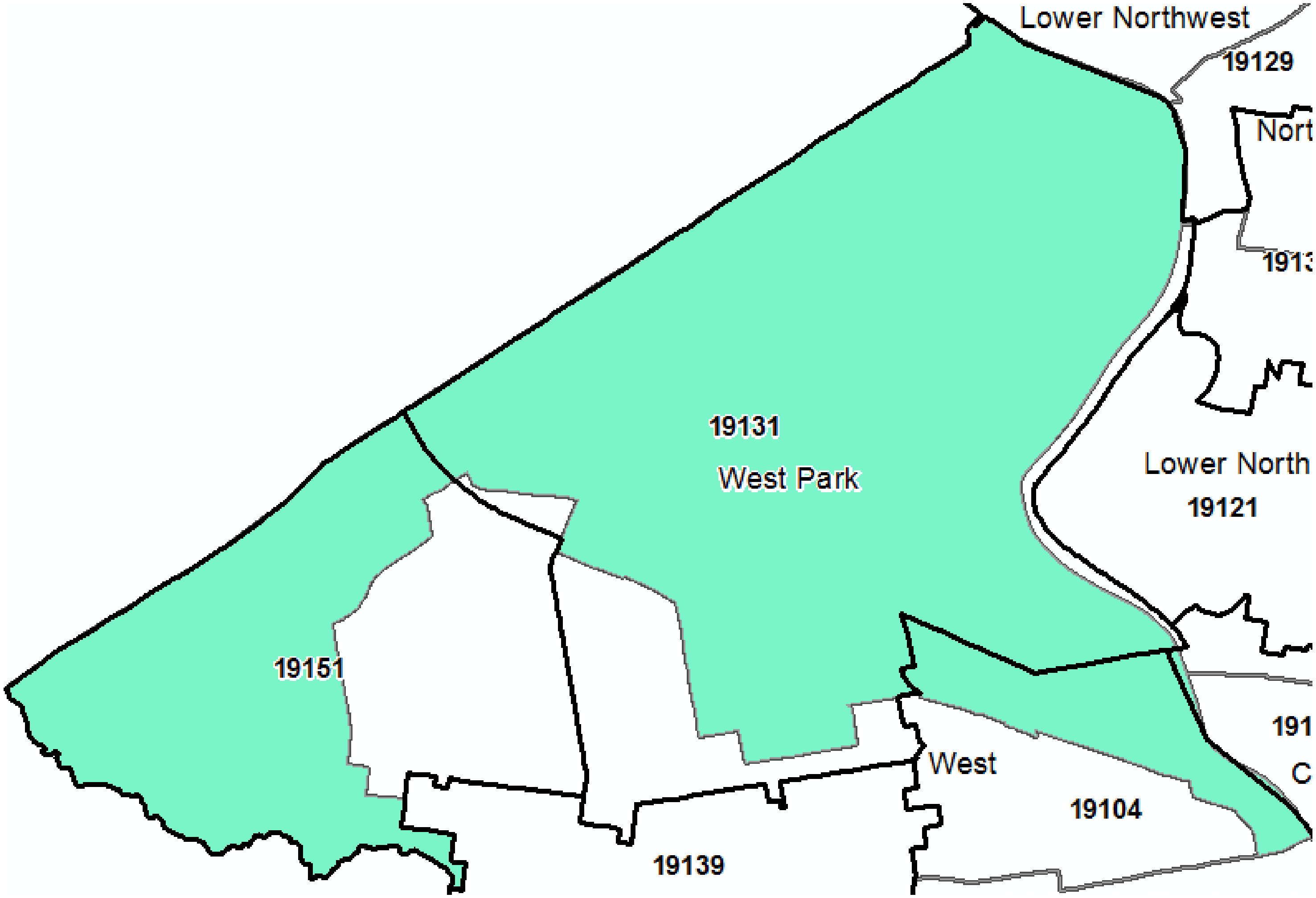


21.1.16 West Park

21.1.16.1 Geography and Hydrology

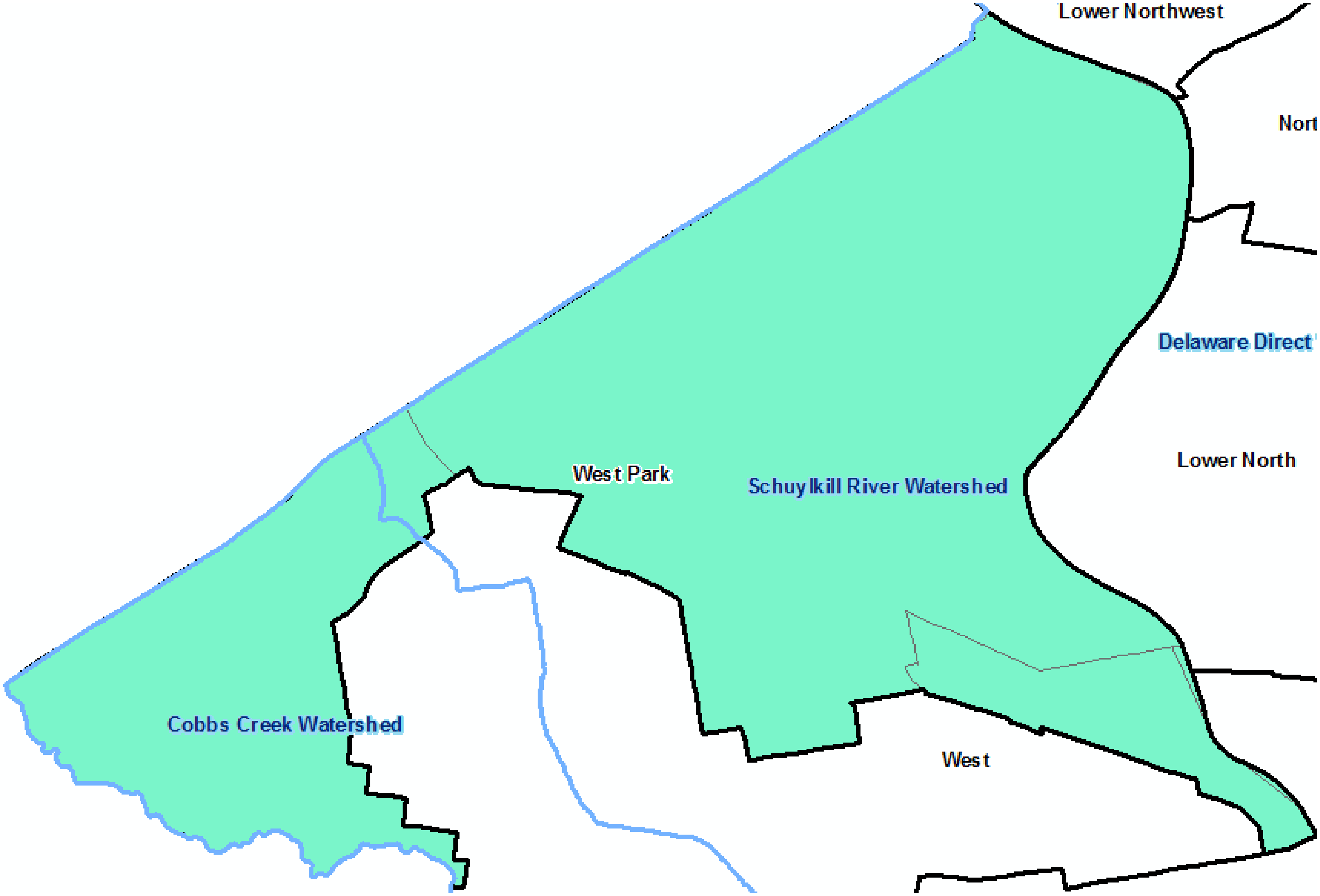
The West Park planning district contains addresses in the zip codes 19151, 19104, and 19131.

Zip codes in the West Park Planning District



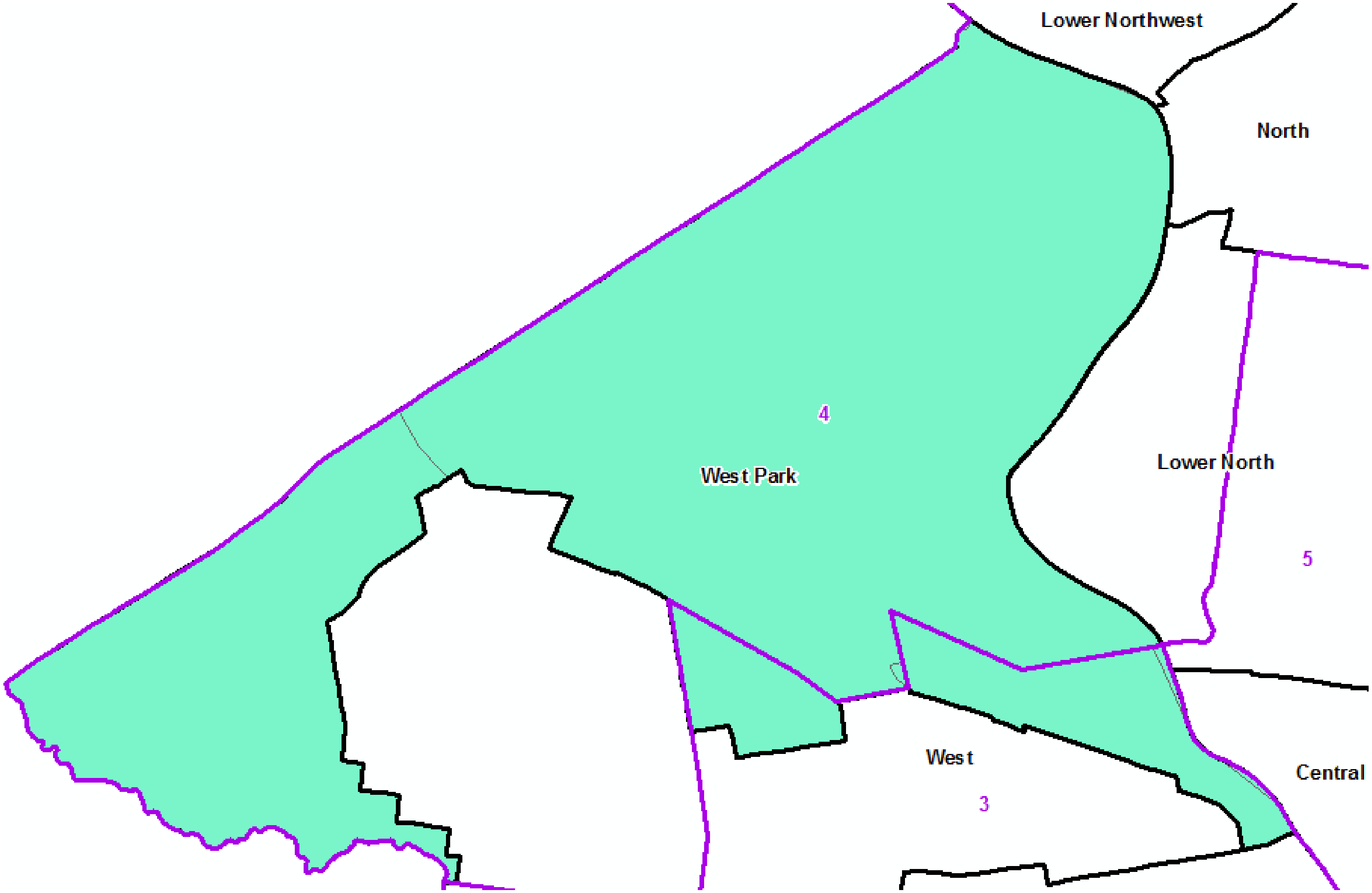
The West Park planning district falls partially in the Cobbs Creek and Schuylkill River Watersheds.

Watersheds in the West Park Planning District



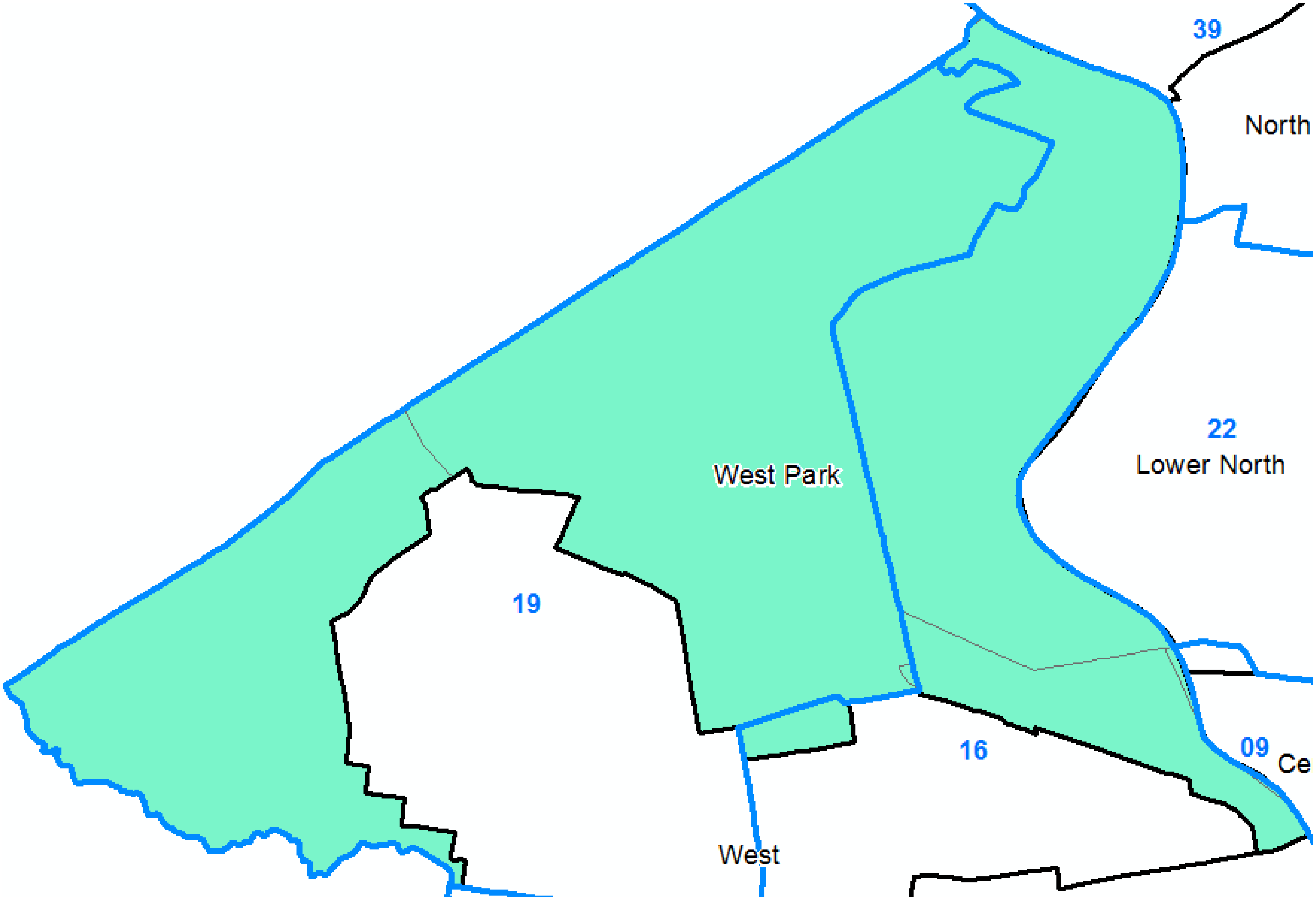
The West Park planning district resides within the 4th and 3rd Council Districts of Philadelphia.

Council Districts in West Park Planning District



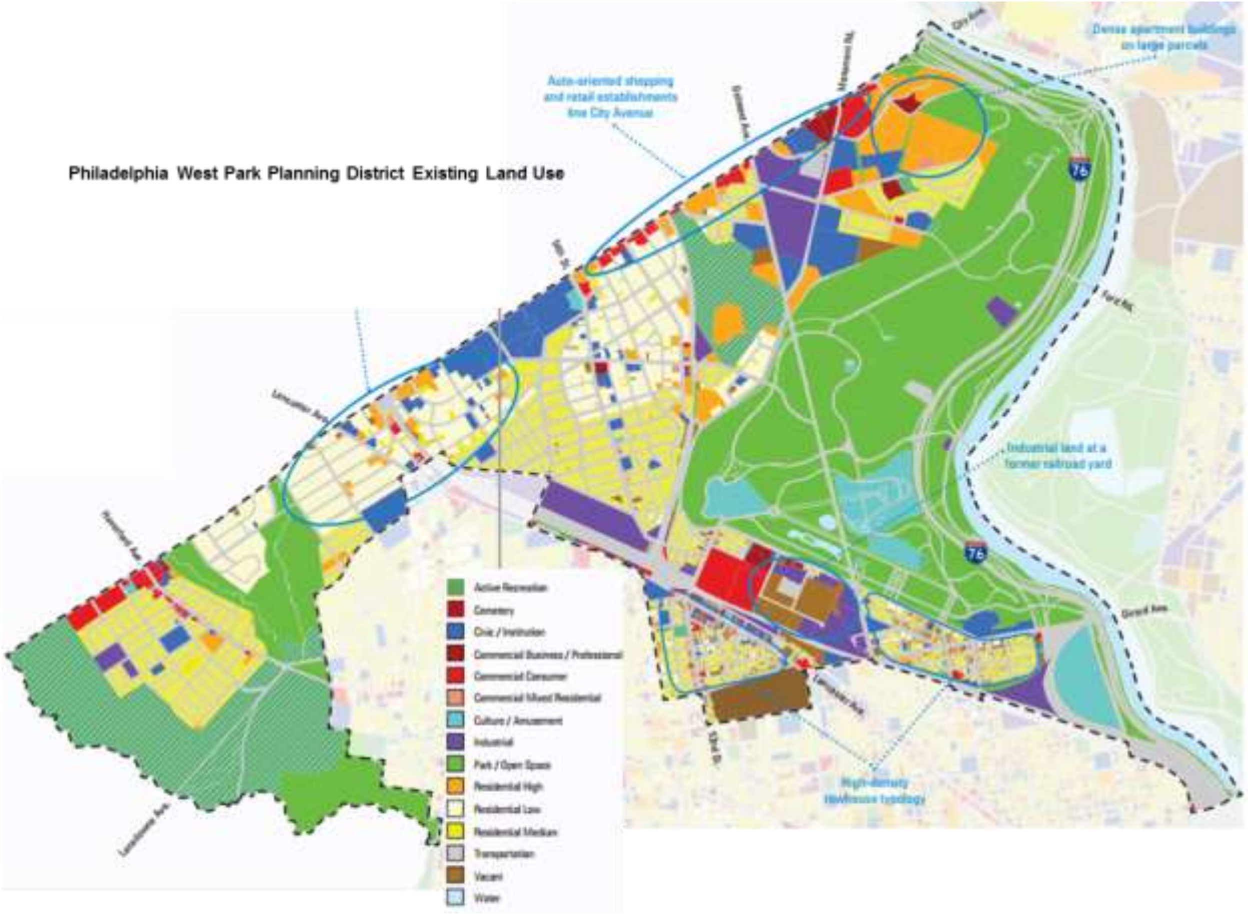
The West Park planning district falls mostly within the 19th Police District, and also crosses into the 16th Police District.

Police Districts in the Upper Far Northeast Planning District



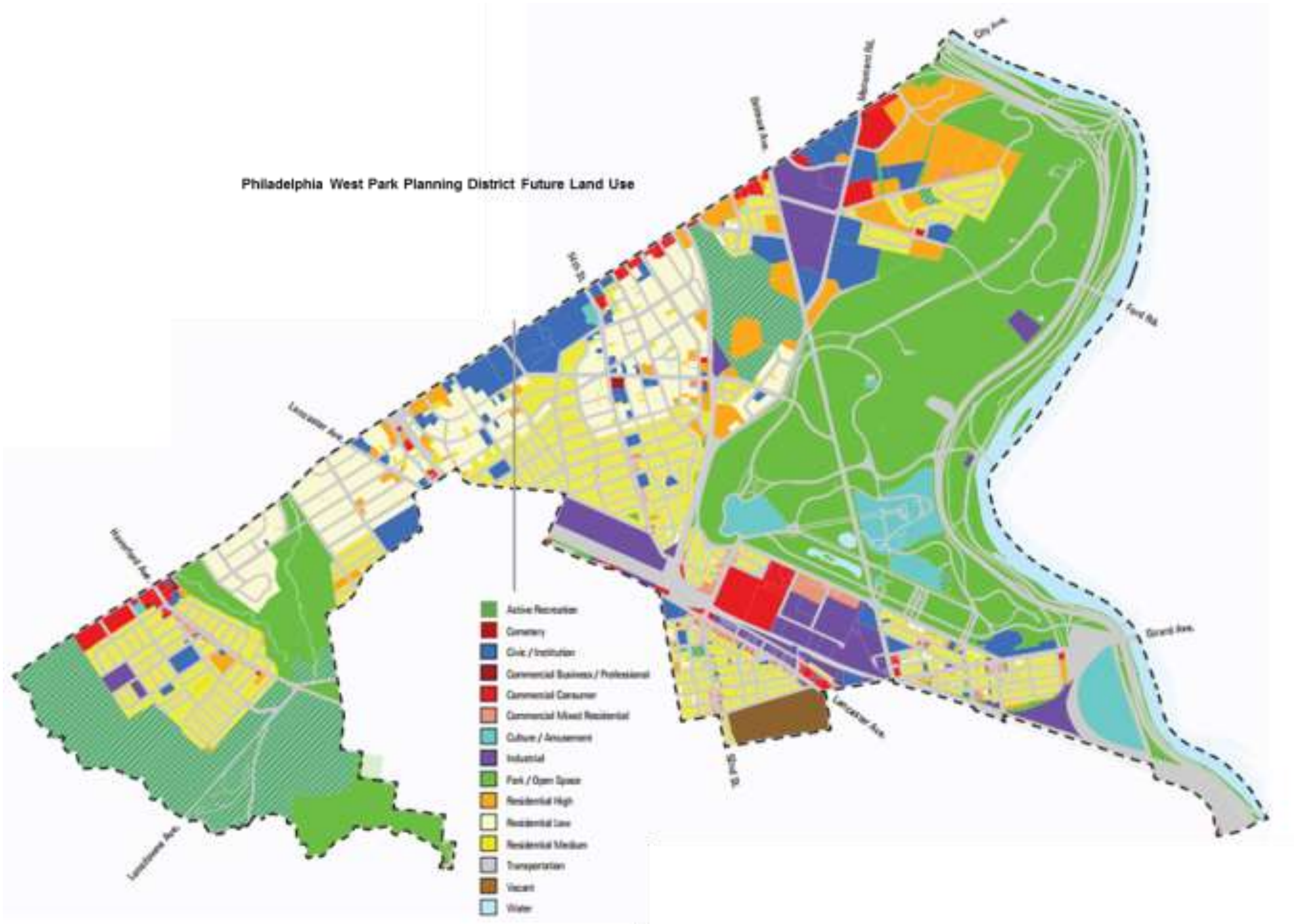
21.1.16.2 Current and Future Land Use

PCPC forecasts that the West Park District will see modest growth over the next 10 years.[564] Future land use of the district takes into account those areas where the zoning and land use currently do not match, as well as where best to place incoming and growing populations.[565] [566]



---

[564] City of Philadelphia, Philadelphia 2035. West Park District Plan. Retrieved November 20, 2015.
[565] Ibid.



Philadelphia West Park Planning District Future Land Use

---

[566] All graphics, charts, and recommendations come from the City of Philadelphia: Philadelphia 2035 West Park District Plan. Retrieved November 20, 2015.

21.1.16.3 Social Characteristics

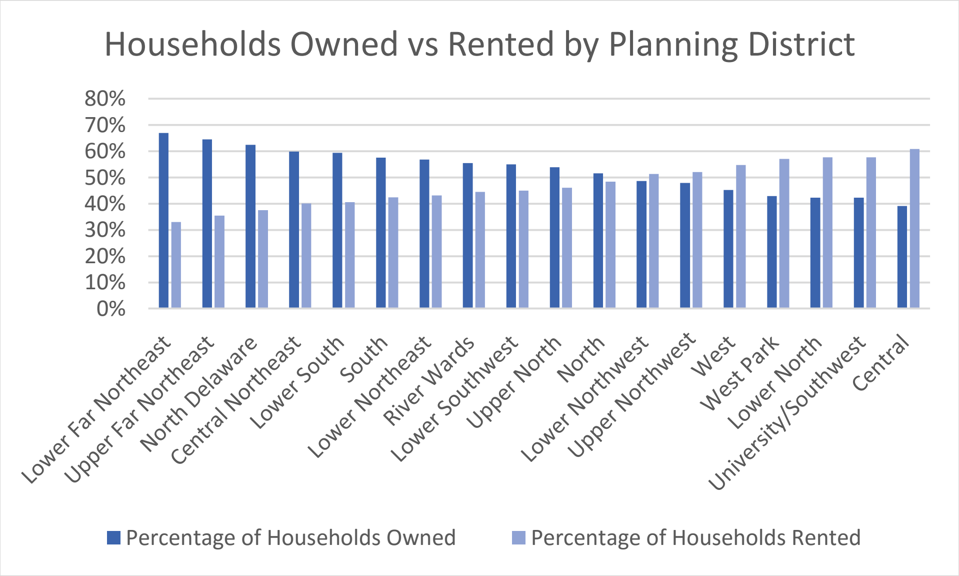
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

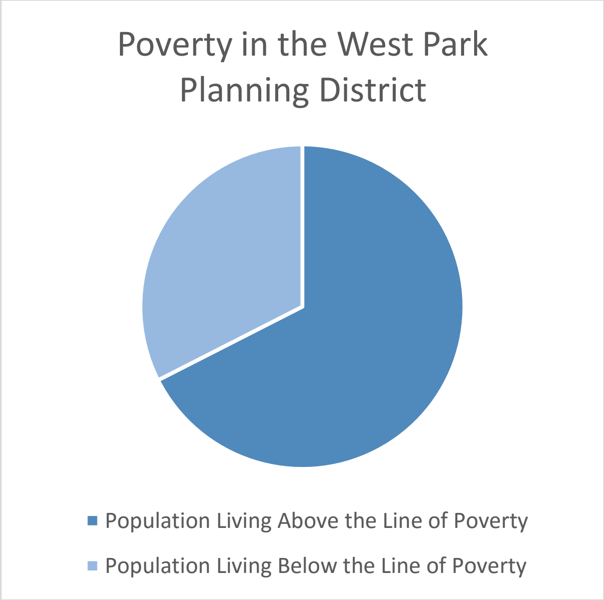
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	210,017
- Male population	98,122
- Female population	111,985
Median Age	31.8
- Age dependency ratio (the percentage of the population under 15 and over 64)	45.6%
- Population under 15	28.4%
- Population over 64	17.1%

21.1.16.4 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	62,524
- Households owned	26,796
- Households rented	35,728
No vehicle access	5,631
Population below the federal line of poverty	32.5%





21.1.16.5 Disability

Of those individuals residing within the West Park Planning District, 11.5 percent reported having a disability. Disabilities reported by individuals in the West Park Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	6.9%
Vision difficulty	7.1%
Cognitive difficulty	7.8%
Ambulatory Difficulty	8.0%
Self-care Difficulty	7.8%
Independent Living Difficulty	5.7%

21.1.16.6 West Park Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

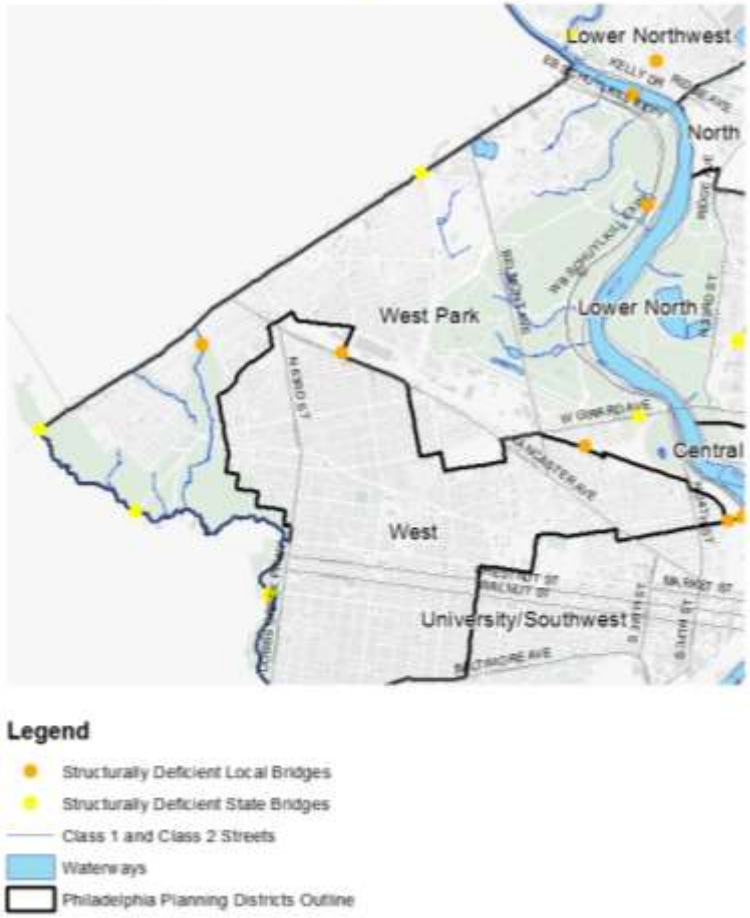
Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[567] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessmentsection of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A "structurally deficient bridge" typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[568] [569] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the West Park Planning District.[570]

Structurally Deficient Bridges in the West Park Planning District



---

[567] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[568] 2010 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[569] Ibid.

[570] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the West Park Planning District

Name	Location	Year Built
Amtrak and SEPTA	Spring Garden St and N. 30th Station	1964
Amtrak Northeast Corridor	Spring Garden St near 31st St	1964
Indian Creek	Sherwood Ave, west of 66th St	1918
Conrail	Greenland Drive, west of West River Dr	1974
Falls Bridge	Schuylkill River	1895
Amtrak	41st St, south of Poplar	1928
Amtrak and SEPTA	59th St, north of Lancaster Ave	1926
Cobb’s Creek	State Rd, 0.5 miles east of PA-3	1935
CSX Railroad	Girard Ave at the Philadelphia Zoo	1890
Cobb’s Creek	Township Line Rd	1934
SEPTA (Bala Station)	City Line Ave, 0.5 miles south of Belmont Ave	1910

Dam Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. The table below shows the dam name, the waterway on which the dam is located, whether the dam is a high hazard dam, and who currently holds the permit for the structure.

Dams in the West Park Planning District

Dam Name	Waterway	High Hazard?	Permitted Owner
Fairmont	Schuylkill River	No	Philadelphia Water Department
Belmont Raw Water Basin	Schuylkill River Watershed	Yes	Philadelphia Water Department

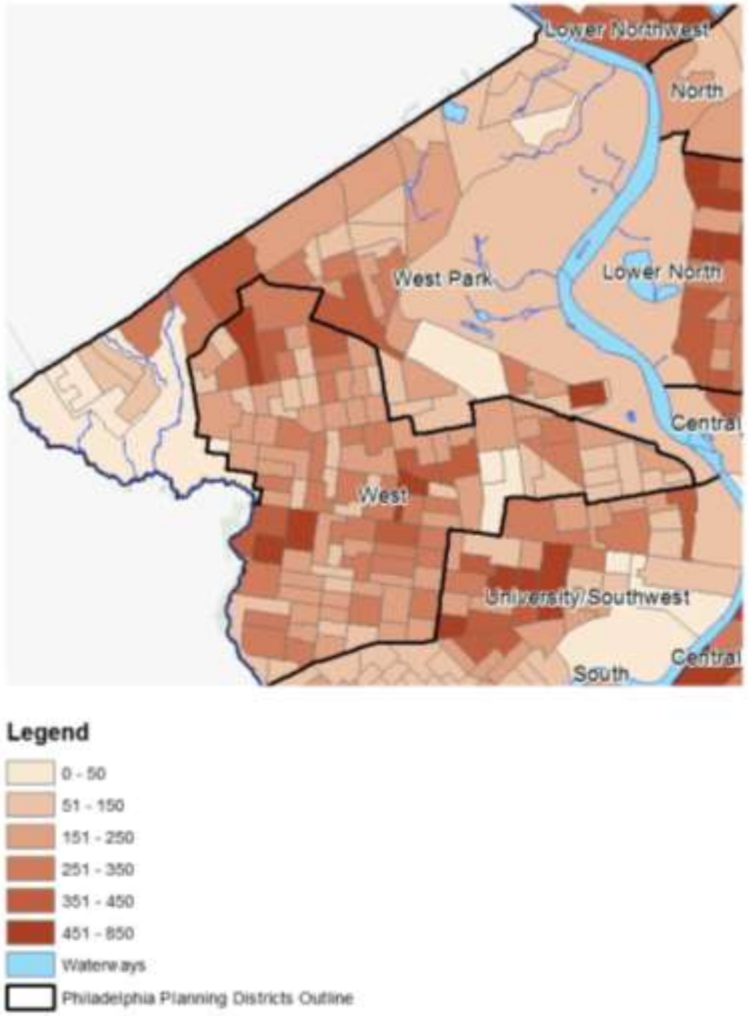
Building Collapse

Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance;
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

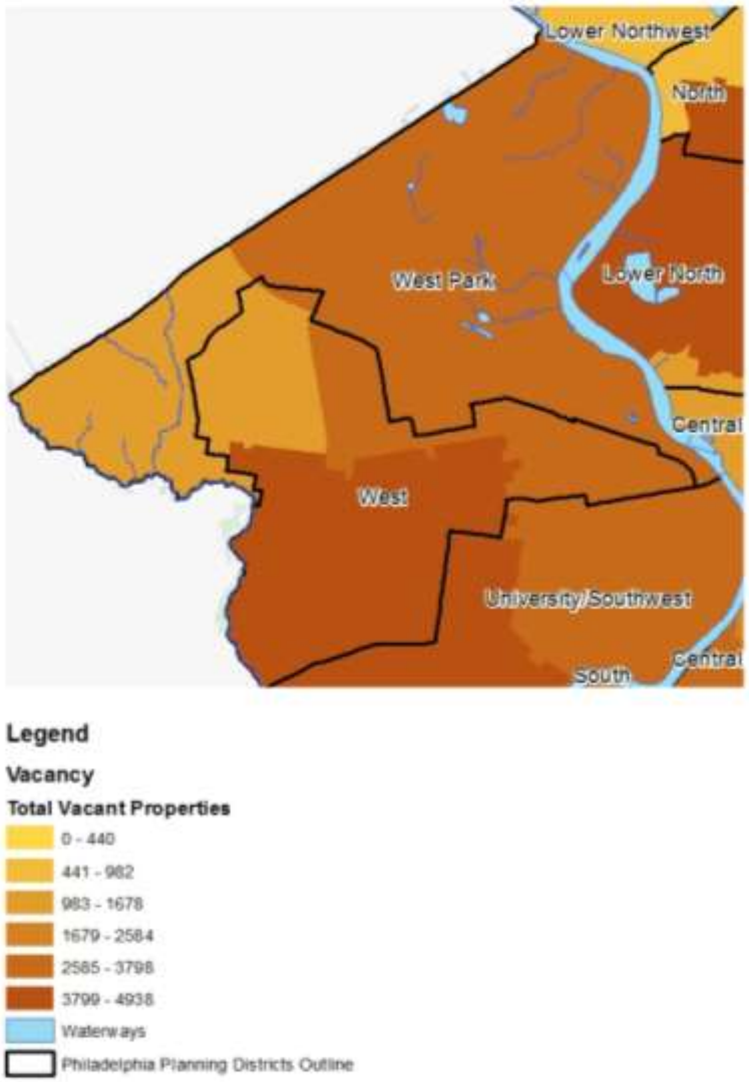
Building age increases the risk of collapse. The map to the right shows the number of properties built in the West Park Planning District built before 1939.

Structures Built Prior to 1939 in the West Park Planning District



Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the West Park Planning District. The West Park Planning District has a lower concentration of vacant structures than other planning districts in the city.

Vacancy in the West Park Planning District



Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the West Park Planning District.


Imminently Dangerous Structures in the West Park Planning District

Extreme Heat

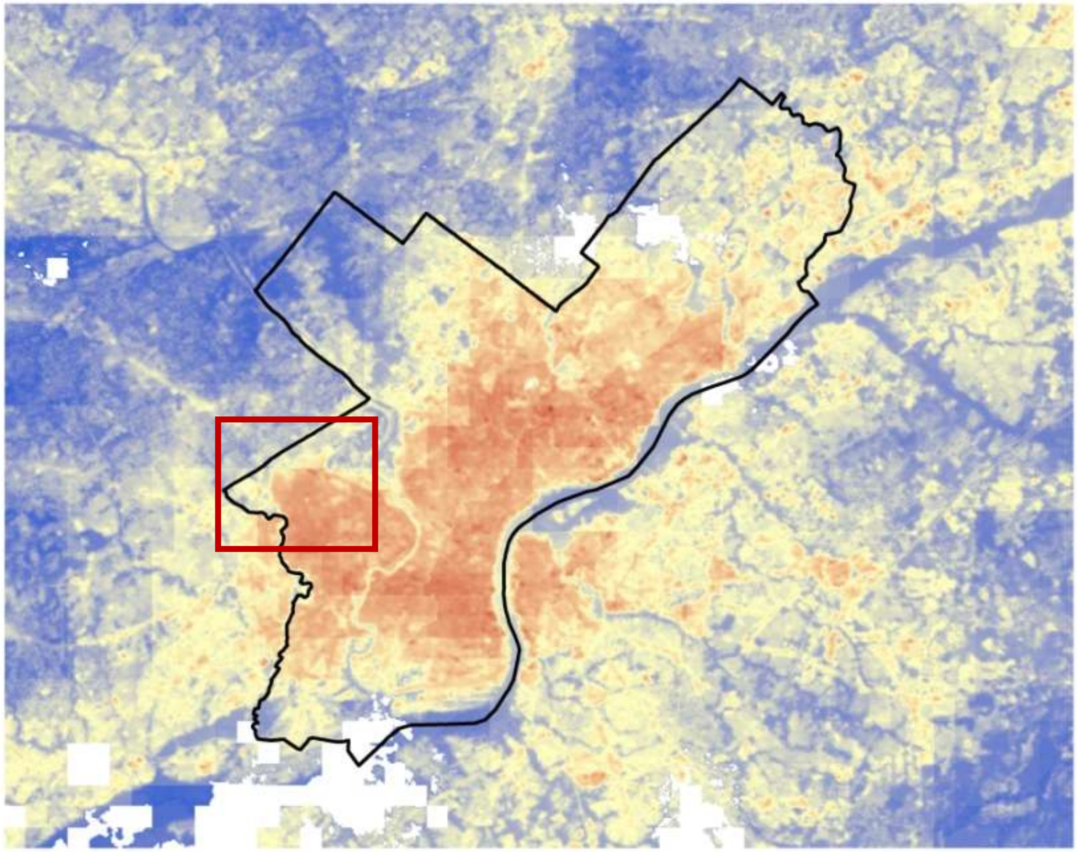
Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[571] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[572] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the West Park Planning District.

---

[571] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[572] "Heat Island Effect". US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[573] As the map shows, the West Park is located in an area which experiences some heat island effects, and experiences greater effects of such an event more than the bordering counties.



---

[573] "Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002". URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[574]

Winter flooding includes 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. All forms of flooding can damage

---

[574] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

infrastructure.[575] For more information on flooding and its impacts, please see Flooding under the Risk Assessmentsection of the 2017 Hazard Mitigation Plan.

A small portion of the West Park Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the West Park Planning District there are 26 of policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

---

[575] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Flash flooding is a concern for some areas of the West Park Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the West Park Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.

Impervious Surfaces in the West Park Planning District

Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[576]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the West Park Planning District

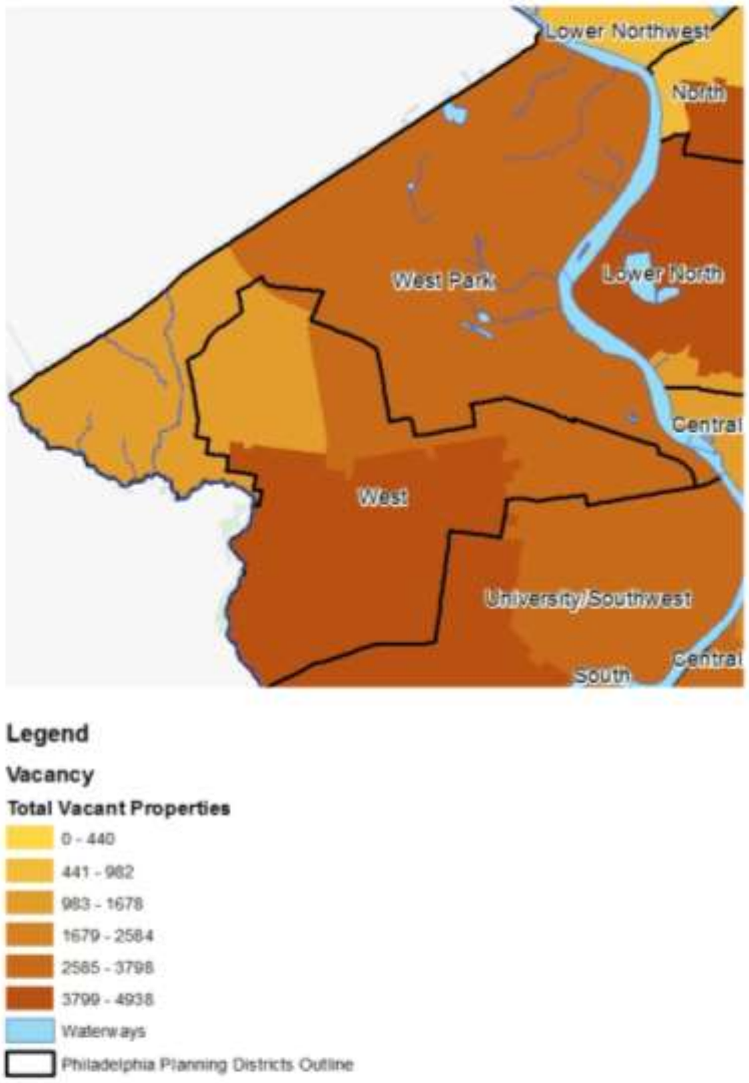
---

[576] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[577] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[578] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The West Park Planning District has a lower concentration of vacant properties than many other parts of Philadelphia, and therefore has a slightly lower risk for urban conflagration.

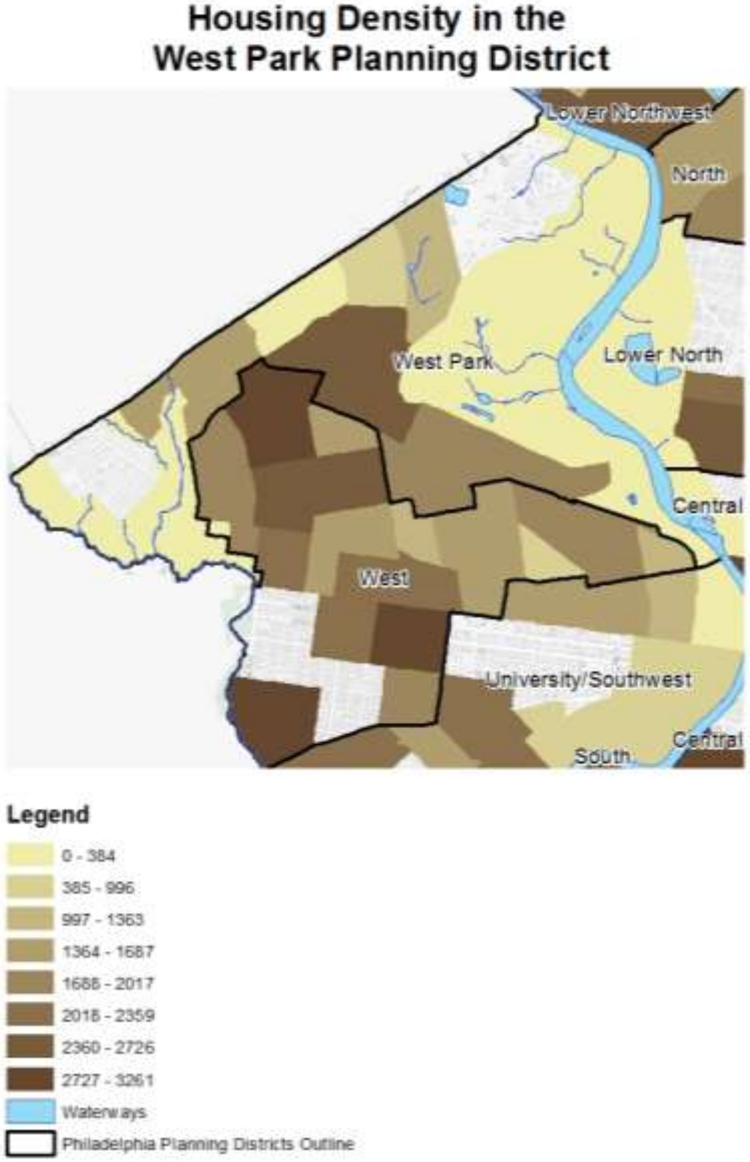

Vacancy in the West Park Planning District

---

[577] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.

[578] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the West Park Planning District's housing density. Data was unavailable for those portions of the map left uncolored.

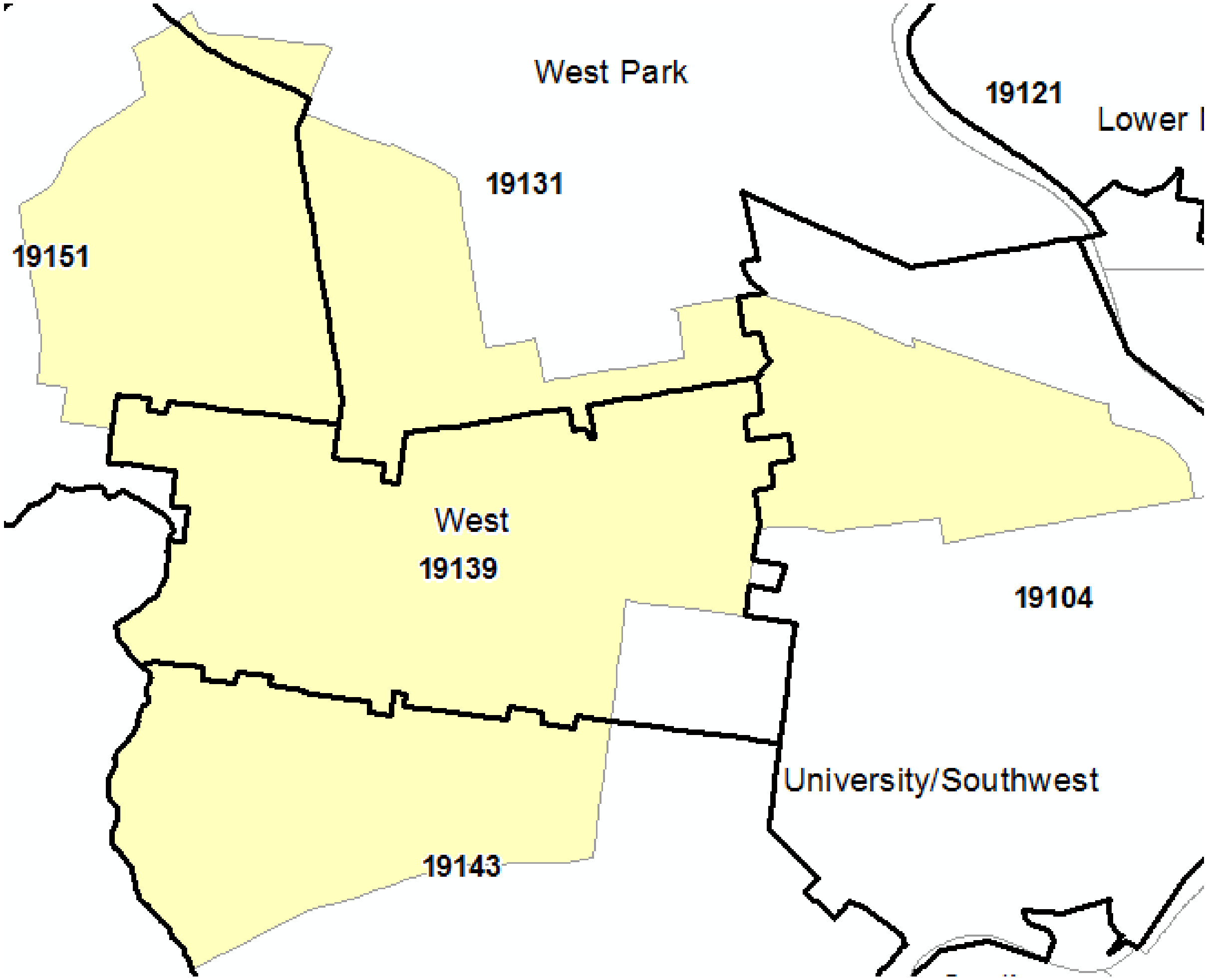


21.1.17 ***West***

21.1.17.1 Geography and Hydrology

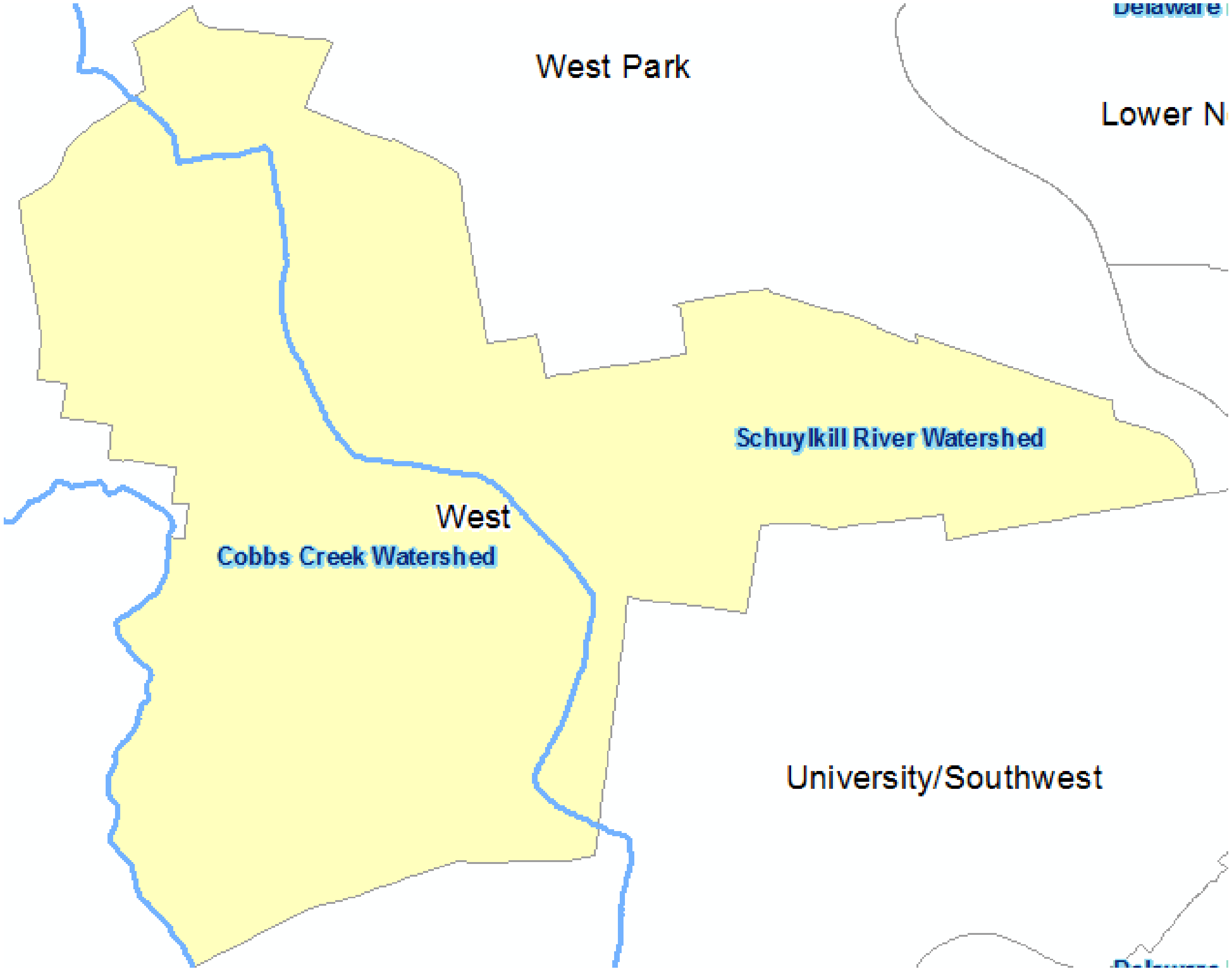
The West Planning District contains addresses in the zip codes 19151, 19139, 19131, 19104, and 19143.

Zip codes in the West Planning District



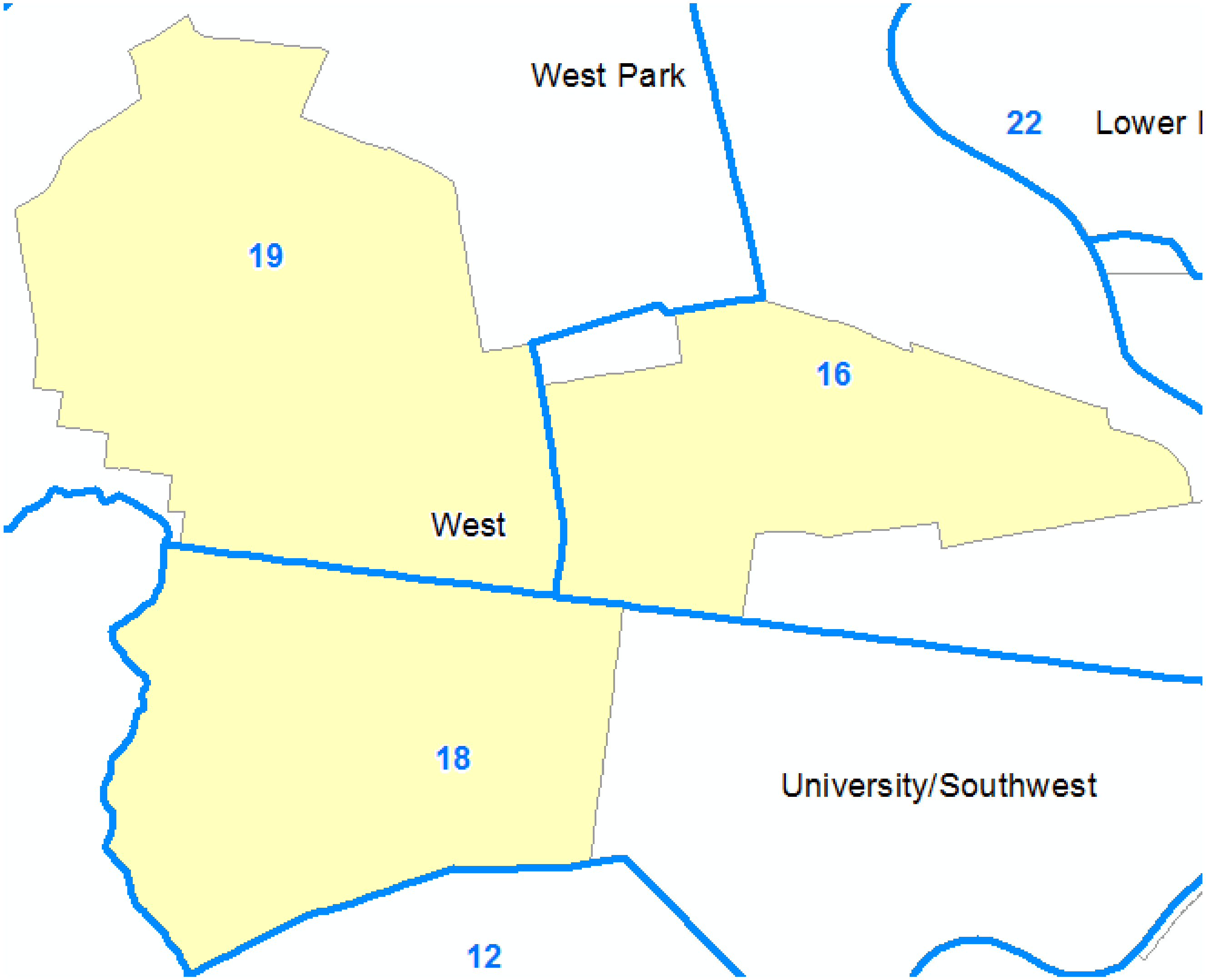
The West planning district falls partially in the Cobbs Creek and Schuylkill River Watersheds.

Watersheds in the West Planning District



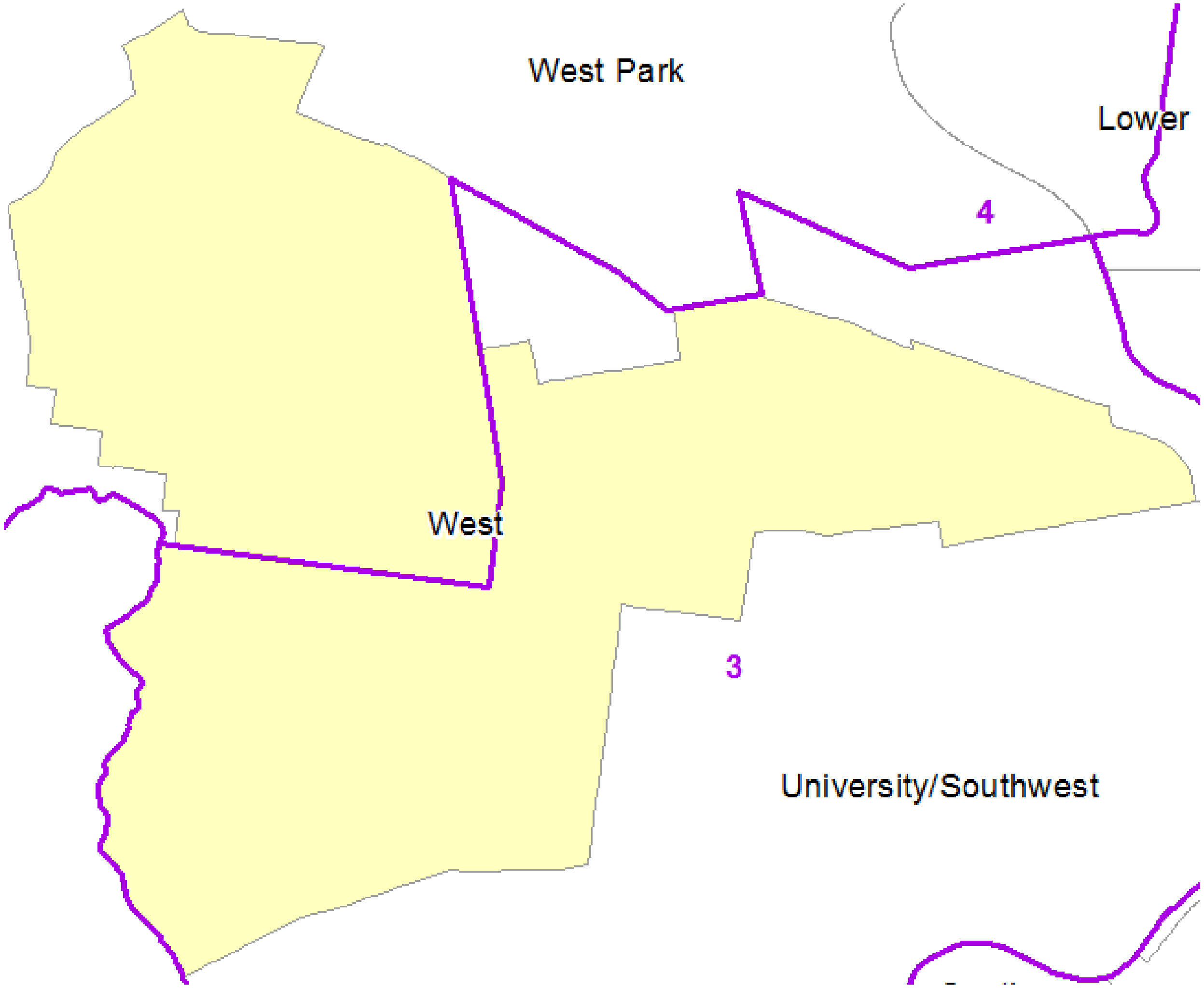
The West Planning District resides within the 4th and 3rd Council Districts of Philadelphia.

Council Districts in West Planning District



The West Planning District falls within the 19th, 18th, and 16th Police Districts.

Police Districts in the West Planning District



21.1.17.2 Social Characteristics

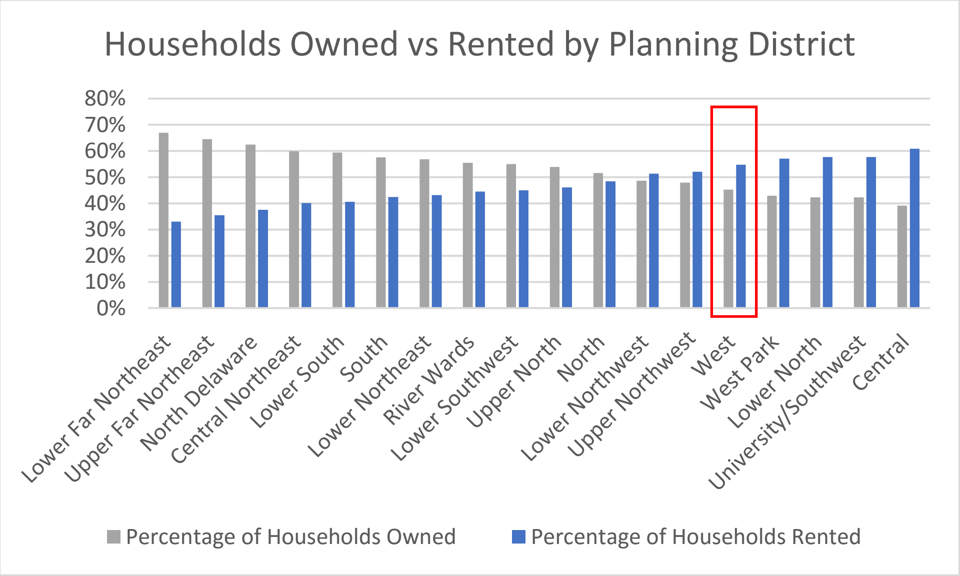
Data used for social characteristics is from the most recent American Community Survey provided from the U.S. Census. The ACS produces population, demographic and housing unit estimates over a five-year period between censuses. The data used for these statistics is from 2014.

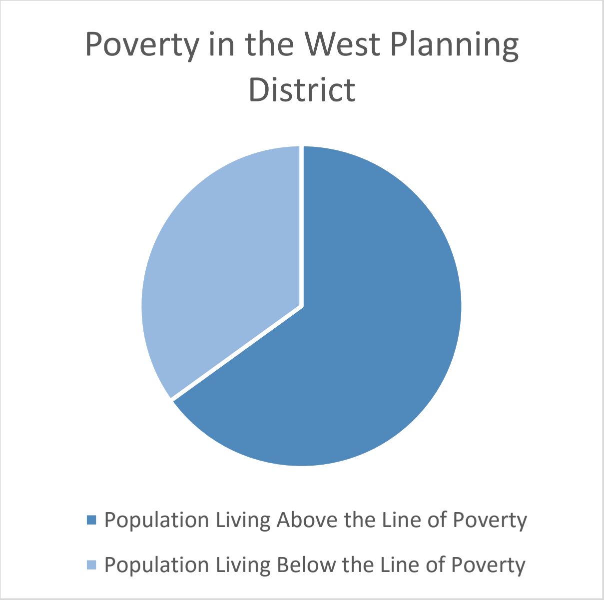
Population, Gender and Age Characteristics of the Upper Far Northeast Planning District	
Population	236,060
- Male population	107,798
- Female population	128,262
Median Age	32.2
- Age dependency ratio (the percentage of the population under 15 and over 64)	51.1%
- Population under 15	32.7%
- Population over 64	18.4%

21.1.17.3 Housing, Mobility, and Poverty

For emergency management, whether a home is owned or rented division implies a difference in insurance coverage which affects long-term recovery. Renters insurance covers exists mainly to cover the occupants' belongings, not the housing itself. This can present challenges in housing unit repair and re-occupancy. Those households living in poverty may have a more difficult time preparing for and recovering from disasters, and the district's population living below the federal line of poverty.

Housing, Mobility, and Poverty Characteristics of the Upper Far Northeast Planning District	
Number of households	86,908
- Households owned	39,290
- Households rented	47,618
No vehicle access	38,041
Population below the federal line of poverty	35.0%





21.1.17.4 Disability

Of those individuals residing within the West Planning District, 14.3 percent reported having a disability. Disabilities reported by individuals in the West Planning District are listed in the table below by the percentage of the total population of the District. Disabilities are not exclusive.

Disability Reported	Percentage of Population
Hearing difficulty	6.1%
Vision difficulty	6.3%
Cognitive difficulty	7.0%
Ambulatory Difficulty	7.4%
Self-care Difficulty	7.1%
Independent Living Difficulty	7.5%

21.1.17.5 West Hazards

Many hazards affect the City of Philadelphia on a wide scale, such as windstorms or hurricanes, while others can have varying levels of risk across the city. These hazards include:

- Infrastructure Failure
- Extreme Heat
- Flooding
- Hazardous Material Train Derailment
- Urban conflagration

Each of these hazards are detailed below on the risk factors present in the Upper Far Northeast Planning District. For a complete list of hazards in the 2017 Hazard Mitigation Plan and a description of the city-wide risk level for each, please see the Risk Assessment section in the main body of the plan.

Infrastructure Failure

Bridge Failure

A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly.[579] Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. For more information on bridge failures and its impacts, please see Bridge Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Structurally deficient bridges are those have major deterioration, cracks, or other flaws that reduce its ability to support vehicles. A “structurally deficient bridge” typically requires maintenance and repairs to remain in service, or rehabilitation or replacement to address the underlying issue.[580] [581] Depending on the type and extent of deterioration, the Philadelphia Streets Department or PennDOT may impose weight restrictions. If the deterioration is severe, regulating agencies may shut down the bridge to traffic until maintenance crews can repair the damage. The table below shows those bridges found to be structurally deficient. The map to the below shows those bridges deemed structurally deficient in the West Planning District.[582]

Structurally Deficient Bridges in the West Planning District

---

[579] City of Philadelphia Threat and Hazard Identification and Risk Assessment. Retrieved February 16, 2016.

[580] 2010 Status of the Nation’s Highways, Bridges, and Transit: Conditions & Performance - System Conditions: Highways and Bridges. Federal Highway Administration. Retrieved March 23, 2016.

[581] Ibid.

[582] Map Information: MPMS IQ. PennDOT. Retrieved March 2, 2016.

Structurally Deficient Bridges in the West Planning District		
Name	**Location**	**Year Built**
Amtrak and SEPTA, 32nd	Spring Garden St, North 30th St Station	1964
Amtrak Northeast Corridor	Spring Garden St, near 31st St	1964
Amtrak (HSBG Branch)	41st St, south of Poplar St	1928
Amtrak and SEPTA	59th St, north of Lancaster Ave	1926
Cobb’s Creek	Marshall Rd	1964
Schuylkill River, West River Dr	Spring Garden St near the Art Museum	1966

Dam Failure

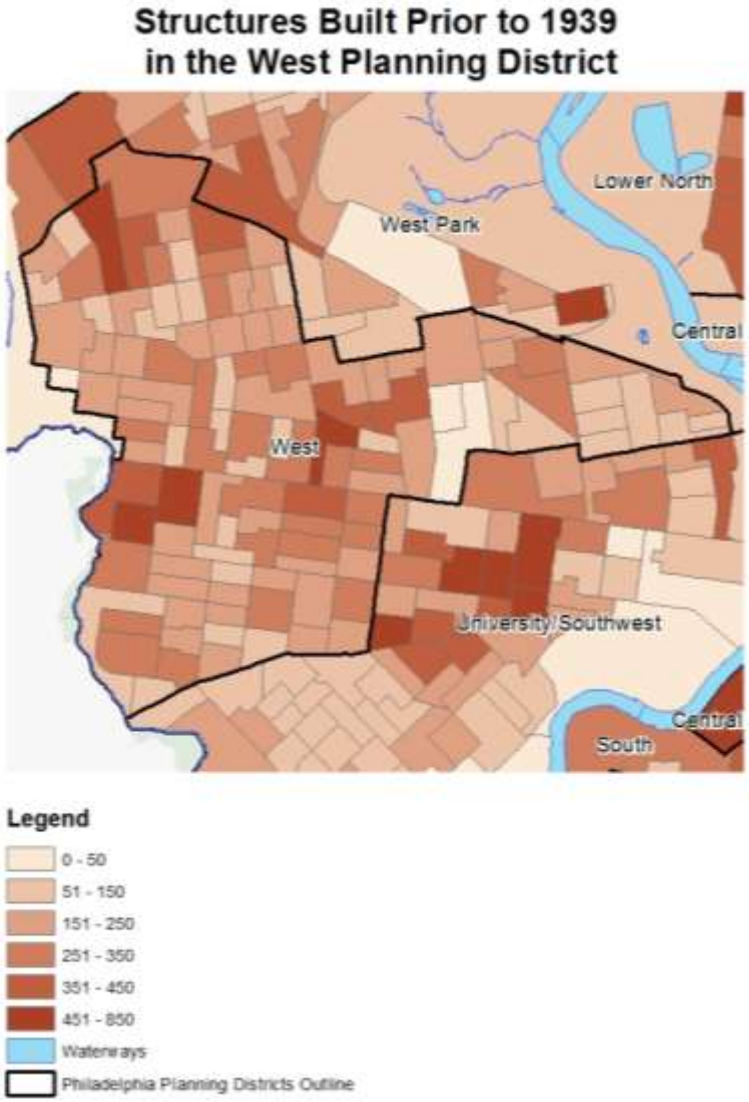
A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but structural damages and injuries are possible in downstream communities when such events occur. For more information on dam failures and its impacts, please see Dam Failure under the Risk Assessment section of the 2017 Hazard Mitigation Plan. There are no dams in the West Planning District.

Building Collapse

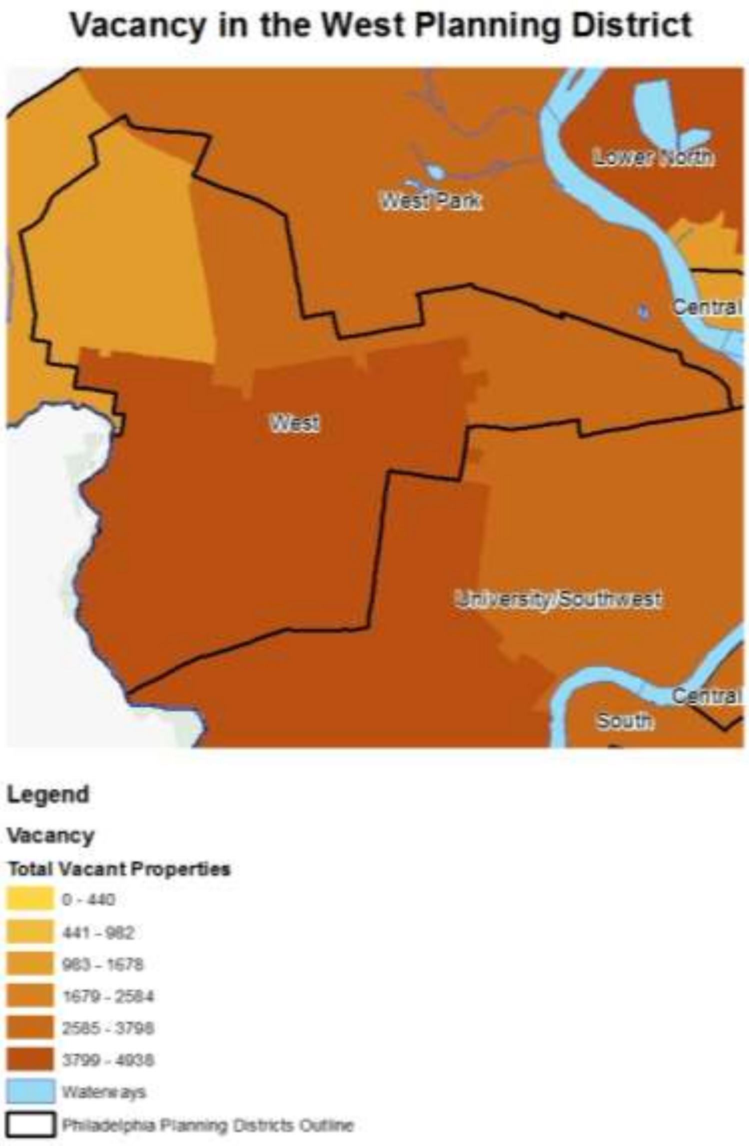
Buildings may collapse for a variety of reasons, including:

- Overall structural integrity;
- Poor construction or maintenance;
- Accidents;
- Environmental forces, such as wind or heavy snowfall; or
- Earthquakes.

Building age increases the risk of collapse. The map to the right shows the number of properties built in the West Planning District built before 1939.



Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. The map to the right shows the number of vacant properties in the West Planning District. The West Planning District has a higher concentration of vacant properties in the southern portion of the district than the rest of the district.

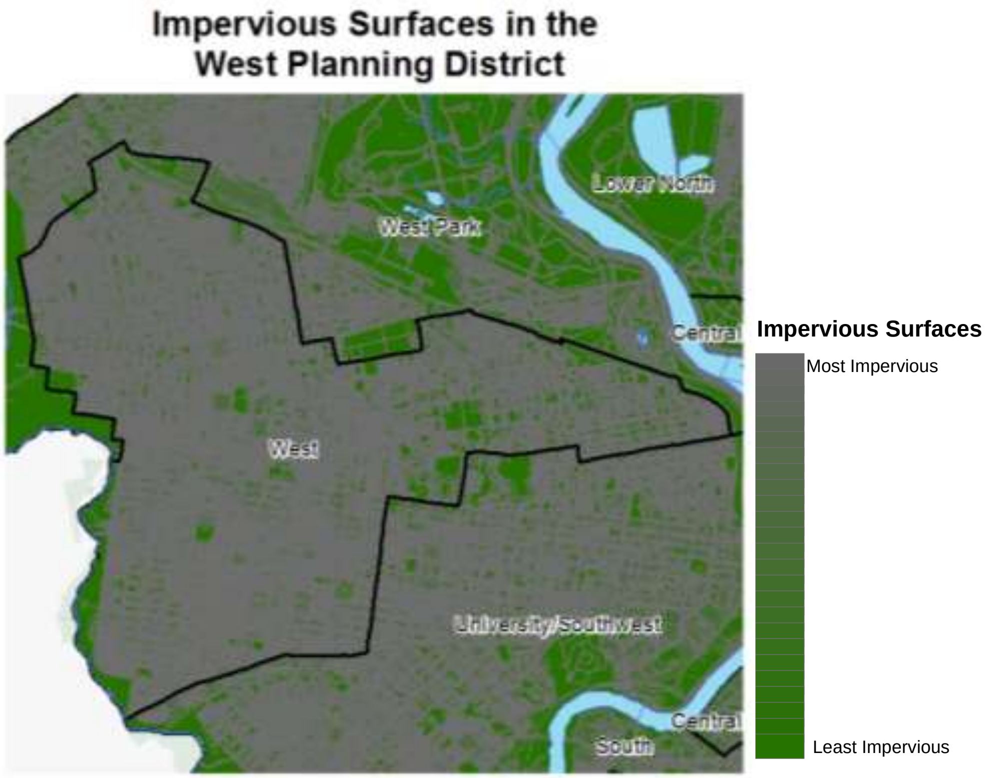


Philadelphia Licenses and Inspections (L&I) records imminently dangerous structures found each year through inspections. Some of these structures have partially collapsed, while others are found and acted upon before they collapse. Property owners can repair or demolish these structures. The map below shows the location of imminently dangerous structures in the West Planning District.

Extreme Heat

Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.[583] For more information on extreme heat and its impacts, please see Extreme Heat under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

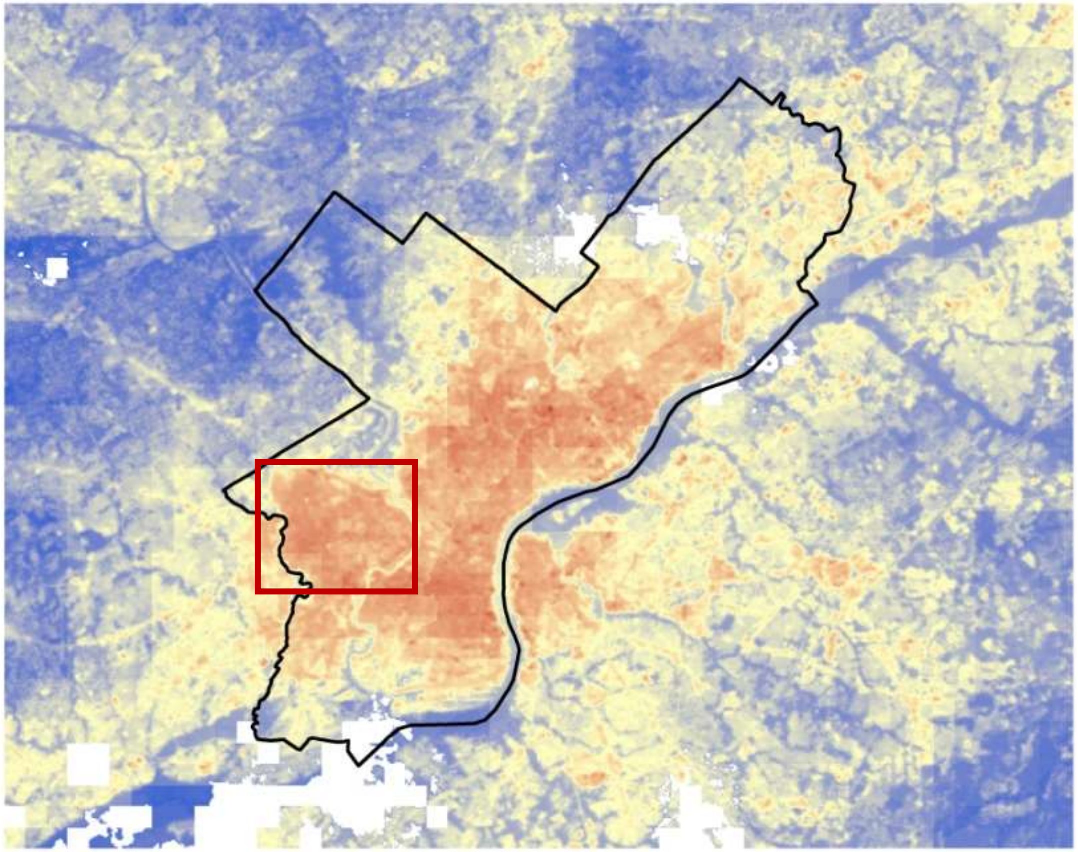
Philadelphia is subject to heat island effects. The heat island effect describes the phenomenon that built up areas are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings.[584] Heat islands can affect communities by increasing energy demand, air conditioning costs, air pollution, and heat-related illness and deaths. Impervious surfaces contribute to the heat island effect. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the West Planning District.



---

[583] 2013 York County Hazard Mitigation Plan. Retrieved February 16, 2016.
[584] “Heat Island Effect”. US EPA. Retrieved March 3, 2016.

Philadelphia, like other metropolitan areas, heats unevenly because of variations in vegetation, impervious surface coverage, and proximity to bodies of water. The map below shows this heating pattern.[585] As the map shows, the West is located in an area which experiences higher heat island effects, and feels the effects of such an event more than the bordering areas outside the city.



---

[585] "Downscaling Air Temperature and LST Using MODIS and Landsat Data: Philadelphia 2002". URSA. Retrieved March 7, 2016.

Flooding

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding typically occurs when precipitation occurs over a given river basin for an extended period of time. 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 cover is primarily impervious surfaces.

The severity of a flood event is dependent upon a combination of:

- stream and river basin topography and physiography,
- hydrology,
- precipitation and weather patterns,
- present soil moisture conditions,
- the degree of vegetative clearing, and
- the presence of impervious surfaces in and around flood-prone areas.[586]

Winter flooding includes 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

Flood Hazard Areas in the West Planning District

---

[586] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

dams. All forms of flooding can damage infrastructure.[587] For more information on flooding and its impacts, please see Flooding under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

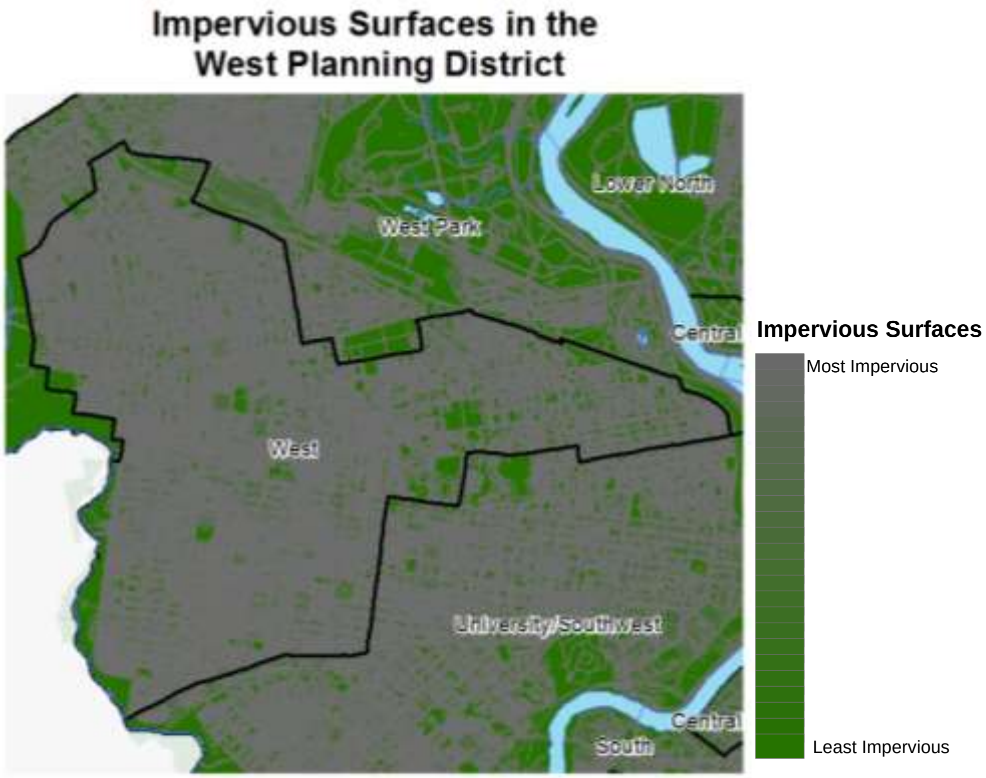
A small portion of the West Planning District falls within either the one percent or 0.2 percent annual risk areas for a flood event. The map above shows the one and 0.2 percent annual percent flood hazard areas. Data available does not capture surface flooding from overwhelmed water management infrastructure.

Those homes with a federally backed mortgage in the 1% annual chance flood event area are required to carry flood insurance. Flood insurance is not part of an average homeowner's insurance policy and must be purchased separately. Within the West Planning District there are 16 of policies in force. For more information on the National Flood Insurance Program, see the National Flood Insurance Program section of the Capability Assessment.

---

[587] "Standard Operating Guide". Commonwealth of Pennsylvania's All Hazard Mitigation Planning. October 18, 2013. Retrieved February 16, 2016.

Flash flooding is a concern for some areas of the West Planning District, but less so than other parts of Philadelphia given the greater amount of permeable surfaces in the district. A flash flood is rapidly rising water that occurs during an intense rain storm, such as those that accompany hurricanes. A flash flood may also occur as a result of rapidly melting snow. The presence of impervious surfaces contributes to an increased risk of flash flooding. Impervious surfaces are those that are impenetrable by water, such as roads, sidewalks, driveways, buildings, and parking lots. The map to the right displays impervious surfaces in the West Planning District. Those areas with greater concentrations of impervious surfaces that are already in flood prone areas are at a greater risk for flash flooding.



Hazardous Material Train Derailment

Derailments can happen for a variety of reasons, including:

- Issues with the track, roadbed, and structures the train travels on;
- Signal and communications issues;
- Human error in train operations;
- Mechanical and/or electrical failures; or
- Other causes such as environmental conditions or loading procedures.[588]

In many cases, derailments do not result in the compromise of tank cars carrying hazardous materials or the release of dangerous chemicals. In rare cases, a derailment can result in the release of hazardous materials. Depending on the characteristics of the material released, these events can pose explosive and/or contaminant threats to the community. For more information on hazardous material train derailment and its impacts, please see Hazardous Material Train Derailment under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Rail lines throughout the city often are multi-use lines. The same freight lines can carry a variety of different materials, both non-hazardous and select hazardous products. The map to the right illustrates those freight lines that run through Philadelphia and carry many different kinds of materials and equipment.

Rail Lines in the West Planning District

---

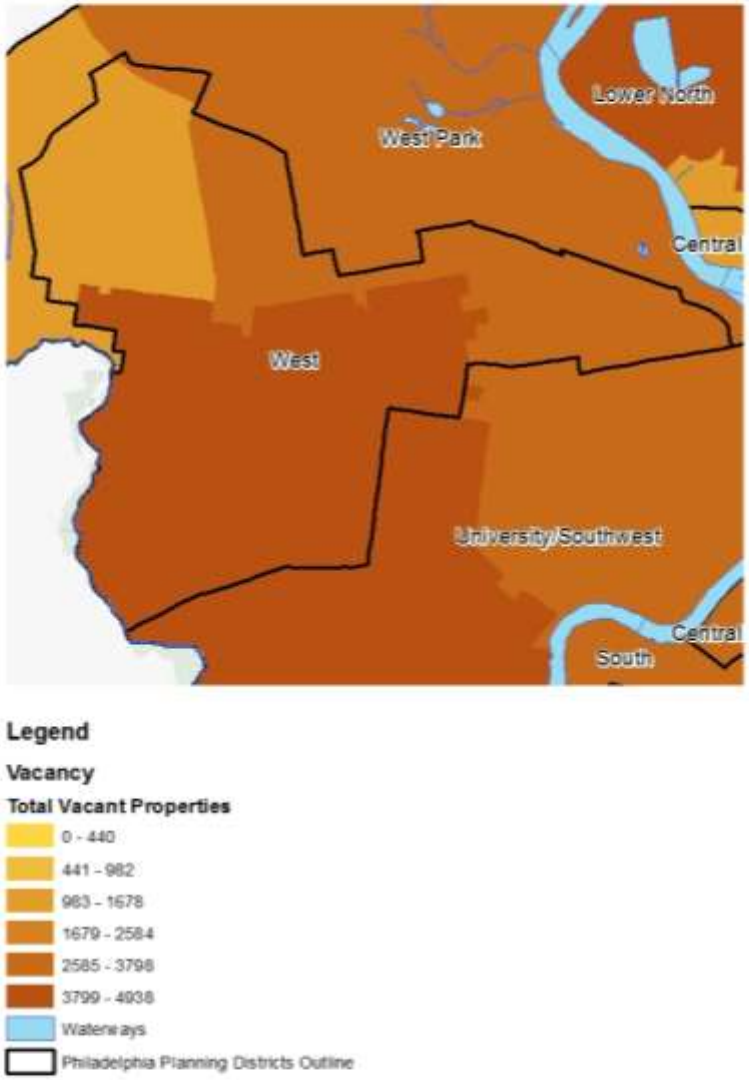
[588] Federal Railroad Administration Office of Safety Analysis. Train Accident Cause Codes. Retrieved April 13, 2016.

Urban Conflagration

Conflagrations are extensive, widespread fires that damage property and potentially endanger lives. Urban conflagrations spread beyond artificial and natural barriers to destroy whole sections of a city.[589] While conflagrations are rare in modern, developed cities, there is the risk that they could occur after a large storm, earthquake, or during civil unrest. Simultaneous ignitions can overwhelm emergency responders. For more information on urban conflagrations and its impacts, please see Urban Conflagration under the Risk Assessment section of the 2017 Hazard Mitigation Plan.

Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes.[590] Vacant properties that are also uninsured or under-insured greatly increase the likelihood of a longer recovery time. The West Planning District has a higher concentration of vacant properties in the southern portion of the district than the rest of the district.

Vacancy in the West Planning District



---

[589] William Michael Kramer. “Disaster Planning and Control”. Fire Engineering. Retrieved January 11, 2016.

[590] Income, Housing, and Fire Injuries: A Census Tract Analysis. Donna Shai, PhD. Public Health Reports, Vol. 121, No. 2 (Mar. - Apr., 2006), pp. 149-154. Retrieved March 7, 2016.

Densely built urban environments pose an additional risk for conflagration. Closely built environments allow fire to spread more easily than less dense environments if not placed under control. Density mapping assists in the identification of densely built environments. The map to the right depicts the West Planning District's housing density. Data was unavailable for those portions of the map left uncolored.