The City of Chester Vision 2020 Climate Adaptation Planning Elements

APROVED BY CHESTER CITY COUNCIL

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Authored by: The Chester Hazards and Climate Project Team

The City of Chester Vision 2020

Climate Adaptation Planning Elements

Acknowledgements

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Chester Hazards and Climate Task Force

Kenneth P. Barrow, Chester City Planning Commission
Brian Crimmins, Crozer-Keystone Health System
Beverly Harris, Chester City Roads Department
William Jacobs, Chester City Council
Jim Johnson, Chester City Fire Commissioner
Kim Hoover, PA DEP Brownfields Section
Barron Lacy, 9th Street Youth & Community Center
Michelle Lewis, Senator Pileggi's Office
John Linder, Chester City Mayor
Richard Linderman, Linderman Group Architects
Steve Madigoski, Widener University
Anthony Moore, Chester City Parks Coordinator
Nafis Nichols, Chester City Council
Jacqueline Parker, Chester Economic Development Authority
Terri Pelegrino, Crozer-Keystone Health System
Ian Piro, DELCORA
Ricardo Soto-Lopez, Chester City SC2 Fellow
James Turner, Chester City Planning Board, Chester Water Authority
Brian Vadino, DE County Conservation District
Christine Volkay-Hilditch, DELCORA
Portia West, Chester City Council
Dan Whaland, Chester Economic Development Authority
Elizabeth Williams, Chester City Council

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Executive Summary

Present-day climate stressors, such as extreme heat, severe coastal storms, flooding and drought, threaten the City of Chester's developed and natural environments. Past observations and current modeling suggest that these climate stressors will become more severe in the future and expose the city and its residents to new hazards and heightened risks. The City of Chester is at a critical juncture for revitalization; brownfield sites and other lands along the Delaware River are priority areas for redevelopment. Yet protecting and enhancing existing wetlands, riparian buffers, and open space is also important for mitigating the storm impacts associated with climate change. While the extensive damage from past flooding and storm events demonstrates a critical need to enhance Chester's resiliency to climate change, adaptation planning for Chester's industrial waterfront and its urban, residential, and community spaces is hampered by a lack of capacity to respond to vulnerabilities in its economic, environmental, and social infrastructure.

With funding from the 2012 National Sea Grant Climate Adaptation Competition, Chester was selected as a model coastal community for integrating climate change adaptation planning into economic revitalization efforts. This two-year project advances Pennsylvania Sea Grant's work piloting the NOAA Coastal Services Center's "Roadmap for Adapting to Coastal Risk" in 2011 and subsequent climate change adaptation goals included in *The City of Chester Vision 2020* comprehensive plan. The project goals were to:

1. Understand how the City is vulnerable to extreme heat, severe storms, flooding, and sea-level rise;
2. Prioritize and plan actions to increase community resiliency to climate-related hazards; and
3. Engage city leaders, staff and the public in a dialogue on the value and outcomes of investing in resiliency.

Under the leadership of Pennsylvania Sea Grant and the Delaware Valley Regional Planning Commission, the Chester Hazards and Climate Adaptation Project Team was formed in 2012. The Project Team comprised a coalition of planners and coastal outreach specialists including: the City of Chester, ICF International, the Delaware County Planning Department, the Partnership for the Delaware Estuary, and the US EPA Region III Office Strong Cities, Strong Communities (SC2). To guide the climate adaptation planning efforts, the Project Team established the Chester Hazards and Climate Adaptation Task Force. Members included a range of city officials, government agencies, industry, and planning agencies that provided expertise and local knowledge about vulnerabilities and the City's existing plans and operations. Public input was sought through the Task Force meetings, City Council meetings, and community workshops, as well as through the project website which provided interactive flood maps for Chester City.

To examine the City's vulnerabilities to extreme heat, severe storms, flooding, and sea-level rise, the Project Team conducted a vulnerability assessment of critical assets in the City of Chester using existing plans and relevant spatial and demographic data. Working with the Chester Hazards and Climate Adaptation Plan Task Force, the Project Team identified additional areas that are susceptible to flooding, have high concentrations of vulnerable populations, provide critical infrastructure, contribute to the economic vitality of the city, or might otherwise be vulnerable to existing and future climate stressors.

Their findings were divided into three categories: primary infrastructure vulnerabilities, primary environmental vulnerabilities, and primary societal vulnerabilities. Infrastructure vulnerabilities addressed redevelopment efforts along the Delaware River waterfront, as well as transportation, utilities, commercial and industrial sites, and emergency facilities and city services. Ecosystem vulnerabilities focused on surface water assets, air quality, vegetation and tree cover, and invasive species and pests. Societal vulnerabilities considered the impacts of storm-related flooding and extreme heat events on Chester's disadvantaged populations.

Based on the vulnerabilities identified in the assessment, the Project Team consulted with the Task Force to prepare seven adaptation strategies addressing short-term and long-term planning needs. Modeled after successful programs implemented in other states and coastal communities, the individual strategies are summarized below:

1. **Create an Environmental Advisory Council (EAC)** to steward the implementation of Chester City's climate adaptation plan;
2. **Engage in a Post-Storm Redevelopment Planning Process** with community stakeholders to guide recovery and redevelopment efforts and reduce vulnerability to future coastal hazards;
3. **Develop a Heat Emergency Plan** to minimize the number of heat-stress related illnesses and death in Chester by improving access to cooling centers, enhancing communication to at-risk populations during extreme heat events and coordinating programming efforts among neighborhoods and organizations providing social services to city residents;
4. **Seek Certification in the National Flood Insurance Program Community Rating System (CRS)** and identify a central CRS coordinator to help protect the health, safety, and welfare of city residents through a comprehensive approach to floodplain management;
5. **Improve Floodplain Management** to protect Chester's residents, sensitive habitats, and property from flooding in areas adjacent to the Ridley Creek, Chester Creek, and Delaware River waterways; recognize an Expanded Flood Risk Area with suggested best practices that includes development in areas with a history of flooding; and encourage building owners and developers to adopt voluntary measures to increase building resilience to periodic inundation;
6. **Expand Vegetated Buffers, Restore Wetlands and Streams, and Protect Open Space** by adopting creek conservation plans, developing codes for floodplain management, mapping areas for open space preservation and restoration projects and identifying restoration goals, i.e. acres of wooded lands or wetlands added; and
7. **Develop a Plan to Implement Green Stormwater Infrastructure (GSI)** by creating a GSI guide for city planners and developers, incorporating GSI into land development ordinances and codes, and identifying funding sources for demonstration projects.

As the City of Chester begins to implement the strategies outlined in the climate adaptation planning process, it should be noted that some of the strategies are poised for immediate action, while others can be carried out as funding opportunities arise. If the devastating floods and extreme heat predicted for Chester come to fruition, this report will provide city officials and planning agencies with a strong foundation to make informed policy decisions and develop appropriate codes and guidance to protect important natural areas that aid in flood control, to promote climate-minded development and revitalization efforts in flood-prone areas, and to mobilize emergency efforts for disadvantaged residents during extreme heat and storm-related events.

SECTION I: Introduction

This report is a synthesis of the results and recommendations from a two year project funded by the 2012 National Sea Grant Climate Adaptation competition to help coastal communities better plan for future coastal hazards and climate risks. It builds upon PA Sea Grant's work piloting the NOAA Coastal Services Center's "Roadmap for Adapting to Coastal Risk" in 2011 and subsequent climate change adaptation goals included in *The City of Chester Vision 2020* comprehensive plan (www.chestercity.com/images/vision2020.pdf). Chester was selected as a grant recipient to model how coastal communities could integrate climate change adaptation into wider economic revitalization strategies. The Chester Hazards and Climate Adaptation Project Team (the Project Team) prepared the report that follows as an element of the City of Chester Vision 2020 comprehensive plan, and this addendum was formally adopted by Chester City Council on June 25, 2014.

Climate change presents new threats and exacerbates existing hazards for Atlantic coastal communities. More severe and frequent storms, increased precipitation, sea-level rise, and extreme heat waves will likely lead to increased stormwater runoff, coastal and inland flooding, saltwater intrusion, erosion, short-term drought, and heat-related stress.

Chester is no stranger to damage caused by inadequate protection from climate hazards. On the night of September 5, 1971 more than 11 inches of rain fell on Montgomery and Delaware counties. In Chester, flooding swept across Eyre Park destroying nearly a hundred homes and forcing 300 residents to relocate at an estimated cost of $17.6 million (1978 dollars). A levee was built to protect the City from Chester Creek. However, in 1999 flooding from Hurricane Floyd breached the levee causing over $1 million in damages to the Chester High School (Federal Emergency Management Agency, 1999; Associated Press, 1971a; Associated Press, 1971b). Will devastating floods be the new normal under future climate conditions? What steps can Chester take to be more resilient to future flooding and extreme heat? These were questions the Project Team examined while exploring ways to incorporate climate resilience into infrastructure investments, the redevelopment of abandoned properties and former manufacturing sites, and the Chester community's overall planning and decision-making process for adapting to climate change.

The project had three main objectives:

1. Understand how the City is vulnerable to extreme heat, severe storms, flooding, and sea-level rise;
2. Prioritize and plan actions to increase community resiliency to climate-related hazards; and,
3. Engage City leaders, staff and the public in a dialogue on the value and outcomes of investing in resiliency

The **Project Team** included a coalition of planners and coastal outreach specialists (see sidebar to right). Co-led by Pennsylvania Sea Grant and the Delaware Valley Regional Planning Commission (DVRPC), the Project Team worked closely on all aspects of the planning process and organized and held Chester Hazards and Climate Task Force meetings to engage local decision-makers, City staff, and the community.

The **Chester Hazards and Climate Adaptation Task Force** contributed local knowledge throughout the process. Members provided feedback on local vulnerabilities and adaptation strategies, and discussed ways to integrate adaptation strategies into the City's existing plans and operations. Task Force Members included Mayor John Linder and Chester City Council, the Chester Economic Development Authority, representatives from the Chester Business Association, the Chester Water Authority, the Crozer-Keystone Health System, DELCORA sewage treatment authority, the Strong Cities- Strong

The Project Team

*** Pennsylvania Sea Grant (PASG)** – Ann Faulds (Collaborating Investigator), Jaclyn Rhoads led the project with assistance from Sara Grisé-Stahlman. PASG helped with community outreach, managed partnerships, coordinated with the City of Chester, and organized meetings to establish a bottom-up approach for developing hazard and climate change adaptation strategies.

*** The City of Chester -** William Payne, Director for Planning, served as project liaison to represent the City. Mr. Payne helped determine local climate adaptation priorities, harmonize with the Mayor's Office and Chester City Council, and helped organize community engagement and the Climate Hazards Task Force.

*** Delaware Valley Regional Planning Commission (DVRPC)** – Chris Linn (Collaborating Investigator), Elizabeth Compitello, and other staff assisted with guiding the City through the risk and vulnerability assessment, advised on climate data and resources, and created Chester specific planning maps including inundation and storm surge maps from high resolution LiDAR data.

ICF International – Anne Choate and Dana Spindler facilitated the Task Force meetings, walked the community through the risk and vulnerability assessment process, provided technical guidance on the development of a climate risk profile for the City of Chester, and led the production of this synthesis document.

US EPA Region III Office, Strong Cities, Strong Communities (SC2) – Michael Dunn from the Office of Innovation and Assessment served as a liaison with the SC2 community revitalization initiative to insure good lines of communication with the economic development community. He also helped with outreach and stakeholder engagement.

*** Delaware County Planning Department (DCPD)** – Karen Holm assisted with stakeholder engagement and mapping, and coordination with other county planning initiatives. DCPD also kept the Delaware County Coastal Zone Task Force apprised of the project in order to assist and educate other Delaware County waterfront communities on climate and hazard adaptation planning.

*** The Partnership for the Delaware Estuary (PDE)** - Sari Rothrock contributed to outreach activities and coordinated with their EPA-sponsored Climate Ready Estuary outreach campaign for the Delaware Estuary, *Weathering Change* (http://delawareestuary.org/pdf/Climate/weathering_change.pdf)

* **Members of the Project Team who participated in the 2011 Roadmap project.**

Communities (SC2) team, Widener University, and others.

The Project Team engaged residents and decision-makers to develop the City's capacity to adapt to existing and future climate hazards. This synthesis report is the culmination of research, community feedback, and planning that spanned from March 2012 to January 2014. The following tasks were completed as part of the project:

- Established the Chester Hazards and Climate Adaptation Task Force to guide plan development (Section I).
- Assessed local climate hazards and the effects of climate change (Section II).
- Developed profiles to assess the vulnerability of infrastructure, natural systems and the community to climate hazards (Section III). Profiles were organized based on the NOAA Coastal Services Center Roadmap to Adapting to Coastal Risk process
- Created customized storm surge inundation models for the City (utilized during Task Force and community engagement meetings) http://easternpaseagrant.org/chester
- Engaged the public through: (1) four Task Force meetings that included City council members; (2) two City Council meetings; (3) two community engagement workshops; and (4) the project website and interactive Chester flood maps http://easternpaseagrant.org/chester
- Produced interactive Google maps that will be hosted on Pennsylvania Spatial Data Access (PASDA) website that illustrate Chester City and Delaware County data http://easternpaseagrant.org/chester
- Identified and described adaptation options that can be implemented in the City of Chester (Section IV)

By approving the hazards and climate adaptation planning recommendations contained in this report, the City Council has taken steps to make Chester more prosperous and resilient to hazards and climate change.

SECTION II: Climate Stressors

Present-day climate stressors, such as extreme heat, severe storms, flooding and drought, already pose threats to the City of Chester's built and natural environments. Observations and modeling suggest that these climate stressors will become more severe in the future and expose the city and its residents to new hazards and heightened risks. As a result, historical climate patterns are no longer sufficient data points for long-term planning. In order to understand Chester's vulnerabilities and to identify actions that could make the City more physically, ecologically, and economically resilient, it is necessary to first understand climate change impacts.

This section contains a description of climate stressors or hazards. The following information provides a straightforward explanation of the best available science on how the climate is forecast to change. It was used to inform the subsequent sections of this report and provides a foundation the City can use for long-term planning, risk assessment, adaptation, and preparedness efforts. For Chester City, the primary climate stressors include:

Rising Temperatures: Average annual temperatures in southeastern Pennsylvania are projected to increase by 8 to 11 degrees Fahrenheit (°F) by the end of the century, relative to the 1981-2010 average (Union of Concerned Scientists, 2008).

Extreme Heat Events: The average number of days of extreme heat (above 90 °F) is anticipated to more than double on by mid-century, over the current average (Union of Concerned Scientists, 2008).

Changing Precipitation Patterns and Drought: Increased winter precipitation will likely increase peak stream flows and flooding. Variable summer precipitation may lead to both flooding and short-term soil moisture losses and droughts.

Severe Storms: More frequent and heavier thunderstorms and downpours will lead to an increase in localized flooding.

Coastal Storms: Recent events such as Nor'easters and hurricanes Floyd, Irene and Sandy illustrate the severe impacts from coastal storms. These events are predicted to become more intense due to climate change, though they will still vary greatly from year to year.

Sea-level rise: Globally, sea level is expected to rise 2.5 to 6.5 feet by 2100 (National Research Council, 2010). The amount of rise in the Delaware Estuary will be even greater due to land subsidence, the sinking of land that results from natural geological processes (Partnership for the Delaware Estuary, 2011).

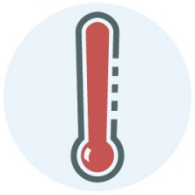
The City of Chester already faces multiple climate stressors. Extreme storms, floods, droughts, and heat waves have occurred in the past, and a record-breaking storm could occur at any time. While it is impossible to predict the precise timing and magnitude of these kinds of extreme events, advances in climate science allow us to make predictions about the *likelihood* of these events occurring as well as how precipitation and temperature will change on *average* on annual and decadal timescales.

To obtain the best scientific information available, the project team examined a wide range of data and studies available for the region covering Pennsylvania, Delaware, and New Jersey. The focus for this analysis is on those climate stressors that have the greatest likelihood of occurring in Chester and which may have the greatest impact on the City and its residents.

Projecting future climate change is not an exact science. Variables such as the amount of greenhouse gases humans continue to emit and the sensitivity of the planetary climate system to those greenhouse gases come into play. Because of the uncertainty of these variables, future projections are typically given in ranges, e.g., annual average temperatures will increase 2.5 to 4.0 degrees; precipitation will increase by 10 to 15 percent, etc. Climate scientists use models, called global circulation models (GCMs), to predict how the climate will change as greenhouse gases in the atmosphere continue to build up. All projections provided below are based on the results of GCMs.

Climate Stressors in the City of Chester

The following pages provide detailed information about current trends, observed changes, and future projections for the six climate stressors that are likely to affect Chester. This information is used in the subsequent chapters to assess vulnerability and identify adaptation options that will increase the economic, social, and environmental resiliency of the City.



RISING TEMPERATURES

Changes in outdoor average air temperatures could stress ecosystems and native vegetation, increase invasive species and vector-borne disease problems, impair water quality, stress buildings and infrastructure, and impact heating and cooling demands.

Current Trends & Observed Changes: Temperatures across the Northeast U.S., including southeastern Pennsylvania, have increased 1.5 degrees Fahrenheit (°F) annually on average since 1970, with a greater increase in the winter months (www.climatechoices.org/assets/documents/climatechoices/pennsylvania_necia.pdf) (Union of Concerned Scientists, 2008).

Projected Future Temperature: Over the course of the next several decades (2015–2039), annual average temperatures across Pennsylvania, including southeastern Pennsylvania, are projected to increase by an additional 2.5°F. By mid-century, (2040-2069), temperatures are projected to increase by 4°F to 5.5°F, and by late century (2070-2099), average temperatures are expected to rise 8°F to 11°F (Union of Concerned Scientists, 2008).

EXTREME HEAT EVENTS

Heat waves cause hundreds of deaths annually. The number of days of extreme heat along the East Coast is projected to increase dramatically. Without adequate infrastructure, more frequent days above 90 degrees Fahrenheit (°F) may be detrimental to community health.

Current Trends & Observed Changes: The City of Chester currently experiences approximately 20 days of extreme heat annually.

Projected Future Extreme Heat: By 2025 the City is expected to experience 30 days of extreme heat on average. By mid-century, Chester will likely experience 50 days over 90 °F on average, more than doubling the amount of high heat days currently experienced by the City (Union of Concerned Scientists, 2008).

PRECIPITATION PATTERNS AND DROUGHT

Changes in **precipitation patterns** will affect natural vegetation and surface and groundwater flows. While more precipitation is expected overall, short-term summertime "soil moisture droughts" are expected to become more common. A soil moisture drought occurs when the upper layers of soil become exceedingly dry. Such droughts can occur in the span of a couple of weeks, but do not cause significant drops in the water table assuming rainfall levels return to normal. While soil moisture droughts do not affect long-term water supplies, these types of droughts place significant stress on vegetation.

Current Trends & Observed Changes: The area around Chester City in Pennsylvania and New Jersey experienced an increase in overall precipitation (about 5 to 20 percent) during the 20th century. According to reports from the Office of the New Jersey State Climatologist, almost all of these increases have occurred in the winter, spring and fall (Rutgers Climate Institute, 2013). And while precipitation has increased overall; inter-annual variability has also increased over the last several decades – dry years are often followed directly by wet years (Union of Concerned Scientists, 2007).

Projected Future Precipitation Patterns: Global climate models (GCMs) consistently report that annual precipitation in southeastern Pennsylvania is expected to increase by 5-10 percent at mid-century and by 10-15 percent by late century, if nothing is done to curb greenhouse gas (GHG) emissions (Union of Concerned Scientists, 2007).

As with recent observations, much of this increase is expected to occur in the winter months. Summer precipitation is not forecasted to increase much, if at all, and is not likely to be evenly distributed throughout the season. This fact, combined with greater evapotranspiration due to additional heat, is likely to lead to more frequent occurrences of short-term soil moisture droughts across the Northeast. However, given the likelihood of heavier cool-season precipitation, current modeling indicates that long-term water supply droughts will be no more likely or severe than under existing climate conditions (Union of Concerned Scientists, 2008).

SEVERE STORMS

Severe storms and extreme weather, including thunderstorms, intense downpours, and heavy rains, can lead to both localized and regional flooding events. These types of events, while highly variable, can occur relatively frequently. While inland flooding is the result of multiple factors, including the level of ground saturation; extreme precipitation is its primary cause.

Current Trends & Observed Changes: Extreme precipitation is highly variable both spatially and temporally. New York City evaluated extreme precipitation events – defined as more than 1, 2 and 4

inches of precipitation occurring at daily timescales – and found that year to year variation in these events is large. Accordingly, long time series data are required to observe statistically meaningful trends. Despite a seemingly large increase in local media reports on flooding in recent years, data gathered by regional studies for the northeast indicate that there has only been a modest (and not statistically significant) trend towards more extreme precipitation events in the region during the last three decades (New York City Panel on Climate Change, 2009).

Projected Future Precipitation Patterns: Extreme precipitation events like thunderstorms and downpours which lead to localized and regional flooding are difficult to project with accuracy, but current theory and climate models show that the frequency of extreme precipitation events for the northeast is likely to increase throughout the century by as much as 25 percent (New York City Panel on Climate Change, 2009). In short, a greater percentage of the overall precipitation is likely to fall in *quick bursts* or *single intense events*.

COASTAL STORMS

The recent experience of hurricanes Irene and Sandy underscore the reality of strong storms and their catastrophic impacts. To become resilient, coastal communities must plan for severe **coastal storms.**

Current Trends & Observed Changes: The power and frequency of Atlantic hurricanes have increased in recent decades. However, despite the high visibility of recent events like hurricanes Irene and Sandy, no historical trend is apparent in the record for *land-falling* hurricanes or nor'easters on the Atlantic coast of the U.S. (U.S. Global Climate Change Research Program, 2009).

Projected Future Coastal Storms: Models and theory predict that hurricanes and nor'easters will become more intense, particularly at the latitudes occupied by Chester City, but the natural pattern for hurricanes and nor'easters will continue to be characterized by large amounts of variability.

SEA LEVEL RISE

Sea-level rise will result in inundation, coastal erosion, wetland loss and an increase in salinity in the Delaware River at Chester City. Most significantly, sea-level rise will exacerbate the impact of coastal storms and storm surge-related flooding.

Current Trends & Observed Changes: Sea level is rising worldwide and the rate of rise has been accelerating, increasing from 1.5 mm per year in the middle part of the 20th century to 3.1 mm per in recent decades. Since 1900, global sea level has risen about 8 inches. According to Titus *et al*. (2003), two major factors contribute to global sea-level rise: increased melting of land-based ice and

warming ocean temperatures cause water expansion. Both lead to an increase in overall volume.

While thermal expansion and melting ice have contributed about equally to global sea-level rise in the past 50 years, contributions from the melting of glaciers and ice sheets will eventually become the dominant factor as temperatures continue to rise (Pfeffer, Harper, & O'Neel, 2008).

In the mid-Atlantic region, there also is an effect from land "subsidence." Here, sea-level rises relative to the land because the land is slowly dropping or sinking due to the after-effects of the last Ice Age. For the Chester City area, subsidence has contributed approximately six additional inches of relative sea-level rise since 1900 (Delaware Department of Natural Resources and Environmental Control, 2012).

Projected Sea-level Rise: Current studies that model ice sheet dynamics predict approximately two to six feet of *global* sea-level rise by 2100 (Rahmstorf, 2007). The 2007 International Panel on Climate Change (IPCC) assessment projected that mean sea level would rise one to two feet by the end of the century, but these projections do *not* take into consideration melting of the Greenland and West Antarctic ice sheets, which will contribute substantially to sea-level rise. The Greenland ice sheet, in particular, has been experiencing record amounts of surface melting in recent years. A new IPCC assessment that incorporates the effects of melting polar ice on sea-level rise is expected in 2014.

The neighboring state of Delaware uses three sea-level rise scenarios – 0.5 meters (1.7 feet), 1.0 meters (3.3 feet) and 1.5 meters (4.9 feet) – for statewide planning purposes (Delaware Department of Natural Resources and Environmental Control, 2013). Adopting a range of estimates similar to Delaware could be useful for planning purposes in Chester City as well.

SECTION III: Vulnerabilities in Chester

Heat waves, severe storms, downpours, and hurricanes have the ability to negatively impact the City of Chester in small and big ways. Potential consequences like storm surge, coastal flooding, erosion and wetland loss will have economic, social and physical impacts on the City and its residents.

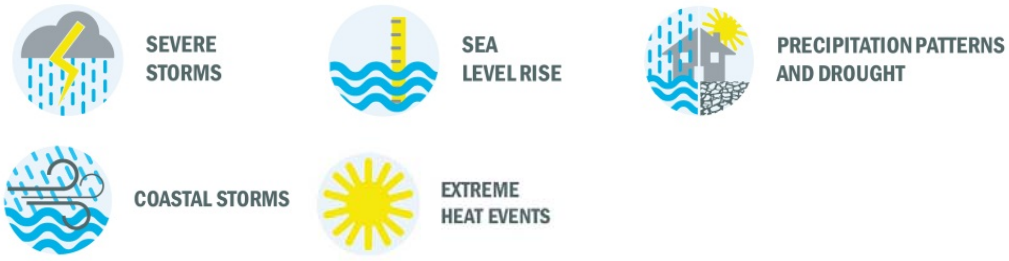
This section looks at how Chester residents, infrastructure, and ecosystems are vulnerable to climate hazards. Where possible, the impacts of climate hazards on specific locations, facilities and assets are highlighted. However, a more focused study will need to be completed to understand the unique vulnerabilities of individual locations and facilities within the City.

The Project Team conducted an initial assessment of critical assets in the City of Chester that may be vulnerable to the regional climate change impacts described in Section II. The Project Team reviewed existing plans developed for Chester as well as spatial and demographic data to understand the economic, social, and environmental geography of the City. The Project Team presented this information along with the previously mentioned climate change projections to the Chester Hazards and Climate Adaptation Plan Task Force to ground-truth the assumptions. The Task Force further identified areas that are susceptible to flooding, have high concentrations of vulnerable populations, provide critical infrastructure, contribute to the economic vitality of the City, or might otherwise be vulnerable to existing and future climate stressors. The Project Team updated the vulnerability profiles to reflect the local knowledge.

Primary Infrastructure Vulnerabilities

The City of Chester is located on 4.7 square miles of land abutting 3.2 miles of waterfront along the Delaware River. Over the past several decades as manufacturing moved out of the City, Chester's land use has changed. Many commercial and industrial enterprises have closed down or left the waterfront, and remaining industrial uses now share the area with utilities, office space, and entertainment venues. At the same time, the steep drop in population over the past fifty years has left a legacy of abandoned or vacant residential properties. To counteract this trend, the City of Chester has actively attracted uses to the waterfront to spur redevelopment. Several of these uses, such as the waste to energy plant, the wastewater treatment facility, and the silica chemical plant – while serving a vital service to the region – pose a heightened threat to the City's ecosystem and its residents. These waterfront uses may pose a potentially hazardous situation in the face of flooding, sea-level rise and coastal storms. This section is an initial attempt to identify potential vulnerabilities and risks that these waterfront uses may pose both now and in the future. In cases where the characteristics of these uses are unknown, we have suggested potential questions that the City could ask to clarify vulnerabilities.

Transportation Vulnerabilities



The City of Chester is well situated within the regional transportation network with direct access to public transportation, major highways, and waterways.

Roads: Several major routes (I-95, I-476, US322, SR291, SR352, SR320 and US13) run through Chester, and US 322 connects to southern New Jersey via the Commodore Barry Bridge to I-295 and the New Jersey Turnpike. While many of the major routes running through Chester can accommodate flooding, there are several local roads and arterial roadways connecting portions of Chester to the major roads that experience frequent and disruptive flooding.

Increased frequency and intensity of precipitation events, as projected in Section II, are likely to exacerbate the flooding challenges on these local roads. The Adaptation Project Taskforce members identified the following roadways in Chester that commonly flood.

- **Roadways near Ridley Creek:** The area east of Route 13/Morton Ave and north of 4th Street is particularly susceptible to flooding.
- **14th St. & Kerlin St:** Although this intersection is not located entirely in the floodplain, it is an area that experiences frequent flooding during storms and rain events. This area is a mandatory evacuation site for residents during major storms, and power often will be shut off for this area during major storms as a safety precaution. Residents are evacuated to the Showalter Middle School. Efforts have been made in the past to mitigate flooding at this site, unsuccessfully. Attempts have been made to buy-out residents, but the residents either sold their houses to new owners or they did not want to move.
- **Neighborhood of Parker Manor:** Flooding near 6th & Parker and 13th & Parker has resulted in mandatory evacuations and preemptive power shutdowns by PECO.
- **The 300-block of Kerlin Street; Barclay Street; 3rd & Townsend; and 2nd & Booth/291: These locations** were also identified as areas that flood frequently. Further investigation should be conducted to understand the characteristics and cause of flooding at these locations.

Public Transportation: Passenger rail (via the Wilmington/Newark line) and bus services are provided by Southeastern Pennsylvania Transportation Authority (SEPTA). Both rail lines and roads are susceptible to damage during rain and snow storms. Additionally, extreme heat can cause both rail lines and roads to buckle. Such damage would likely cause disruptions in public transportation services.

Freight Rail: CSX and Conrail operate the freight rail lines that run through the City. The Conrail freight rail line serves industries along the waterfront, including the Kimberly-Clark paper mill, and the Evonik Industries and Degussa Corporations chemical plant.

The Chester Hazards and Climate Adaptation Project Taskforce expressed concern that the freight rail line serving the waterfront industries is in the floodplain. Since the line transports and holds chemicals and other hazardous materials, flood damage could cause widespread water contamination and serious public health concerns. Taskforce members would like to investigate what is being transported and stored in those freight cars.

Utilities

Utilities in Chester process, treat, and transport water, wastewater, and municipal solid waste–services that are critical to the health and safety of Chester City and surrounding municipalities in Greater Philadelphia. A handful of these facilities are located in Chester along the Delaware waterfront. Major facilities include DELCORA, the Delaware Valley Resources Recovery waste-to-energy plant, and Chester Water Authority's administrative offices.

Delaware County Regional Water Control Authority (DELCORA) wastewater treatment plant serves eastern Delaware County, including the City of Chester. It is a 44 million gallons per day (MGD) active sludge facility. The stormwater collection system includes a combined sewer outfall – during high flow storm events when the volume of stormwater runoff exceeds the system capacity, the combined stormwater and untreated sewage are discharged directly into Chester Creek and the Delaware River.

The DELCORA wastewater treatment plant is situated in the 500 year floodplain (see Appendix C, Map 5), and is located in the area of inundation modeled for a Category 2 hurricane (see Appendix C, Map 6). Increased frequency and intensity of extreme precipitation and severe storms, as projected by climate models and described in Section II, will likely increase the number of combined sewer overflows (CSO). DELCORA has submitted a CSO Control Plan to the Pennsylvania Department of Environmental Protection that is pending approval. Delaware County has prepared stormwater management plans (SMPs) as required by Act167 for most watersheds in the county including Chester and Ridley creek. As required by NPDES II regulations, the City of Chester adopted Delaware County's model stormwater management ordinances included in the Act167 Plans for the Chester and Ridley creek watersheds.

Delaware Valley Resource Recovery waste-to-energy (WTE) plant located on the Delaware River waterfront is operated by Covanta. The WTE plant processes up to 3,510 tons of municipal and commercial waste each day, generating up to 80 megawatts of electricity per day that is supplied to the Atlantic City Electric Company, an investor owned utility based in Cape May Courthouse, NJ. The plant captures and processes all municipal solid waste generated in Delaware County, including the City of

Chester. The City of Chester should investigate whether this use poses a threat in the event of flooding along the Delaware Waterfront.

Chester Water Authority (CWA) serves over 200,000 customers in southern Chester County, southern Lancaster County, and southern Delaware County including the City of Chester. CWA supplied 54 million gallons of water to the City of Chester in 2012. While the CWA's administrative offices are located in Chester, the water is supplied from the Octoraro Reservoir, nearly 40 miles west of Chester in the Susquehanna River basin. Water supply was switched from the Delaware River to the Octoraro Reservoir in 1951 based on over-projected City growth and the deteriorating quality of Delaware River water (Chester Water Authority, 2012). The Octoraro Reservoir is an inland basin that is not subject to coastal climate and sea level rise water supply risks such as saltwater intrusion and contamination from combined sewer overflows. The CWA water supply is further protected by a network of interconnected water companies with the capacity to provide backup in cases of drought.

Commercial and Industrial Sites

The City of Chester supports diverse industrial activities including manufacturing, warehousing, and distribution centers. These commercial and industrial facilities provide jobs and revenue for the City and its residents. A handful of active industrial sites are located along the waterfront in Chester, including the Kimberly Clark paper mill and the Evonik Degussa Corporations silica plant, which together employ 850 individuals. There are several other large commercial and entertainment facilities located in Chester, including Harrah's Casino and Racetrack, the PPL Park soccer stadium, and several companies located in the Wharf at Rivertown.

Facilities sited along the Delaware waterfront may be particularly vulnerable to increased flooding and sea-level rise. Currently, all land uses along the Delaware waterfront are situated within the 500 year floodplain (Appendix C, Maps 5 and 6). The likelihood of a 500 year flood occurring is expected to increase in frequency due to climate change, a factor that will be further exacerbated by sea-level rise. Map 6 in Appendix C shows a NOAA SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model of storm surge inundation that may result from category 1-4 hurricanes. The SLOSH model illustrates how all waterfront land uses would be inundated by a direct hit from category 2 or higher hurricane. Again, the level of inundation from storm surge is likely to be higher with the added effect of future sea-level rise.

An additional climate impact for Delaware River water users is the possible occurrence of saltwater along the waterfront. With future sea level rise and intense droughts, the saltwater line may extend upstream from the Delaware Bay beyond Chester. Further investigation is needed to determine the future threat to Chester City industries with Delaware River water intakes.

Emergency Facilities and City Services

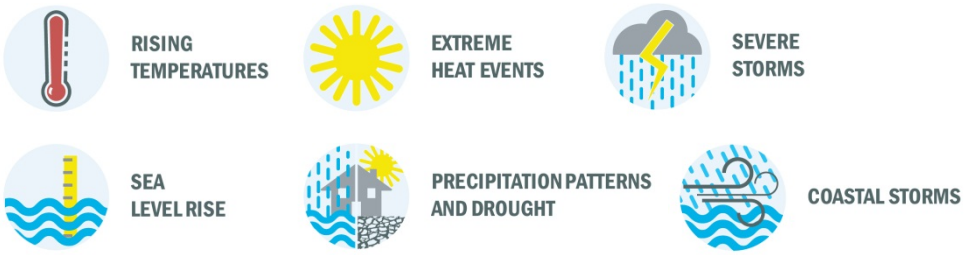
The City of Chester provides services to help maintain public safety – including coordination of shelter and first response to Chester's citizens in times of crises or natural disasters. Extreme weather events and flooding will impact low-lying, poorly sited or poorly constructed emergency facilities and schools (see Appendix C, Map 20), which could inhibit the functioning of these facilities during extreme weather events when they are most needed.

- Chester City's Department of Streets and Public Improvement operates its fleet of 18 vehicles responsible for snow removal, sewer cleaning, street sweeping, regular upkeep of street signs, and other aesthetic and safety needs out of a garage located at W. 2nd and Dock Streets. This facility is located in the 100-year floodplain.
- The elevation of the prison is between 9 and 12 feet above sea level. Portions of the facility are in the 100-year floodplain.

Primary Ecosystem Vulnerabilities

The health of Chester's ecosystem resources – including its air, streams, wetlands, floodplains, tree cover, natural vegetation, biodiversity, and soils – is vitally important to residents' well-being, community cohesion, and the economic vitality of the City. In Chester, as with many other older urbanized cities, the natural resources that support ecosystem services have been diminished by intense industrial, commercial, and residential development and the impacts of pollution. While improving these assets is a goal of the City with or without climate change, they take on increased importance given the ability of natural resources to ameliorate climate change impacts, such as extreme heat and flooding. At the same time, the health and value of these ecosystem resources are vulnerable to increased temperatures, flooding, sea-level rise, and extreme storm events. This section documents the vulnerabilities of Chester's natural resources to climate change.

Surface Water Assets



Chester's surface water assets include its streams, floodplains, wetlands, and the surface water they contain. All of these elements ultimately function together as a single system, although for the purposes of discussion below, they are broken up. When functioning properly, they minimize flooding, ensure good water quality, and maintain stream channel health in the City of Chester and the surrounding region.

Streams and Rivers

The Delaware River forms the 3.5 mile southeastern border of Chester City. It originates in the Catskill Mountains in New York State and is fed by surface water runoff upstream. From Trenton, New Jersey through the Delaware Bay, including the entire section that flows next to Chester, the river is influenced by tidal waters flowing upriver from the Delaware Bay. As a result, the water levels of the Delaware River fluctuate daily between high and low tides and are influenced by both upstream flooding and runoff, as well as coastal storms and sea-level rise. Chester and Ridley creeks are smaller streams that flow through the City and drain to the Delaware River. A portion of Stoney Creek is also located in Chester, although it is mostly piped underground within the City boundaries.

The major threats from climate change to Chester's streams are the degradation of water quality and stream channel health. Rapid runoff from intense precipitation events results in stream scouring and increased siltation. This hampers a stream's ability to slow and dissipate floodwaters. And once a stream begins to be scoured, the process tends to reinforce itself with each successive heavy runoff event. A warming climate will also lead to warmer water temperatures, further degrading water quality and aquatic habitat.

Floodplains

Floodplain zones for both the 100-year and 500-year floods are associated with Stoney, Chester, and Ridley Creeks, as well as the Delaware River (see Appendix C, Map 5). About 9.7 percent of Chester's 3,062 acres are located within the FEMA-designated 100-year floodplain and over 20 percent of Chester's land area is within the 100-year and 500-year floodplain. While some of Chester's floodplain areas are developed, particularly along the Delaware, much of Chester's wooded areas and many of its parks – such as Eyre Park and parts of Deshong Park and Chester Park – are also located in the floodplain along Chester and Ridley creeks.

The vegetated floodplains surrounding Chester's streams (and the Delaware River) will take on increased importance as severe precipitation events become more common. Without healthy, naturally-vegetated floodplains to store and slow stormwater runoff, flooding, including both major and minor events, will likely become a bigger problem for the city. This challenge is made more acute in Chester, where parts of the floodplain and much of the surrounding watershed are developed, thereby increasing stormwater flows. Additionally, because the Delaware River is tidal, the 3.5 mile southeastern border is also vulnerable to sea-level rise, salt water intrusion, and storm surge. The City's Floodplain Conservation District is intended to regulate use, activities, and development within areas subject to flooding, but it primarily applies to new facilities seeking approval. Existing development, which covers much of the City, is not directly affected by the ordinance.

Wetlands

As with healthy stream channels and vegetated floodplains, wetlands dissipate stormwater flows minimizing their potential to erode streams and creeks. Wetlands in tidal areas dissipate the wave energy associated with coastal storms. Wetlands also filter pollutants and provide high-quality aquatic habitat. Most wetlands in Chester City were filled or drained prior to the passage of environmental laws regulating their use. Current mapping shows only approximately 25 acres of wetlands within the City. These wetlands are limited to locations along the banks of Ridley Creek and the Delaware River. Before wetland vulnerabilities can be evaluated, the City should conduct a formal wetlands delineation to verify the presence of these and other areas that could be classified as wetlands in the City boundaries. Climate change threatens these wetlands through drowning, erosion and salinity increase. Sea-level rise can drown tidal wetlands, such as those found along the Delaware River and in tidal creeks, while increases in salinity brought on by sea-level rise, can stress or kill wetland vegetation. Wetlands, both the tidal and upland varieties, can suffer erosion during powerful storms, such as nor'easters and hurricanes.

Water Quality

The Pennsylvania Department of Environmental Protection's 2012 water quality monitoring report lists the surface waters of Chester as impaired for siltation and pollutants. Unless steps are taken to improve the health of Chester's streams, the impacts of climate change are likely to make these impairments harder to reverse.

Wetlands and vegetated floodplains will become more important for maintaining water quality in Chester given the expectation of more extreme precipitation events. Runoff from storms not only leads to flooding, but also washes oils, chemicals, nutrients, heavy metals and debris into streams from streets, parking lots, and other developed areas. Vegetated floodplains and wetlands can store stormwater and filter these pollutants before they enter Chester's waterways. Vegetated stream banks and floodplains also slow the velocity of waters during extreme events, reducing channelization and siltation.

Air Quality

Elevated levels of ozone and particulate matter have adverse health effects, especially on the elderly, children, and those with respiratory illnesses. The Greater Philadelphia region, including the City of Chester, is currently designated a "non-attainment" area under the Clean Air Act, meaning that it does not meet the federal health-based standards for ground level ozone and fine particulate matter (PM 2.5)[1]. From 2000-2010, the City of Philadelphia averaged 25 days a year in the "unhealthy air quality" category (City of Philadelphia Department of Public Health, 2010).

Ground-level ozone is not directly emitted, but forms when nitrogen oxides combine with volatile organic compounds in the presence of heat and sunlight, making ozone a heat-exacerbated (and typically summertime) problem. Fine particle pollution, or high PM 2.5 levels, often corresponds with elevated levels of ozone. Therefore, ground-level ozone and PM 2.5 levels will increase as temperatures increase in the region and during extreme heat events. Higher concentrations of these pollutants in the air will lead to more "unhealthy" days for Chester's residents, preventing elderly people, children, and those suffering from respiratory ailments from enjoying outdoor summer activities and recreational opportunities.

Vegetation and Tree Cover

Natural vegetation and tree cover are a key component of Chester's ecosystem resources. As stated above, natural vegetation slows, dissipates and absorbs stormwater, removes pollutants from urban runoff, prevents erosion, and stabilizes stream banks. Natural vegetation and tree cover also ameliorate the urban heat-island effect by shading paved surfaces and buildings and dissipating heat through evapotranspiration. Finally, natural vegetation and urban trees improve air quality by filtering pollutants (Nowak & Heisler, 2010).

Currently, natural vegetation and tree cover in the city are relatively sparse. Approximately 160 acres or only 5 percent of the City is covered by tree canopy. Many of these wooded areas are located in riparian zones along Chester and Ridley creeks.

[1] *PM refers to airborne particulate matter that includes dust, dirt, soot, smoke, and liquid droplets. These particles can range in size from microscopic to large enough to be seen. PM is characterized by its size, with fine particles of less than 2.5 micrometers in size designated as PM 2.5.*

The primary threats to the City's natural vegetation from climate change include flooding-induced erosion and increasing temperatures. Warmer weather and changes in the growing season will affect vegetation throughout the City. In particular, a warming climate will stress and/or kill native plants and trees, and allow further encroachments by invasive species that are more tolerant of heat-related stress. The spread of invasive plants often results in a reduction in biodiversity and potential increases in nuisance insects and pests. Invasive vegetation is already a problem throughout Chester's vegetated zones, and climate change-induced heat stress will make this situation harder to manage.

Invasive Species and Pests

Invasive species and pest are organisms that breed outside their native range and cause damage to the economy, the environment, or human health. Pimentel et al. (2005) estimated that invasive species cost the United States more than $120 billion in damages each year. Since invasive species are typically highly adaptable to disturbance and change, future climate regimes are likely to stress ecosystems and trigger conditions that are ideal for invasive species to reproduce and become established. While a certain amount of chance will determine exactly which invasive species will flourish in Chester, the pace of new invasions throughout North America is expected to accelerate (Pimentel, Zuniga, & Morrison, 2005).

The climate of the future may generate conditions in Chester's ecosystems that will exacerbate the impact of invaders already present. For example, the warmer average temperatures and wetter winters predicted for Chester will likely increase mosquito breeding pools and prolong the breeding. Research indicates that climate change my increase the reproduction, survival, and biting rates of the *Aedes aegypti* mosquito (World Health Organization and World Meteorological Organization, 2012). *A. aegypti* is a non-native mosquito present in Chester which can transmit diseases. Bigger mosquito populations would likely trigger more cases of mosquito-borne disease, such as like West Nile virus, eastern equine encephalitis, and canine heartworm. Cockroaches, termites, ticks, invasive plants and other pests may respond in a similar manner.

Warmer temperatures can expand the geographic area suitable for warm-weather species. For example, a recent Pennsylvania study indicated that as average temperatures trend upward, the Commonwealth would become increasingly more suitable for (and vulnerable to) a number of potential new invaders One popular aquarium predators stands out; the red piranha (*Pygocentrus nattereri*). Intentional or accidental releases of the piranha present an especially high risk to Pennsylvania's ecosystems, fisheries,

and recreational economy. Regions near Chester scored the highest future suitability for establishment in Pennsylvania (Grisé, 2011).

Primary Societal Vulnerabilities

Climate change impacts will pose significant threats to public health and local communities. Communities that contain brownfields and significant industrial sites and are subject to contaminant exposure, like Chester, may face amplified societal impacts since flooding, extreme heat, compromised air quality, and extreme weather events are likely to further affect already vulnerable populations. As highlighted in earlier sections of this report, Chester City residents are exposed to many existing environmental threats, such as roadway flooding, poor local air quality, and the presence of potentially hazardous land uses located along the waterfront.

Over the past 55 years, Chester City has experienced rapid population decline, leaving the current population only about half of what it was five decades ago. This exodus has left a legacy of abandoned or vacant residential properties, and drained the City of much of its economic resources. According to the 2010 Census, 30.3 percent of all Chester City people live below the poverty level, compared to 12 percent in Delaware County as a whole. In census tracts along the Delaware waterfront, the poverty rate is even higher, with 35 percent or more of the population living in poverty. Disadvantaged populations, including those living in poverty, the elderly, renters, and carless households are particularly vulnerable to existing and future climate stressors because they may lack resources to adapt quickly to changes.

In Chester, 4.7 percent of the City's population is aged 75 and older – a segment of the population that is more likely to have existing health and mobility concerns. More than 65 percent of the population rents housing (U.S. Census Bureau, 2014). Since renters typically have little control over their residence, they rely on their landlords or building owners to make decisions about air conditioning and upgrades that could prevent flooding (see Appendix C, Map 19). Storms and incremental climate change (in the form of increased flooding, severe storms, and extreme heat) will potentially pose a greater threat to these populations due to constrained resources, limited mobility, or compromised health.

Flooding and extreme weather events pose threats to the community overall, but disadvantaged populations face unique challenges. During a flooding event, the elderly, and the 40 percent of Chester's population who do not own their own vehicle, may have difficultly evacuating or finding another location for refuge. The more than 60 percent of residents that rent housing, and the elderly who may

be dependent on others for assistance, may have limitations in their ability to recover after flooding occurs. These residents may have to wait for flood damage or leaking roofs to be repaired by family members or landlords—some of whom may be absent or slow to respond to tenant demands. When housing is damaged, destroyed or becomes uninhabitable due to storms, tenants and the elderly may have fewer options for relocation and more difficulty doing so, placing greater stress on their physical, social and financial health.

Those living in poverty face similar challenges. Deferred property maintenance, which may be more common in lower income households, limits a structure's ability to keep occupants safe and comfortable during severe weather events. Likewise, structural damage and leaks that do occur as a result of storms or flooding may be less likely to be repaired, exacerbating the cycle of deferred maintenance.

Extreme heat may have a greater impact on some residents such as the elderly, the poor, the carless, female heads of households, renters, and those with limited English proficiency (see Appendix C, Maps 12-19). Studies have found that certain types of living conditions may increase a household's vulnerability to extreme heat, such as a lack of air conditioning (or the reluctance to turn on air conditioning and fans in an effort to avoid high electric bills), or a lack of access to vehicles or transit – and thus an inability to seek refuge to a cooler area or cooling center during a heat event. Further, communities with low tree coverage and high levels of impervious surfaces, such as the City of Chester, are exposed to the urban heat island effect, which exacerbates the impact of extreme heat. Social isolation—such as a lack of connectivity to neighbors, the fear of crime and theft (resulting in a reluctance to open windows), and a lack of access to media or information regarding the onset of a heat event—further contribute to vulnerably to extreme heat (Cooley, Moore, Heberger, & Allen, 2012). Some studies have found a correlation between race/ethnicity and increased risk of heat-related deaths. In a Chicago 1995 heat wave, for example, African Americans were 50 percent more likely than whites to die of extreme heat. This disproportionate risk to African Americans is thought to be a product of inner-City living conditions, poverty, poor housing conditions, and pre-existing medical conditions (McGeehin & Mirabelli, 2001; Cooley, Moore, Heberger, & Allen, 2012).

SECTION IV: Adaptation Strategies

After examining the future climate vulnerabilities detailed in Section III, the Task Force and Project Team outlined several strategies for community adaptations to climate change.

Strategy 1: Create an Environmental Advisory Council (EAC)

The City of Chester has many competing priorities and would benefit from identifying a specific group of people to carry on the work of this adaptation report. Previously, the City of Chester authorized the creation of an Environmental Advisory Council. A reinstated EAC can serve the City of Chester as a steward of the adaptation plan and help implement many of the plan's recommendations.

Goal

The Chester City Council will establish an EAC to steward the implementation of this adaptation plan.

Solution

An EAC is typically a group of 3-7 people appointed by the municipality's elected officials to advise the City on protection, conservation, management, promotion, and use of natural resources. By reinstating the EAC, the City of Chester would be able to focus on implementing elements of this adaptation plan. The City of Chester EAC should consist of community residents and include members representing local agencies, businesses, and institutions. Such representatives may include Pennsylvania Sea Grant, Widener University, the Chester-Upland school district, the Chester City Parks Department, etc.

Learning from others

The following examples demonstrate how other municipalities have used similar task forces to steward the implementation of their plans and programs

Sustainable Jersey Certification Program

The Sustainable Jersey Certification Program began in 2009 to provide municipalities in New Jersey with a framework and recognition for efforts to "go green," save money, and take steps to sustain their quality of life over the long term. To achieve certification, a town must first create a green team to implement all the steps of the certification program. The green team is the responsible liaison between the community, volunteers, and organizations and the municipality for all sustainability initiatives.

Out of the 566 municipalities in New Jersey, 116 are certified, and 398 are registered. Each municipality created a green team that consists of residents with some at-large members. Some green teams serve the municipality in lieu of an Environmental Commission (New Jersey's version of an EAC) and some are a sub-committee of the Environmental Commission.

More information can be found at http://www.sustainablejersey.com .

City of Homer, Alaska

The City of Homer, Alaska created a Climate Action Plan in 2007. One of the plan's elements called for creation of a Global Warming Task Force, which is responsible for plan implementation.

The City of Homer, AK Climate Action Plan is available at:
http://www.cityofhomerak.gov/sites/default/files/fileattachments/climate_action_plan.pdf

Pittsburgh, Pennsylvania

The City of Pittsburgh, Pennsylvania created the Pittsburgh Climate Initiative (PCI) – a coalition of local stakeholders and members of the wider community involved in implementing the climate action plan. Due to the larger size of the City, the PCI operates on a much larger scale than the suggested Chester EAC. The PCI includes local residents as well as non-profit organizations, city representatives, and elected officials. It also has sub-committees focused on green buildings, government, community, etc. This initiative differs from Chester in that the climate action plan is focused on both mitigation as well as adaptation. http://pittsburghclimate.org/about-us

Recommended Action

Create an Environmental Advisory Council (EAC)

The Chester City Council should adopt a version of the model environmental advisory council resolution (see Appendix B) to reinstate the Environmental Advisory Council. The City should charge the EAC with overseeing the implementation of climate adaptation planning efforts.

Strategy 2: Engage in Post-Storm Redevelopment Planning Process

> *"Rebuilding a community after a major or catastrophic disaster is a huge undertaking. The most effective way to accomplish holistic post-disaster redevelopment is to be prepared before a disaster strikes. Developing a Post-Storm Redevelopment Plan requires envisioning the potential obstacles to reconstructing a community in a compressed timeline – and hopefully not just reconstructing what was there, but redeveloping a more sustainable and disaster-resilient community with participation from various community stakeholders."*
>
> Florida Division of Emergency Management Guide on the Post Disaster Redevelopment Planning Process (*http://www.floridadisaster.org/Recovery/IndividualAssistance/pdredevelopmentplan/Index.htm*)

Many communities have plans to mitigate hazards related to natural disasters such as flooding and storms. For example, many of the recommendations in this report are examples of strategies to put in place to reduce the impact of major storms and flooding *before* they occur. By contrast, more and more communities are being forced to create rebuilding plans *after* a major storm or flooding event. In some cases, the damage in these communities is significant enough to qualify them for federal or state funding for rebuilding.

Many of these communities express frustration with the difficulty managing the recovery process due to the intense pressure to rebuild quickly. Under these circumstances, it is particularly difficult to engage community members to rebuild in ways that improve a community's resiliency to climate hazards. Without advance planning, the City may lose an opportunity to achieve long term goals while trying to meet the immediate needs of residents and businesses eager to rebuild and get back to work. For example, homes and stores may be rebuilt to their original design in the same flood-prone areas – only to be vulnerable to the next big storm.

Goal

The City of Chester should engage in a post-storm planning process with community stakeholders to increase the likelihood that the post-disaster rebuilding efforts will be an efficient and inclusive process that also reduces community vulnerabilities to future hazards.

Solution

The Environmental Advisory Council or another form of a resiliency task force should identify which areas of the City are particularly vulnerable to storms and flooding. The elements of climate adaptation planning identified in this report and its associated maps and data can be used to help identify those areas. The City should create an inclusive community engagement process to communicate information about the vulnerable areas of

Figure 1. Chester Creek Flooding in Delaware County, 2010 (Source:http://articles.philly.com/2010-10-02/news/24999556_1_flood-victims-flood-stage-basement)

the City to the public and key stakeholders. The process would create a post-storm recovery plan with support from key government stakeholders such as the Federal Emergency Management Agency (FEMA), PEMA, U.S. Army Corps of Engineers, etc. The plan should be a shared vision of how to implement recovery goals and determine roles and responsibilities of stakeholders during a recovery process.

The post-storm redevelopment plan should identify and map areas to rebuild immediately, areas to rebuild with flood mitigation designs, and areas where rebuilding should not take place as well as ways to properly compensate private property owners in those areas. The recommendations may propose that these areas should become natural riparian buffer zones or flood parks to protect against future events.

Learning from others

Hillsborough County, Florida: Post-Disaster Redevelopment and Mitigation Ordinance

In 1993, Hillsborough County, Florida enacted a policy to improve their ability to respond to disasters while still meeting the objectives of the county's existing Comprehensive Plan. The county was one of five pilot communities chosen by the State of Florida to initiate a post-disaster planning process. Securing robust participation from key stakeholders and citizens in the county was very important since stakeholder support is essential for implementing the recommendations of the plan after a disaster. The plan provides specific guidance on post-disaster decisions related to:

- Business resumption and economic development
- Environmental restoration
- Financial issues
- Repair and reconstruction of buildings and homes
- Hazards mitigation and restoration plans for physical infrastructure
- Short term recovery actions that may have positive or negative impacts on long term re-development goals
- Sustainability and land-use

> *"A disaster, while tragic, can also create opportunity. With a Post-Disaster Redevelopment Plan, a local government has a better chance of moving the community farther down the road to resiliency. Post-Disaster Redevelopment Planning enables communities to integrate and advance their previous planning efforts to achieve a more sustainable and resilient community after a disaster."*
>
> Florida Division of Emergency Management Guide on the Post Disaster Redevelopment Planning Process (http://www.floridadisaster.org/Recovery/IndividualAssistance/pdredevelopmentplan/Index.htm)

The State of Florida now requires that all local communities along the coast prepare a post-disaster redevelopment plan. For more information about the Hillsborough plan, visit: http://www.hillsboroughcounty.org/index.aspx?NID=1793

Town of Duck, North Carolina: Moratorium on Rebuilding and Reconstruction

North Carolina encourages state and local governments to work collaboratively on land use planning issues. The North Carolina Coastal Areas Management Act recommends that "adequate plans for post-disaster reconstruction should be prepared by and coordinated between all levels of government prior to the advent of a disaster."

Duck is located on the Outer Banks which is especially vulnerable to hurricanes and flooding from coastal storms. Duck created a state-approved land use ordinance that allows for a short-term moratorium on building after a disaster. The ordinance provides guidance on how to assess damage and how to use a short-term moratorium on rebuilding to give the community time to allow rebuilding to occur "in an orderly manner," and the ability to "identify opportunities to mitigate future storm damages." A special reconstruction task force is tasked to oversee the process and advise the Town Council on all reconstruction and recovery issues.

For more information visit: Duck, NC Code of Ordinances; Chapter 152: Rebuilding and Reconstruction; Damaging Storms at http://www.amlegal.com/duck_nc.

Cedar Rapids, Iowa; Recovery and Redevelopment after a Major Flood Disaster

In 2008, flooding across the Midwest caused billions of dollars in damages. The town of Cedar Rapids, Iowa saw intense damage with 5,300 homes impacted, 310 city facilities damaged, and more than 18,000 residents dislocated. Thirteen hundred properties needed to be demolished and many major city buildings were damaged including the Central Fire station, the public works building, and the transportation hub.

Cedar Rapids did not have an "official" post-disaster plan in place, but the City did use a previously established public input system to create a River Corridor Redevelopment Plan to rebuild and reinvest in the community.

Within four days after the flooding, the Cedar Rapids City Council adopted the following six goals:

- Improve flood protection to better protect homes and businesses
- Rebuild high-quality and affordable workforce neighborhoods
- Restore full business vitality
- Preserve our arts and cultural assets
- Maintain our historic heritage
- Assure that we can retain and attract the next generation workforce

After a long engagement and feedback process the final plan was created. The City estimates that recovery and redevelopment will continue for 12-15 more years before it is fully implemented. The plan focuses on four elements:

- Economic Recovery: Housing & Business Investment
- Flood Management & Protection Strategies
- Public Facilities Replacement
- Health and Human Service Needs

For more information visit: http://www.cedar-rapids.org/city-news/flood-recovery-progress/floodrecoveryplans/pages/recovery-and-reinvestment-plan.aspx

Recommended Actions

The following recommended actions will help the City of Chester begin the process of planning for recovery and redevelopment after a storm or other climate related disaster. Due to the serious nature of disaster recovery, the need for a rigorous and inclusive planning process, and the evolving understanding and technical nature of best practices in post-storm planning, Chester should seek funding and collaborate with multiple partners across the Delaware Valley to create a plan that will be successful in the unfortunate event that it is needed.

Seek Federal or State funding and outside assistance to begin the planning process.

In order to develop an effective post-storm plan, an inclusive planning process should be undertaken. The results of this process should be incorporated in existing emergency, hazard mitigation, redevelopment, and community plans, such as the *Vision 2020* plan. Since many states and federal agencies understand the benefits of upfront planning, there are funding programs and technical assistance programs currently available for local governments. Without the pressure of a pending or recent disaster providing impetus for stakeholders to willingly collaborate, state and federal assistance is necessary to create a robust process with the necessary engagement with local residents, businesses, and community leaders. This outside assistance is helpful because many of the recommendations for rebuilding plans will need input or approval of multiple governmental jurisdictions.

Several federal agencies and the State of Pennsylvania offer funding or technical assistance for post-disaster planning including:

- **Federal Emergency Management Agency (FEMA)** The Pre-Disaster Mitigation (PDM) program provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. http://www.fema.gov/pre-disaster-mitigation-grant-program
- **Housing and Urban Development (HUD)** Grantees may use HUD Community Development Block Grants for Disaster Recovery for many recovery efforts and for post-storm planning. http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/drsi

- **Environmental Protection Agency (EPA)** provides grants to the states in support of Clean Water Act requirements through low-interest loans or other assistance to publicly owned wastewater collection and treatment systems, stormwater systems, and nonpoint source pollution control and estuary management projects. States may reserve a portion of their grants received from EPA to finance technical assistance to help utilities plan for and recover from disasters, including both floods and droughts. http://water.epa.gov/infrastructure/watersecurity/funding/fedfunds/esrfunds.cfm
- **National Oceanic and Atmospheric Agency (NOAA)** offers technical assistance and various grant programs. Resources are accessible through their Coastal Climate Adaptation portal (http://collaborate.csc.noaa.gov/climateadaptation/default.aspx), Digital Coast site (http://www.csc.noaa.gov/digitalcoast/), and a Funding Opportunities portal (http://www.csc.noaa.gov/funding/).
- **U.S. Army Corps of Engineers (USACE)** offers technical resources for Coastal Storm Damage Reduction http://www.nad.usace.army.mil/About/NationalCentersofExpertise/CoastalStormDamageReduction(Planning).aspx
- **State of Pennsylvania** oversees a number of programs and services to help prevent, respond to, or recover from disasters. They include federal and state support, as well as citizen-based volunteer opportunities to assist in times of disaster or emergency. http://www.portal.state.pa.us/portal/server.pt/community/programs_and_services/4547/grant_management_programs/458184

Additional technical resources are available from other municipalities or organizations that have already created these types of plans. Many of them offer information and specific guidance designed to help, including:

- **StormSmart Connect** helps coastal professionals find and share information on weather and climate hazards. http://stormsmart.org/
- **Florida's Post-Disaster Redevelopment Planning guide** http://www.floridadisaster.org/Recovery/IndividualAssistance/pdredevelopmentplan/Index.htm
- **Coastal Resilience** offers advanced decision-making tools for coastal risk assessment. It also helps identify nature-based solutions that reduce socio-economic vulnerability to coastal hazards. http://coastalresilience.org
- Insurance Institute for Business and Home Safety's **"Getting Back To Business Guidebook"** http://www.emd.wa.gov/preparedness/business/documents/ibhs_GettingBackToBusiness.pdf
- American Institute of Architects **"Planning for Sea-level Rise before and after a Coastal Disaster"** http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aias076739.pdf

Engage with regional partners to share resources, learn from each other, and add to a more integrated regional plan for post-disaster recovery.

Regional engagement may help Chester learn from jurisdictions that have already begun a planning process or that have additional technical resources to share. For instance, SEPTA is currently working on storm response planning. Benefits of collaboration may include access to existing vulnerability data and leads on key service providers. In addition, many of the funding opportunities available from Federal sources have criteria that may make it easier to obtain resources as part of a regional collaboration.

Strategy 3: Develop a Heat Emergency Plan

In a typical year about 400 people die from extreme heat in the United States (Centers for Disease Control and Prevention, 2013). Heat-related deaths in the United States are higher than the combined death toll for floods, tornadoes, hurricanes, lightning, and earthquakes (Centers for Disease Control and Prevention, 2013). An increase in the number of days and the duration of extreme heat events, as expected in the climate projections outlined in Section II, is likely to exacerbate the existing health risks in Chester.

The elderly (10.4 % of Chester's population), children (27.2%), people with limited resources (31.4 % live below the poverty level) (U.S. Census Bureau, 2014), the homeless, people who work outdoors, and those with chronic medical conditions are more vulnerable to the risks associated with extreme heat (Centers for Disease Control and Prevention, 2013). The City of Chester has a large number of people who fall into at least one of these higher risk categories (see Appendix C, Maps 12-18). The strategy below introduces a framework to minimize the impact of extreme heat events on Chester residents.

Goal

The goal of this strategy is to minimize the number of heat stress related illnesses and deaths in Chester.

Solution

The City of Chester should develop a plan to identify and open cooling centers (air conditioned public spaces) to the public during periods of extreme heat. The strategy includes identifying several easily accessible locations in neighborhoods across the City, developing a plan to locate and assist individuals that may benefit from using cooling centers, and organizing a neighborhood network to oversee and implement the plan and conduct health checks on vulnerable populations during a heat wave. Public policy, infrastructure improvements, preseason education, and a robust early warning system are also important components of an effective heat emergency plan.

Learning from others

Superstorm Sandy

The Associated Press and the NORC Center for Public Affairs Research conducted a New York and New Jersey poll after the devastating 2012 superstorm. The poll found that friends, relatives and neighbors were most often cited as the people who provided assistance during the storm. Although difficult to measure, the author suggests that social cohesion is one of the main factors that influenced a community's resiliency or adaptive capacity to extreme weather events (Barr, 2013).

PlaNYC

New York City recently released PlaNYC, a comprehensive plan for resiliency that outlines several initiatives that would increase community preparedness to extreme events. The strategy includes measures to identify gaps in community capacity, strengthen community response teams, increase access and integration of available data, and explore new methods of notifying residents in

emergency events (Barr, 2013). NYC Department of Aging, New York City Housing Authority, Brooklyn Public Library, New York Public Library, Queens Library and the Salvation Army provide cooling center facilities. The City operates a hotline for residents to obtain information about cooling centers by dialing 311. For more information, visit: http://newyork.resiliencesystem.org/nyc-oem-heat-emergency-plan-cooling-centers-activated

Philadelphia, Pennsylvania

Philadelphia established a robust heat emergency plan to minimize heat related health risks during periods of extreme heat. In preliminary findings of a recent CDC funded survey, government and community leaders reported the following benefits from creating a formal heat emergency plan: assessment of heat mortality at the local level improved; public outreach campaigns increased awareness and citizen responsiveness to risk; the block captain network was more effective at reaching high risk populations; inter-agency coordination improved; white roofs decreased building temperatures; and the distribution of resources during heat waves was more equitable (Buxton, et al., 2011).

The Philadelphia Excessive Heat Plan (http://oem.readyphiladelphia.org/HeatPlan) included the following strategies:

- **The Education and Preseason Preparedness Plan** outlines the preparation activities for agencies to carry out prior to the anticipated start of extreme heat events.
- **The Public Notification and Warning Plan** describes various public notification, alerts, and warning procedures for excessive heat.
- **The Excessive Heat Response Plan** details and coordinates response plans of the City of Philadelphia, non-profit, and private agencies.

The Connecticut Triad for Senior Safety

The Connecticut Triad for Senior Safety hosts a Facebook page that provides information about extreme heat events in various Connecticut communities (www.facebook.com/CTriads/posts/374887585898064). As an extreme heat event unfolds, the Facebook page works as a portal for information about cooling centers. Announcements and links are updated to provide readers with access to current information.

Recommended Actions

The following recommendations are based on participant input from Chester community engagement workshops and the preliminary findings of a CDC-funded study, *Reducing Social Disparities of Heatwave Impacts in a Changing Climate.* In this case study, CDC surveyed Detroit, New York, Philadelphia, and Phoenix community members and government and community leaders about heat-related vulnerabilities, programs, and public perception of risk (Buxton, et al., 2011). Based on community input

and the CDC study, the recommended strategy is divided into four categories: policy and planning to create a heat emergency plan, health communication, programming, and infrastructure.

Create a Heat Emergency Plan

- Designate a community heat health committee or task force for heat emergency planning coordination.
- Conduct public health surveillance to monitor heat-related illness.
- Implement housing regulations that require adequate cooling and white roofs for renovation and new construction.
- Utilize mapping to locate cooling centers relative to vulnerable populations.

Develop Health Communications Materials

- Draft press releases and heat advisory announcements in anticipation of heat emergencies.
- Develop an audience-appropriate alert strategy that utilizes e-mail, text messages, social media, radio, and television.
- Establish a network of "block captains" that can be activated to go door-to-door to check on the health of high risk neighbors.
- Develop educational materials, such as brochures and magnets that provide information about where to find real-time information about resources or tips for limiting exposure to extreme heat.
- Reach out to Chester social networks and service professionals (such as clergy, landlords, hospitals, and social workers) to help distribute information to residents during an extreme heat event.

Coordinate Programming

- Establish cooling centers in vulnerable sections of the City. The centers should have adequate air conditioning, back-up generators (in case of power failure), space, and be centrally located near high concentrations of at risk populations, such as senior housing facilities.
- Extend public swimming pool hours.
- Coordinate existing volunteer neighborhood organizations or mail or utility workers to check on at-risk individuals.
- Organize a volunteer network to help transport at risk individuals to cooling centers.
- Provide financial assistance for those whose power is shut-down during a heat emergency.
- Provide home weatherization training and incentives.
- Facilitate networking and coordination of social services by organizing regular meetings and communications in anticipation of heat emergencies

Improve Infrastructure

- Weatherize schools, homes, and public buildings to achieve cooler temperatures during hot weather.
- Install white rooftops in the most densely settled, hottest neighborhoods.
- Provide mister systems in outdoor public areas during heat emergencies.
- Plant shade trees to reduce heat.

Strategy 4: Seek Certification in the National Flood Insurance Program Community Rating System (CRS)

Flooding is one of the main climate-related concerns in the City of Chester. The Community Rating System (CRS) was created in 1990 to help communities guide development and encourage retrofits that minimize flooding to property insured by the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP). The program utilizes rate reductions as an incentive to encourage communities to proactively protect property from flood damage. The purpose of CRS is threefold: (1) reduce flood damage to insurable property, (2) strengthen and support the insurance aspects of the NFIP, and (3) foster comprehensive flood management. Participating communities can lower insurance premiums by as much as 45 percent. The precise reduction is based on the extent to which the community adopts the optional components of the program.

In addition to protecting vulnerable properties from flood damage, participation in the CRS program will help reduce Chester residents' insurance premiums as FEMA begins implementation of the Biggert Waters Flood Insurance Reform Act of 2012 (BW12). This act will require that property owners with subsidized flood insurance begin to pay premiums that reflect true flood risk.

A municipality can receive credit for 19 types of activities that fall into four major categories: public information, mapping and regulations, flood damage reduction, and flood preparation (Figure 2). Each of the 19 activities is further detailed in the CRS Manual. For example, Activity 420, Open Space Preservation, contains a number of sub-elements, each of which offers points (i.e., open space preservation, deed restrictions, open space incentives, low density zoning, etc.). Chester has the opportunity to lower flood insurance premiums for residents once it enrolls in the CRS program and implements the adaptation strategies outlined in this

Table 110-2. Credit points awarded for CRS activities.

Activity	Maximum Possible Points [1]	Maximum Points Earned [2]	Average Points Earned [3]	Percentage of Communities Credited [4]
300 Public Information Activities				
310 Elevation Certificates	116	116	46	100%
320 Map Information Service	90	70	63	93%
330 Outreach Projects	350	175	63	90%
340 Hazard Disclosure	80	57	14	68%
350 Flood Protection Information	125	98	33	92%
360 Flood Protection Assistance	110	65	49	41%
370 Flood Insurance Promotion [5]	110	0	0	0%
400 Mapping and Regulations				
410 Floodplain Mapping	802	585	65	50%
420 Open Space Preservation	2,020	1,548	474	68%
430 Higher Regulatory Standards	2,042	784	214	98%
440 Flood Data Maintenance	222	171	54	87%
450 Stormwater Management	755	540	119	83%
500 Flood Damage Reduction Activities				
510 Floodplain Mgmt. Planning	622	273	123	43%
520 Acquisition and Relocation	1,900	1,701	136	23%
530 Flood Protection	1,600	632	52	11%
540 Drainage System Maintenance	570	449	214	78%
600 Warning and Response				
610 Flood Warning and Response	395	353	144	37%
620 Levees [6]	235	0	0	0%
630 Dams [6]	160	0	0	0%

1 The maximum possible points are based on the 2013 Coordinator's Manual.

2 The maximum points earned are converted to the 2013 Coordinator's Manual from the highest credits attained by a community as of October 1, 2011. Growth adjustments and new credits for 2013 are not included.

3 The average points earned are converted to the 2013 Coordinator's Manual, based on communities' credits as of October 1, 2011. Growth adjustments and new credits for 2013 are not included.

4 The percentage of communities credited is as of October 1, 2011.

5 Activity 370 (Flood Insurance Promotion) is a new activity in 2013. No community has earned these points.

6 Activities 620 and 630 were so extensively revised that the old credits cannot be converted to the 2013 Coordinator's Manual.

Figure 2. Example credit points awarded for various protective activities recommended in the National Flood Insurance Program Community Rating System Coordinator's Manual FIA-15/2013 (OMB No. 1660-0022).

synthesis report.

In order for a CRS municipality to remain in the program, it will be responsible for continued implementation of its credit-based activities, including designation of a CRS Coordinator, coordination with an Insurance Services Office (ISO)/CRS Specialist, annual recertification, record-keeping, etc.

Goal

Chester will seek CRS certification to help protect the health, safety, and welfare of the City residents through a comprehensive approach to floodplain management which increases resiliency for climate change impacts.

CRS specifically takes into account *"future conditions and impacts of climate change."* (section 116.c of the CRS manual)

Solution

City Council should direct the Office of Emergency Management and Department of Planning to work with appropriate city agencies to identify the appropriate CRS activities for the City of Chester. The City will start by seeking credit for the recommended actions contained in this synthesis report that are eligible for credit under the CRS. The EAC should be available to help with implementation of CRS actions.

Learning from others

Roseville, California was the first community in the nation to receive CRS's highest rating of a Class 1 community. Roseville adopted all of FEMA's recommended activities including voluntary buy-outs for 273 homes, converting the majority of the floodplain to open space, prohibiting construction or infill within the 100-year floodplain (except in the city center), elevating structures, and operating an alert system that predicts and broadcasts flood warnings. These efforts have reduced the impact of riverine flooding, leading to a 45% discount on flood insurance premiums for properties within special flood hazard areas. For more information, visit: http://resiliency.lsu.edu/content/roseville-california-community-rating-system-success-story.

King County, Washington received a Class 2 CRS rating by preserving over 100,000 acres of open space, purchasing and removing more than 40 structures from the floodplain, establishing the King County Flood Control District to manage and fund projects that include, but are not limited to, annual inspection and maintenance, flood warning, and dam safety programs. Additionally, King County publishes online maps and flood information, making them readily available to the public. For more information, visit: http://resiliency.lsu.edu/content/king-county-washington-community-rating-system-success-story.

Recommended Actions

Initiate steps necessary to join the CRS and maintain certification

City officials, including Council, the Emergency Management Coordinator, and other staff as appropriate should meet to identify and initiate steps required for joining the CRS.

- Obtain and review the CRS Coordinator's Manual and determine desire to join the CRS.
- Designate a CRS Coordinator.
- Identify and satisfy CRS prerequisites for desired class (Note: Class 9 requires six prerequisites, including full compliance with full requirements of the NFIP, requirements for elevation certificates, and compliance with repetitive loss criteria).
- Gather all required documentation for CRS.
- Submit letter of interest and activities that would provide at least 500 credit points to the ISO/CRS Specialist for Pennsylvania (refer to CRS Manual). Note: many of the existing Pennsylvania environmental programs as well as City ordinances (e.g., stormwater management) should provide many of the first 500 credit points.
- Meet with the ISO and FEMA as required for admission to the CRS.
- Maintain required records and provide required documentation for annual recertification (for current credited activities).

Identify floodplain management and climate adaptation strategies to enhance resiliency and increase points for CRS activities.

- City officials, including Planning and Emergency Management offices and the CRS Coordinator, should identify floodplain management and climate adaptation strategies, including regulations, programs, and funding sources for activities that further protect the City from flooding.
- Meet with ISO/CRS and FEMA staff as necessary to discuss the feasibility of undertaking additional CRS activities.
- Develop and adopt a schedule for implementation of proposed activities and programs.

Implement floodplain management programs and climate adaptation strategies and request modification of the City's CRS classification.

- Pursue funding, as needed, to implement proposed activities and programs.
- Develop details associated with floodplain management and climate adaptation strategies.
- Implement programs in accordance with the schedule adopted by the City.

Strategy 5: Improve Floodplain Management

Lands adjacent to waterways such as the Chester Creek, Ridley Creek, and the Delaware River are all susceptible to flooding. The lands *most* susceptible to flooding are located within the 100-year floodplain as defined by FEMA (see Appendix C, Map 5). Chester City's existing floodplain management ordinance, adopted in 2010, regulates activities within the 100-year floodplain to protect existing and new development against flooding. However, lands outside the regulated 100-year floodplain are also susceptible to flooding, such as lands within the 500-year floodplain and storm surge zones (see Appendix C, Maps 5 and 6). For the purpose of this discussion, the area beyond the 100-year floodplain and within the 500-year floodplain and category 4 storm surge zone is defined as the "Expanded Flood Risk Area" (see Appendix C, Map 22). Future flooding risk in both areas – the 100-year and the Expanded Flood Risk Area – is expected to *increase* due to sea level rise and climate change.

The existing floodplain management ordinance regulates development in the 100-year floodplain, but it does not regulate development in the Expanded Flood Risk Area unless modified to include this area. tThe City has the option of establishing a new Expanded Flood Risk Area overlay district with a mix of voluntary and regulatory measures to guide development. Like the existing floodplain management ordinance which is also an overlay district, it would not alter the underlying zoning while it protects people, habitat, and property.

In Chester, existing development in the Expanded Flood Risk Area includes utilities, heavy and light industrial manufacturing, transportation, commercial uses (including PPL Park and Harrah's Philadelphia), community services, row homes, multi-family and single family housing stock (see Appendix C, Map 3). The Sample Expanded Flood Risk Area illustrated in Map 22 also includes vacant lands and former industrial sites as well as open space. Since existing and future development in these areas is vulnerable to flooding, standards can be set to insure that this development is resilient to flooding, and that new development does not increase the flood risk for existing development. These standards could also be used to protect open space, which will improve floodplain function and keep development out of harm's way.

At the same time, the City could examine its existing floodplain ordinance to determine if it needs to be strengthened, revised or otherwise improved to protect people, property and the environment in the 100-year floodplain. For example, the City can go beyond the minimum standards required by FEMA, for example, using freeboard to elevating a building's lowest floor above the predicted flood elevations by a small additional height, generally 1-3 feet above National Flood Insurance Program minimum height requirements (StormSmart Coasts, 2014). Strengthening the ordinance could give the City more CRS points that would translate into lower insurance premiums.

Goal

Protect people, habitat, and property from flooding by expanding the area covered by Chester's existing floodplain management ordinance to include the Expanded Flood Risk Area or create a new overlay

district with a suite of voluntary and/or regulatory measures to guide development in the Expanded Flood Risk Area.

Solution

The City of Chester could create an overlay district for the Expanded Flood Risk Area (see Appendix C, Map 22) using three basic steps:

1. Define the purpose of the district.
2. Identify the areas that make up the district.
3. Develop specific rules and/or voluntary measures that apply to the identified district. (ftp://ftp.wi.gov/DOA/public/comprehensiveplans/ImplementationToolkit/Documents/OverlayZoning.pdf)

The City should investigate regulatory and/or voluntary development and redevelopment standards that would apply to the district. Strategies may include **accommodating** inundation (elevating homes and buildings in the flood zone and limiting lowest floor to uses that are "safe to flood"); **protecting** buildings (flood-proofing buildings and assets that cannot be moved or elevated; prohibiting the storage of materials that would cause water contamination; restricting certain land uses, such as prisons and nursing homes; or requiring the use of enhanced stormwater management techniques (see below in Strategy 7).

Figure 3. Home elevation technique as illustrated in *Make It Right*.

Learning from others

Milwaukee River Basin Partnership hosts a website about overlay districts. It highlights the importance of creating zones with specific standards to protect water resource. The website lists several types of overlay districts that could be appropriate to protect all types of water resources from floodplains to aquifers. The overlay districts are recognized to protect natural resources, promote safety, and protect public health. Links provide access to various websites that offer specific overlay district language. For more information, visit: http://clean-water.uwex.edu/plan/overlay.htm

West Nantmeal Township in Pennsylvania adopted a floodplain management ordinance to reduce harm to people and property from flooding. It recognizes flooding hazard based on several parameters: soil type, FEMA 100-year floodplain, lands that have flooded in the past 100 years, etc. The area that the floodplain management ordinance applies to is referred to as the "flood hazard overlay district".

Lands that fall within the flood hazard overlay district are subject to limits on impervious coverage, residential development restrictions, and a prohibition on developing essential services for vulnerable populations, i.e. nursing homes, hospitals, etc. For more information, visit: www.westnantmeal.com/pdf/za5cd.pdf

Cape Cod, Massachusetts passed a zoning regulation to discourage infrastructure in the 100-year floodplain. This approach is an example of preventing new construction in high risk areas. www.mass.gov/eea/docs/czm/stormsmart/ssc/ssc3-chatham.pdf

New Orleans, Louisiana's Make it Right program was established to address the destruction caused by Hurricane Katrina in the Lower Ninth Ward. Make it Right has been a pioneer in this area, building affordable homes to Leadership in Energy and Environmental Design (LEED) standards and incorporating flood resilient strategies. One of the key elements of these homes is that they are designed to **accommodate periodic inundation**. Make it Right has used the work in New Orleans as a laboratory to try innovative approaches that have been replicated in other areas, including those affected by Hurricane Sandy. The organization also provides a library of resources and a "laboratory" that is an interactive platform for developers (Make it Right, 2012). In New Orleans, Make it Right is building houses above the FEMA required 3' above Base Flood Elevation (BFE) or 5' to 8' above BFE. The higher elevation accommodates parking below the main structure also incurs an additional cost of approximately $28,000 while saving on flood insurance costs.

Quincy, Massachusetts created a program to provide assistance for reducing storm risk in developed areas by elevating structures to **accommodate periodic inundation**. Municipal officials work with interested property owners to determine the most cost-effective approach. The solutions often focus on elevating the home's utilities and appliances into upper floors or relocating them to small additions, rather than renovating the entire structure. Funding is provided by FEMA's Pre-Disaster Mitigation and Flood Mitigation Assistance grant programs. The timing and logistics of the Quincy program vary by year based on funding levels and the budget cycle.
www.mass.gov/eea/docs/czm/stormsmart/ssc/ssc4-quincy.pdf

Charlotte-Mecklenburg, North Carolina created a ***Flood Information & Notification System (FINS)*** designed to provide advanced flood notification to emergency responders to help protect residents and property from flooding. The city developed a cooperative partnership with the US Geological Survey to continually monitor rainfall and stream depth levels. Based on these measurements, fire fighters, police, and emergency management staff are notified via pager, cell phone and e-mail alerts. The early warning system allows emergency responders to swiftly investigate the flood conditions and set up barricades to temporarily **protect structures from floodwaters.** Additional precautions such as evacuating residents may also be activated as necessary.
http://charmeck.org/stormwater/StormWaterAgencies/Documents/Peers%20PDF/FloodResilienceCommunityProfile.pdf

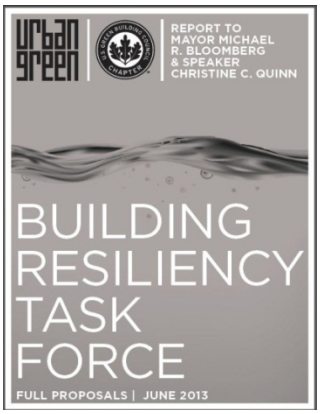


Figure 4. Building Resiliency Task Force Report for New York City.

In New York City, New York, the Building Resiliency Task Force presented a report to Mayor Bloomberg that offered 33 proposals to increase the resiliency of buildings in the City. About half of those proposals applied directly to development in high flood risk areas. The report provides guidance on how to implement each of the proposals as a required upgrade, new code, removal of a barrier, recommended proposal, or further action. The report also includes cost estimates for practices that are suggested for New York City.
www.urbangreencouncil.org/servlet/servlet.FileDownload?file=0150000001EyaR

Recommended Actions

The following are recommended actions to strengthen the City's existing floodplain management policies and further protect itself from flooding:

1. To increase flood protection beyond the existing 100-year floodplain the city can:
   - Establish a flood protection overlay district for the Expanded Flood Risk Area and create voluntary and/or regulatory standards that would apply to the district, or
   - Adopt a suite of voluntary standards for development and redevelopment that would apply equally to the Expanded Flood Risk Area and the 100-year floodplain, or
   - Apply some or all of the 100-year floodplain ordinance requirements to the Expanded Flood Risk Area.

2. The City should direct responsible parties to investigate strengthening existing standards for the 100-year floodplain, whether new standards are transmitted for the Expanded Flood Risk Area or not. Strengthening the existing standards for the 100-year floodplain will help the city earn points in the Community Rating System (see Strategy 4).

   The following are some examples of provisions the City could implement to strengthen the existing floodplain management ordinance (as it applies to the 100-year floodplain):

   - **Increase elevation requirements:** The City of Chester may consider adopting elevation requirements for structures in the 100-year floodplain that are at least 2 feet more stringent than FEMA requirements (e.g., if the FEMA requirement is 3' above BFE, Chester would adopt a requirement to be 5' above BFE). The City should also make sure that any procedural barriers to elevating buildings and building systems are removed.
   - **Remove hazardous materials from high flood risk areas:** The City should consider banning the storage and processing of toxic materials from the 100-year floodplain. In cases where complete removal is not possible, hazardous materials should be elevated or flood-proofed.

- **Update building water supply and sewage systems to avoid contamination: The City should r**equire that building sewage lines be equipped or retrofitted with valves to prevent sewage from entering the building. Toilets and faucets should be capable of operating without grid power.

3. The City can encourage individual landowners and developers to implement the following building upgrades and development practices. These can either be voluntary or required measures and they can apply to the 100-year floodplain or the 100-year floodplain *and* the Expanded Flood Risk Area.
    - **Relocate and protect critical or hazardous building systems:** Consider relocating electrical equipment above the 500-year flood level and follow best practices when flood-proofing.
    - **Use resilient materials:** Construction materials for the lowest floor should be able to withstand periodic inundation.
    - **Anchor structures to prevent damage:** Structures should be anchored or designed to prevent flotation, collapse, or lateral movement in the event of flooding.
    - **Use landscaping and onsite stormwater management: I**ntegrate green stormwater infrastructure best practices (see below, Strategy 7) into the development of sidewalks, streets, parking lots and private property.

Strategy 6: Expand Vegetated Buffers, Restore Wetlands and Streams, and Protect Open Space

Naturally vegetated floodplains, wetlands, and open space minimize flooding, dissipate and filter stormwater flows, and improve water quality. The City of Chester borders three waterways that could benefit from natural buffers: Chester Creek, Ridley Creek, and the Delaware River. The ecosystem services that vegetated floodplains, wetlands, and open space provide will increase in value over time and as severe precipitation events become more common in the region.

The City of Chester's landscape is primarily urban. As a large portion of the City is covered in impervious surfaces, it stands to reap great benefits from incremental increases in naturally vegetated areas. The impervious surfaces (e.g., pavement and buildings) in Chester reduce stormwater infiltration and increase the velocity and volume of stormwater runoff, which in turn leads to stream channelization, water quality impairments, and increased exposure to flooding for structures and people. Vegetated buffers, wetlands, and open space can increase on-site stormwater infiltration, decrease the velocity of runoff, and improve stream conditions.

Goal

Restore naturally-vegetated floodplains to reduce, capture and infiltrate stormwater runoff, improve water quality, and minimize damage to people and structures.

Solution

Enact steps to preserve and restore natural floodplain services though activities that will help expand vegetated buffers, restore wetlands and streams, and protect vital open space. The recommendations in this section apply primarily to lands bordering the Chester and Ridley creeks. *Separate strategies should be identified for balancing redevelopment and flood protection along the Delaware waterfront. This area is a priority for re-development within the City and the threat of coastal flooding from storm surge requires a different approach.*

Learning from others

Saylor's Grove, an urban park in Philadelphia, was a pilot project for the Philadelphia Green Cities Clean Waters program. Philadelphia Water Department (PWD) redeveloped the 3.25 acre park to include a 0.7 acre stormwater treatment wetland. Annually, more than 70 million gallons of stormwater from a 156 acre urban watershed enters the park; the constructed wetland filters a large percent of this stormwater water before it enters the Monoshone Creek. The wetland's natural vegetation has been designed to filter non-point pollution and reduce the flow of the stormwater, resulting in improved water quality and stream channel quality for the Monoshone Creek (Temple-Villanova Sustainable Stormwater Initiative, 2006).

Figure 5. Saylor's Grove stormwater treatment wetland, Philadelphia, PA.

Stream restoration in Philadelphia is part of a wide-scale restoration of the tributaries to the Wissahickon Creek in Fairmount Park. In 2011, the Philadelphia Water Department (PWD) completed restoration of Bell's Mill Creek, which experienced severe erosion and sedimentation in the stream bank as a result of two major stormwater outfalls that discharge stormwater into the creek. PWD's restoration project re-graded the streambank to its natural slope and employed various techniques to stabilize the streambank from further erosion. The Bell's Mill stream restoration project is one of six such projects conducted by PWD to reduce steam bank erosion and enhance in-stream and riparian conditions.

Recommended Actions

The City of Chester should consider pursuing a suite of approaches to expand vegetated buffers and natural approaches to stormwater management. The Project Team suggests that strategy 6 be applied to appropriate land that falls within the Flood Protection Overlay Districts recommended in Strategy 5. The actions could include requirements for developers and redevelopment, voluntary actions that private landholders can implement, and projects that the City can undertake directly to restore naturally-functioning floodplains. Additionally, the recommendations for floodplain development (Strategy 5) and green stormwater infrastructure (Strategy 7) are intended to be complementary to restoring natural functions of the Chester and Ridley creek floodplains. Together these actions will expand vegetated buffers, protect open space, and promote development that supports the natural function of the land.

Figure 6. Bell's Mill Creek before stream restoration, Philadelphia, PA.

The following list of recommended actions will enable the City to improve the functioning of its floodplains, enhance existing public space, and increase its resiliency to minor and major flooding events:

- Pass a resolution to adopt the Ridley Creek Conservation Plan. This will make Chester City eligible for Department of Conservation and Natural Resource (DCNR) funds to implement strategies recommended in the plan. www.dcnr.state.pa.us/cs/groups/public/documents/document/D_001863.pdf
- Acquire and preserve existing vegetated, unprotected areas adjacent to Chester and Ridley creeks.
  - Identify the use and ownership of areas adjacent to Chester and Ridley Creek based on land use and tax parcel maps. Prioritize parcels for conservation easements or acquisition.
  - Identify and secure funding for this purpose by working with non-profit land conservation organizations and the Commonwealth.
- Manage City-owned property along Chester and Ridley creeks so as to preserve and restore natural vegetation in the floodplain (as recommended by the Chester Creek Conservation Plan).
  - Identify opportunities and specific locations to re-vegetate floodplains through tree plantings, meadow restoration programs and other techniques.
  - Identify and secure funding for these purposes.
- Identify opportunities to preserve, restore and create wetlands within parcels owned or controlled by the City.
  - Identify and secure funding for these purposes.
- Provide restoration technical assistance (i.e., riparian buffer restoration, streambank stabilization, etc.) and incentives to maintain vegetated riparian buffers for private property owners.
- Work with the Delaware County Conservation District and the Delaware County Planning Department to develop and adopt a set of codes (i.e., floodplain ordinances, stream buffer ordinances, creek protection overlay districts) to protect and promote vegetated riparian buffers, construct stormwater BMPs (see below, Strategy 7), and discourage additional development and construction of impervious surfaces in the floodplain.
- Enhance Chester's existing floodplain management ordinance to limit development in (and restore) the floodplain. Examples of how municipalities in the Chester and Ridley Creek watersheds have or can exceed the minimum ordinance requirements are included below:
  - No principle structures in the "floodway".
  - A minimum 50 foot setback for all impervious construction (measured from the top of the bank) from all streams having either no 100-year floodplain or a 100-year floodplain of less than 50 feet in width.
  - No clearing of trees or vegetation in the floodway (Middletown and Concord townships)

- Adopt stormwater Best Management Practices (BMP) for new development into land development and subdivision ordinances (see Strategies 5 and 7).
- Require erosion and sedimentation control plans for all development.
  - Adopt a set of maps and plans to identify where the city intends to preserve open space, restore vegetation and construct stormwater wetlands, and set targets for acres of wooded lands and wetlands.
- Construct a demonstration stormwater wetland on City-owned land that will offset the impact of future flooding.

Strategy 7: Develop a Plan to Implement Green Stormwater Infrastructure (GSI)

Impervious surfaces, such as roadways, buildings and parking lots, are characteristic of urban landscapes. As land development increases, pervious areas (e.g., woodlands and wetlands) are replaced with impervious surfaces (e.g., cement). An increase in the percent of land covered by impervious surfaces increases the volume of stormwater runoff to streams and rivers and leads to more combined sewer overflow incidents. Urbanization of Chester's natural areas affects Chester's watersheds by impairing water quality, degrading streams, and increasing flooding in neighborhoods and local waterways after storms. Problems with existing water quality and the infrastructure in flood-prone areas will be exacerbated by the increase in intensity and frequency of extreme rainfall events anticipated due to climate change.

Strategies 5 and 6 explored opportunities to manage land adjacent to Chester's waterways or return it to its natural vegetated state. However, given that most of Chester is heavily developed, the area on which that strategy can be implemented is limited. *Green stormwater infrastructure* (GSI) can be used on developed parcels to effectively manage stormwater and avoid many of the worst consequences of urban runoff. Simultaneously, GSI can provide greenery and visual relief in harsh urban landscapes.

Green stormwater infrastructure mimics the functions of naturally-vegetated systems such as woodlands, meadows and wetlands. GSI includes a range of systems that integrate soil, water, and plants to intercept stormwater, infiltrate a portion of it into the ground, evaporate a portion of it into the air, and in some cases release a portion of it slowly back into the sewer system. Examples include rain gardens, bioswales, tree trenches, planter boxes, and green roofs. GSI can be integrated into the urban fabric, i.e. streets, sidewalks, parking lots, lawn areas and schoolyards, at a variety of spatial scales. Additionally, through a citywide education program, individual property owners can be encouraged to voluntarily implement small scale improvements such as re-directing downspouts to rain barrels and rain gardens.

Goal

Reduce stormwater runoff volume and combined sewer overflows (CSO) to minimize flooding and improve water quality.

Solution

Develop a plan to implement green stormwater infrastructure throughout the city. The plan should identify funding sources, provide an overview of green stormwater infrastructure techniques, and identify opportunities and locations for installing green stormwater infrastructure in a variety of settings. Identifying locations to site green stormwater infrastructure will require an understanding of soil types, drainage patterns and the location or presence of underground utilities. The plan should also identify partners in the private and public sectors that can assist in achieving these goals. Chester City can choose to set specific goals such as managing (infiltrating) runoff from the first inch of rainfall through the use of green stormwater infrastructure techniques (required by the stormwater ordinance).

Learning from others

Philadelphia Water Department's Green City Clean Waters program was developed to meet regulatory obligations while improving water resources and helping to revitalize the city. To meet complex environmental, demographic and financial challenges as well as customer expectations for a safe and affordable water supply; PWD had to choose between significant new investments in "grey" infrastructure (underground storage tanks and pipes) or a paradigm shift in its approach to urban water resources. Adopted in 2011, *Green City, Clean Waters* is Philadelphia's 25-year plan to protect and enhance its watersheds by managing stormwater with innovative green stormwater infrastructure. It also serves as the City's Combined Sewer Outfall (CSO) Long Term Control Plan.

Figure 7. Rain garden on Passyunk Avenue, Philadelphia, PA.

Figure 8. Stormwater "bump-out" on Queen Lane, Philadelphia, PA.

The Philadelphia plan commits to reduce the negative impacts of stormwater flows on the city's sewer collection system, measured by the number of "Green Acres" added to the city that will capture and manage the first inch of stormwater. By the end of the 25-year plan period, the City of Philadelphia plans to invest $2.4 billion in green infrastructure projects and leveraged over $600 million in additional investments. These projects will capture and

infiltrate 85 percent of the stormwater now discharged to streams and rivers by combined sewer outfalls.

To develop an effective and successful plan for the City of Philadelphia, PWD conducted the following activities to better understand its sewer collection system, the workings of the watersheds located throughout Philadelphia, and the opportunities to manage stormwater in the city:

- Developed Integrated Watershed Management Plans in coordination with upstream suburban neighbors in Delaware, Montgomery and Bucks counties
- Conducted watershed-wide chemical and biological assessments to thoroughly understand the physical condition of the City's waterways, and the diversity and health of its water ecosystems
  - Implemented demonstration projects for stream renewal and stormwater management
  - Modeled and characterized the performance of the City's sewer collection system
  - Constructed additional sewer storage capacity
  - Implemented new regulations to manage stormwater for development
  - Sponsored regional, watershed-based stormwater management planning
  - Transitioned to a parcel-based stormwater fee

The program calls for a wide variety of green stormwater infrastructure projects to be installed in streets and sidewalks, schoolyards and parking lots, alleys and driveways, and parks and public lands throughout the city. In addition, the following are also included:

- Green Stormwater Infrastructure (GSI) requirements for private lands
- Tree plantings on streets throughout the city
- Additional access and enhanced recreation on waterways
- Stormwater management practices installed on open spaces
- Vacant and abandoned properties conversion to open space
- Stream restoration projects to enhance aquatic habitats
- Improvements to (gray) stormwater management infrastructure

Recommended Actions

The City of Chester should plan to implement green stormwater infrastructure at a variety of scales. First steps should focus on education, pilot projects, and identifying funding sources and revenue streams. The following recommendations are designed to aid in the rollout and implementation of a GSI plan for Chester.

Reduce Volume of Stormwater Runoff

- Create or adopt a GSI manual for city planners and developers
- Promote natural (green) approaches to stormwater retention such as green stormwater infrastructure (GSI) through the stormwater management plan
- Incorporate GSI requirements into the floodplain management ordinance and Flood Protection Overlay Districts
- Incorporate GSI requirements into the land development and subdivision ordinances and development codes
  - Incentivize (or require) developers to include GSI in large scale development and re-development projects and create a mechanism for project review.
- Incorporate GSI into transportation and road improvement projects.
- Partner with the City of Philadelphia and institute a "technology transfer program" to capitalize on the Philadelphia Water Department's GSI work.
- Identify partners and potential funding sources to implement pilot or demonstration GSI projects in publicly controlled spaces – streets, sidewalks, municipal parking lots, schoolyards, and parks.
- Seek state and federal funding for GSI projects.

Minimize Combined Sewer Overflow Incidents

- Use GSI as a tool within DELCORA's long-term CSO control plan.
- Compare the cost of using green infrastructure to control combined sewer overflows as opposed to "gray" infrastructure. Redirect funds from gray to green infrastructure where appropriate

SECTION V: Moving Forward

The City of Chester is at a critical juncture for revitalizing the City while building resiliency to future storms and extreme heat. Hazard and climate planning recommendations are offered at a time when the City is embarking on rewriting its zoning code and beginning to implement the *Vision 2020*. This synthesis report is designed to serve as a blueprint that will allow individual projects to be incorporated into an overarching, coherent plan for future resilience. As the City moves to the implementation stage of the climate adaptation process, some steps outlined in this synthesis report will unfold sequentially while others can be accomplished as opportunities arise.

Now that Chester City Council has adopted these Climate Adaptation Planning Elements into the Vision 2020, some practical next steps emerge that would complement ongoing efforts and continue the momentum generated by the Climate Adaptation Project Team and Task Force. The following measures from each strategy are recommended as initial next steps.

Strategy 1:

- Reinstate the Chester City Environmental Advisory Council with a focus on overseeing the implementation of adaptation strategies and identifying adaptation implementation grants. Priority should be placed on the immediate (within 3 years), low-cost measures summarized in Appendix A.
- Task the EAC to coordinate their efforts with ongoing efforts including:
  - The rewriting of Chester Zoning Ordinances
  - The EPA Strong Cites, Strong Communities (SC2) initiative
  - Brownfield inventory, assessment, and remediation initiatives

Strategy 2:

- Seek federal and state funding to begin post-storm redevelopment planning efforts.

Strategy 3:

- Collaborate with partners to create a heat emergency plan and communication program for at-risk populations.

Strategy 4:

- Initiate the National Flood Insurance Program CRS certification by identifying a CRS coordinator and outlining existing programs that contribute points for certification.

Strategy 5:

- Improve floodplain management along Chester and Ridley creeks and the Delaware Riverfront through recognizing an Expanded Flood Risk Area and adopting voluntary and mandatory flood protection standards for re-building and new development.

Strategy 6:

- Adopt the Ridley Creek Conservation Plan.
- Work with Delaware County to develop and adopt codes that protect and restore natural vegetation in the floodplain.
- Map areas and establish goals for open space preservation, re-vegetation of wetlands and other natural buffer areas, and wetland construction.

Strategy 7:

- Identify sites and contexts appropriate for green stormwater infrastructure (GSI).
- Compare the costs of “gray” to “green” infrastructure.
- Create a green stormwater infrastructure manual to guide developers, landowners, watershed organizations, and City planners.

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APPENDIX A: Summary Table of Adaptation Strategies

Recommendation	Responsible Entity	Potential Funding Sources	Estimated Cost to City
Strategy 1: Create an Environmental Advisory Council (EAC)			
Reinstate Environmental Advisory Council	City Council	None Needed	Low: <$100k
Strategy 2: Engage in a Post-Storm Redevelopment Planning Process			
Seek Federal or State funding and outside assistance to begin the planning process.	EAC	Identify agencies, grants, city, or private funding available for creating post-disaster redevelopment plans.	Low: <$100k
Engage with regional partners to share resources, learn from eachother, and add to a more integrated regional plan for post-disaster recovery.	EAC, the City of Chester, other business and public stakeholders	Seek federal, state, and private funding for technical aspects of the planning process. For example, EPA has offered Chester technical assistance to analyze brownfield properties in vulnerable areas and recommend the types of land-use tools available to help create natural buffers on selected sites.	Low: <$100k
Strategy 3: Develop a Heat Emergency Plan			
Create a Heat Emergency Plan	EAC, the Planning Department, Emergency Managers, and other city agencies	PA Coastal Resources Management, Delaware Valley Regional Planning Commission, State funds, Federal funds, or other grant opportunities.	Low: <$100k
Develop Health Communications Materials	City of Chester, Chester Health Department, Chester health care providers, PA Sea Grant	PA Coastal Resources Management, Delaware Valley Regional Planning Commission, State funds, Federal funds, or other grant opportunities.	Low: <$100k
Coordinate Programming	City of Chester, Chester Health Department, Senior Centers, Chester Housing Authority, Chester Church Community, and Schools	PA Coastal Resources Management, Delaware Valley Regional Planning Commission, State funds, Federal funds, or other grant opportunities.	Medium: <$600k

Improve Infrastructure	Individual building owners and developers, the Shade Tree Commission, City of Chester, Chester Department of Parks and Recreation	Funding for individual building owners may be available through Coastal Management, the Delaware Valley Regional Planning Commission, State funds, Federal funds, or other grant opportunities.	Low: <$100k (mostly costs external)
Strategy 4: Seek Certification in the National Flood Insurance Program Community Rating System (CRS)			
Identify a CRS coordinator and initiate steps necessary to join and maintain certification.	City Planning with City Emergency Management officials	Not Applicable	Low: <$100k (mostly staff time)
Identify floodplain management and climate adaptation strategies to enhance resiliency and increase points for CRS activities.	City Planning with Emergency Management officials and CRS Coordinator.	State and federal agencies, grants, city, or private	Low: <$100k (mostly staff time)
Strategy 5: Improve Floodplain Management			
Create Overlay Districts	City Council	Couple with zoning code updates	Low: <$100k
Create Standards for Overlay Districts	City Planning, EAC	FEMA/PEMA, DVRPC, National Fish and Wildlife Foundation	Low: <$100k
Create incentives to limit development in "high risk flood areas," as delineated by the Flood Protection Overlay District.	Department of Planning, Emergency Managers, and other city agencies	Identify agencies, grants, city, or private sources.	Low: <$100k (mostly staff time)
Upgrades and Development Practices: Building owners and developers can adopt additional voluntary measures to increase building resilience to periodic inundation of ground level facilities.	Individual building owners and developers	Coastal Zone Management, the Delaware Valley Regional Planning Commission, State funds, Federal funds.	Low: <$100k (mostly costs external)

Recommendation	Responsible Entity	Potential Funding Sources	Estimated Cost to City
Strategy 6: Expand Vegetated Buffers, Restore Wetlands and Streams, and Protect Open Space			
Work with Delaware County to develop and adopt codes that protect and restore natural vegetation in the floodplain.	Chester City, EAC, Delaware County Conservation District, DCPD	City funds, outside grants	Low: <$100k
Protect natural areas adjacent to Ridley and Chester creeks through acquisitions and easements	Chester City	Federal/state agencies, DCNR, non-profit land trusts	High: >$600k
Restore natural vegetation on publicly-owned lands	Chester City, DCCD	PennVEST, DCNR, city funds	Low: <$100k
Adopt the Ridley Creek Conservation Plan	Chester City	Administrative	Low: <$100k
Institute landowner assistance program to encourage stream protection and stewardship.	Chester City, EAC, DCCD		Low: <$100k
Construct a demonstration stormwater wetland on city-owned land	Chester City, EAC, DELCORRA	Wetland mitigation funds	High: >$600k
Map areas and establish goals for open space preservation, re-vegetation, and wetland construction	Chester City, EAC		Low: <$100k
Strategy 7: Develop a Plan to Implement Green Stormwater Infrastructure (GSI)			
Incorporate GSI into ordinances and codes	Chester City, EAC, DCPD, DVRPC	City funds, DECD, outside grants	Low: <$100k
Create or adopt a GSI manual or guide	Chester City	City funds, DCNR, DVRPC	Low: <$100k
Use GSI as a tool within DELCORA's long-term CSO control plan	DELCORA, Chester City		Low: <$100k

APPENDIX B: Model Environmental Advisory Council Ordinance

Ordinance No.

AN ORDINANCE OF CITY OF CHESTER, DELAWARE COUNTY, PENNSYLVANIA CREATING AN ENVIRONMENTAL ADVISORY COUNCIL

WHEREAS, the City of Chester recognizes the importance of maintaining waterway buffers, green space, and shade trees throughout the City;

WHEREAS, the General Assembly of Pennsylvania enacted legislation, Act 148 of 1973, 53 P.S. §11501, et seq. (hereinafter referred to as the "Act"), authorizing municipalities to establish, by ordinance, an Environmental Advisory Council to advise the municipality's planning commission, park and recreation board and electoral affiliates on matters dealing with protection, conservation, management, promotion and use of natural resources located within the municipality's territorial limits;

WHEREAS, the City of Chester is committed to the identification, preservation and protection of the natural resources within the City in order to enhance the City and provide guidance and information to residents of the City in the use of natural resources;

WHEREAS, the City of Chester wishes to reinstate an Environmental Advisory Council having the purpose and composition as established under the Act.

NOW, THEREFORE, pursuant to the authority conferred by the Act, the City of Chester does hereby enact and ordain the Environmental Advisory Council Ordinance, as follows:

SECTION 1. Environmental Advisory Council. The Chester Environmental Advisory Council is hereby created, having the powers and operating procedures set forth in this ordinance, and shall continue in existence until this ordinance is revoked.

SECTION 2. Powers of the Environmental Advisory Council. The Environmental Advisory Council shall have the following powers:

a. To identify environmental problems and recommend plans and programs to the City Council, the Planning Commission and other committees and boards of the Township for the promotion and conservation of the natural resources and for the protection and improvement of the quality of the environment within the City.

b. To make recommendations as to the possible use of open land areas of the City.

c. To promote a community environmental program.

d. To keep an index of all open space areas, publicly or privately owned, including, but not limited to, flood prone areas, wetlands and other unique natural areas, for the purpose of obtaining information on the proper use of such areas.

e. To help implement elements of the climate adaptation plan including monitor and organize heat captains throughout the City.

f. To perform such other duties and responsibilities authorized by the Act and delegated by the City Council.

SECTION 3. Members and Term of Office.

a. The Environmental Advisory Council shall be composed of at least five (5), but no more than seven (7), residents of the City who shall be appointed by the Council. Any vacancies in the membership of the Council shall be filled by Council members

b. The EAC shall also include at-large members to provide outside expert as necessary for following through on its duties and activities. At-large members shall include no more than 7 members representing non-governmental organizations, universities, companies, or other entities as necessary to provide support to the other EAC members.

b. Duly appointed Council members shall serve for a term of three (3) years, except that the initial appointments to the Council shall be so staggered that the terms of approximately one-third (1/3) of the membership shall expire each year, the terms of their successors to be three (3) years each. Council members' terms of office shall expire on the first Monday in January following the last of their term of office.

c. The Council shall designate the chairperson of the EAC. The council may elect such other officers having specific responsibilities as the Council determines necessary to effectively carry out the Council's powers.

d. Whenever possible, one member of the EAC shall also be a member of the Planning Commission.

SECTION 4. Expenses. Members of the EAC shall receive no compensation for their services, but shall be reimbursed for the expenses actually and necessarily incurred by them in the performance of their duties.

SECTION 5. Reports. The EAC shall keep records of its meetings and activities and shall make an annual report which shall be made available in a manner consistent with the availability of annual reports by councils and committees.

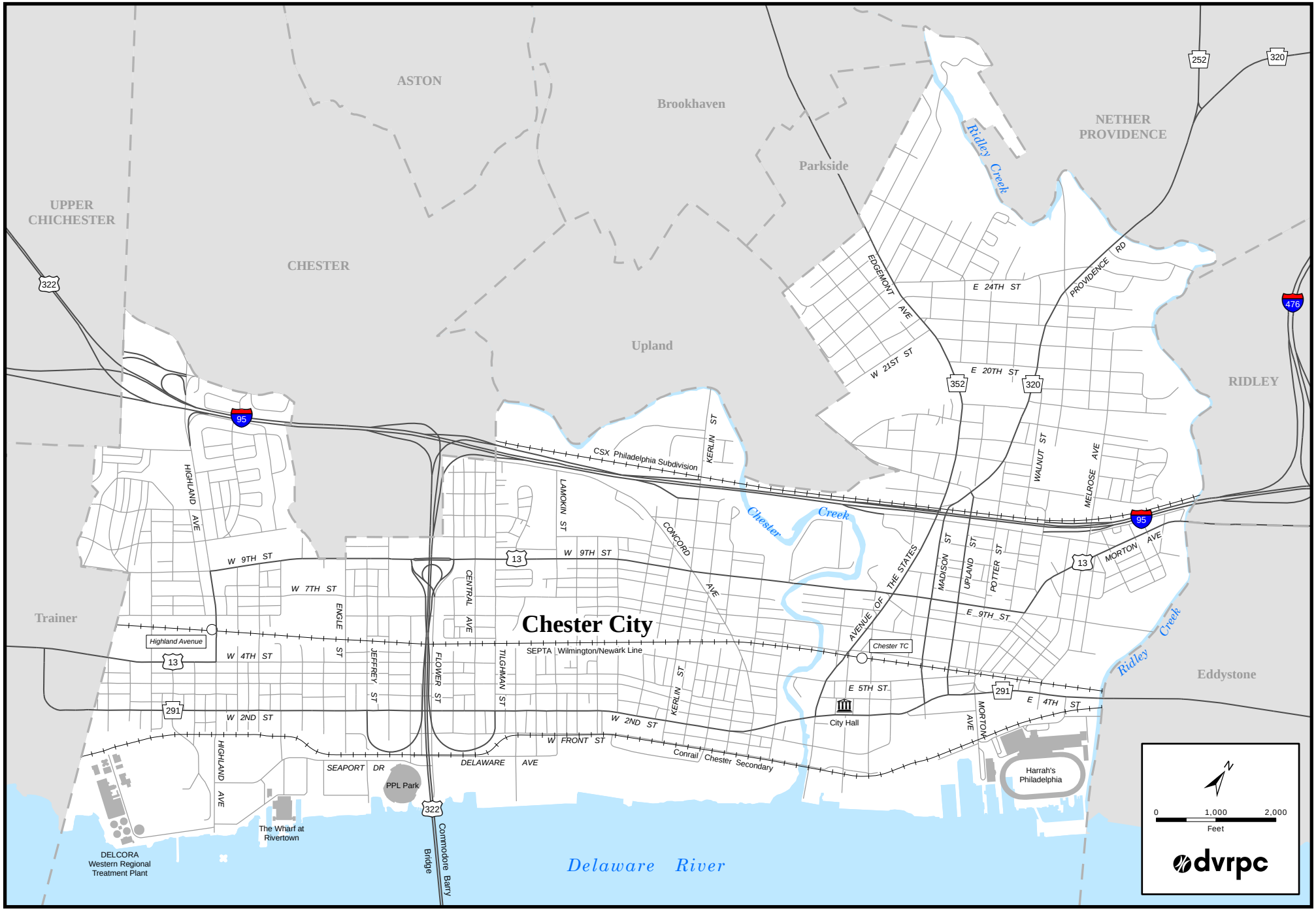
SECTION 6. Appropriations and External Funding.

a. The Council may appropriate funds for the expenses incurred by the EAC. Appropriations may be expended for such administrative, clerical printing and legal services as may from time to time be required and as shall be within the limit of funds appropriated to the EAC. The whole or part of any funds so appropriated in any year may be placed in a conservation fund allowed to accumulate from year to year, or be expended in any year.

b. The EAC may seek funding for specific programs and projects pursued by the EAC on behalf of the City, with the approval of the Council. Sources of funding include grants and other forms of financial assistance from County and State agencies.

ENACTED AND ORDAINED DATE:

Study Area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Ridley Creek
Chester Creek
CSX Philadelphia Subdivision
SEPTA Wilmington/Newark Line
Conrail Chester Secondary
Delaware River
Commodore Barry Bridge
DELCORA Western Regional Treatment Plant
The Wharf at Rivertown
PPL Park
Harrah's Philadelphia
City Hall
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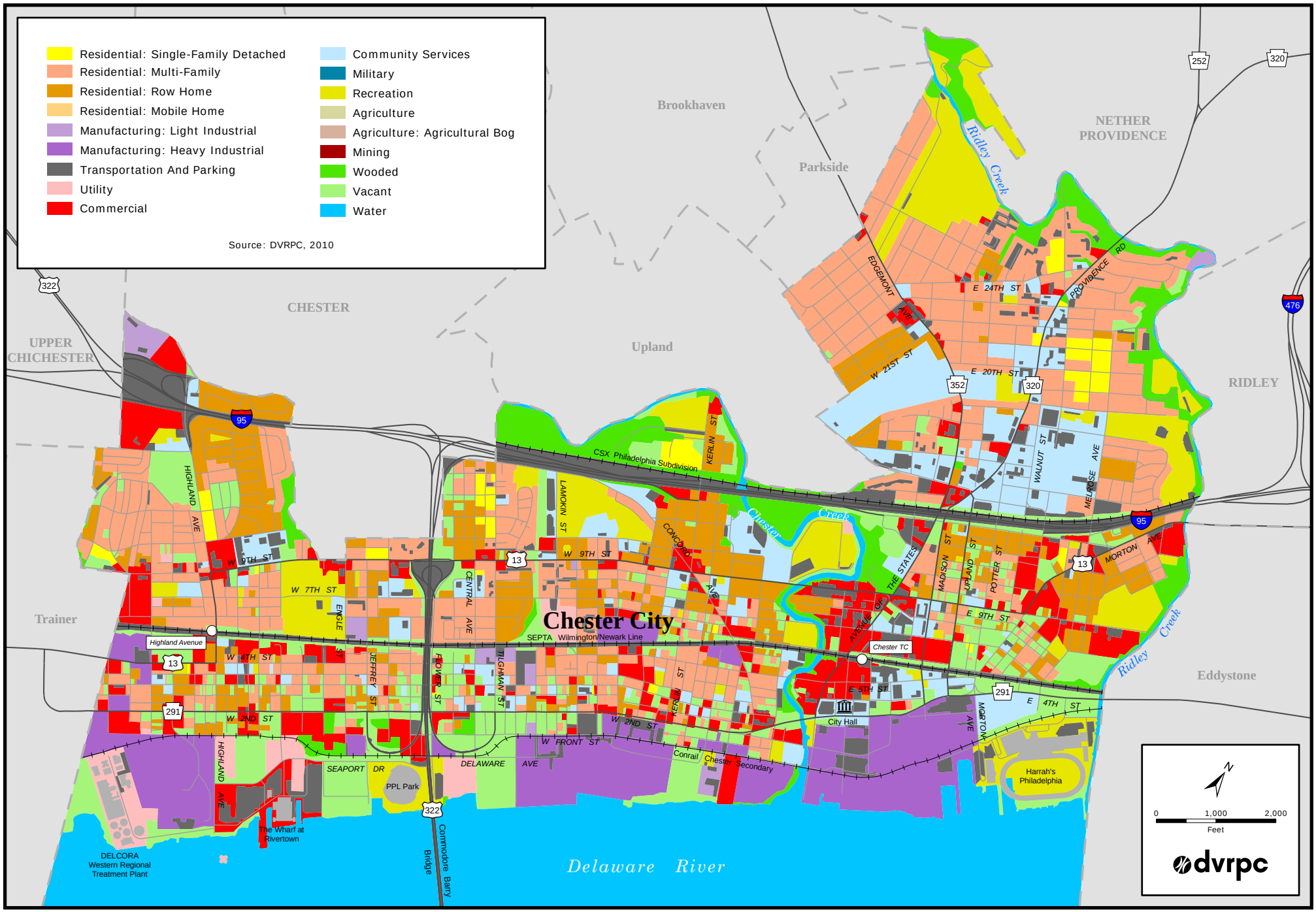
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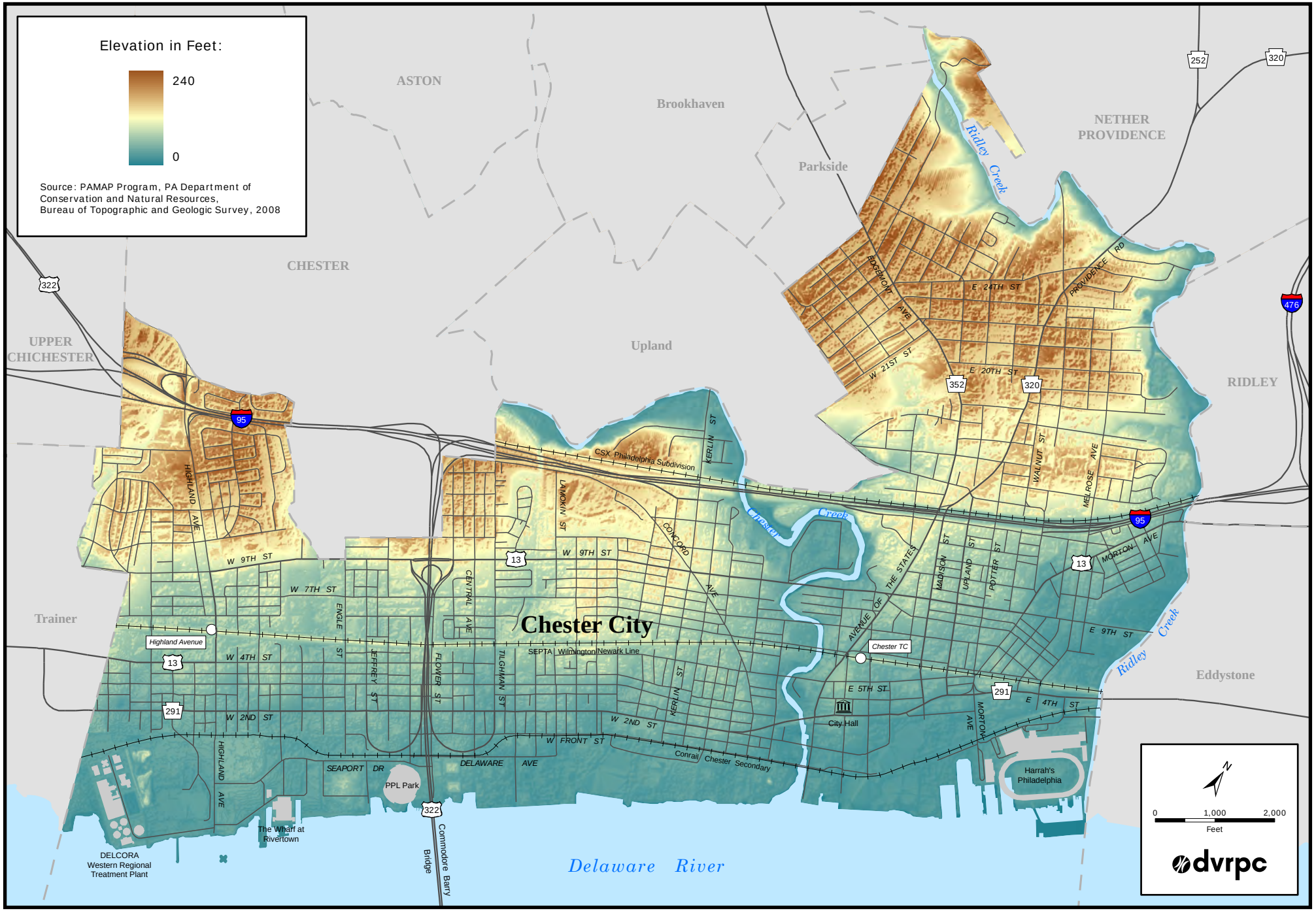
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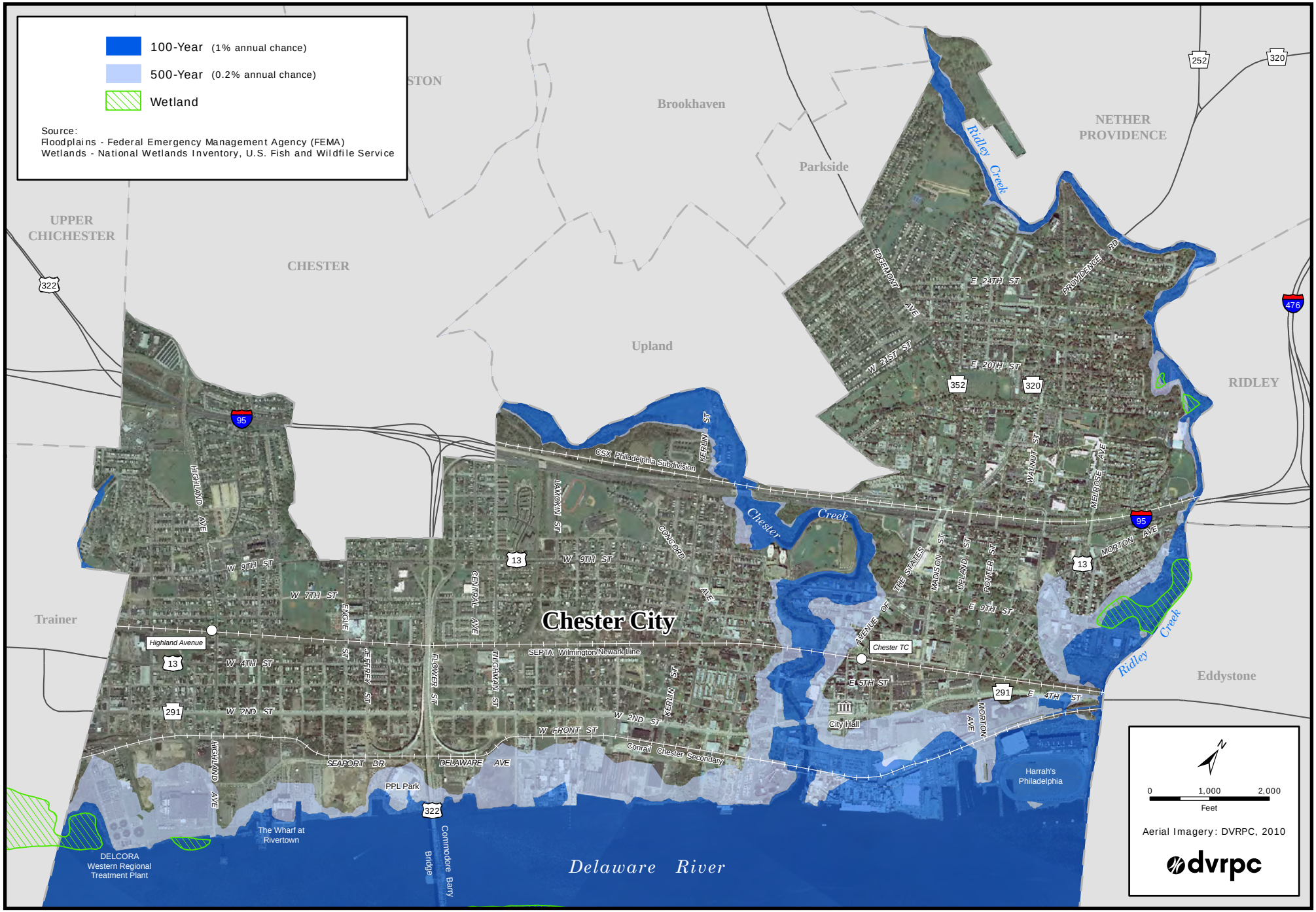
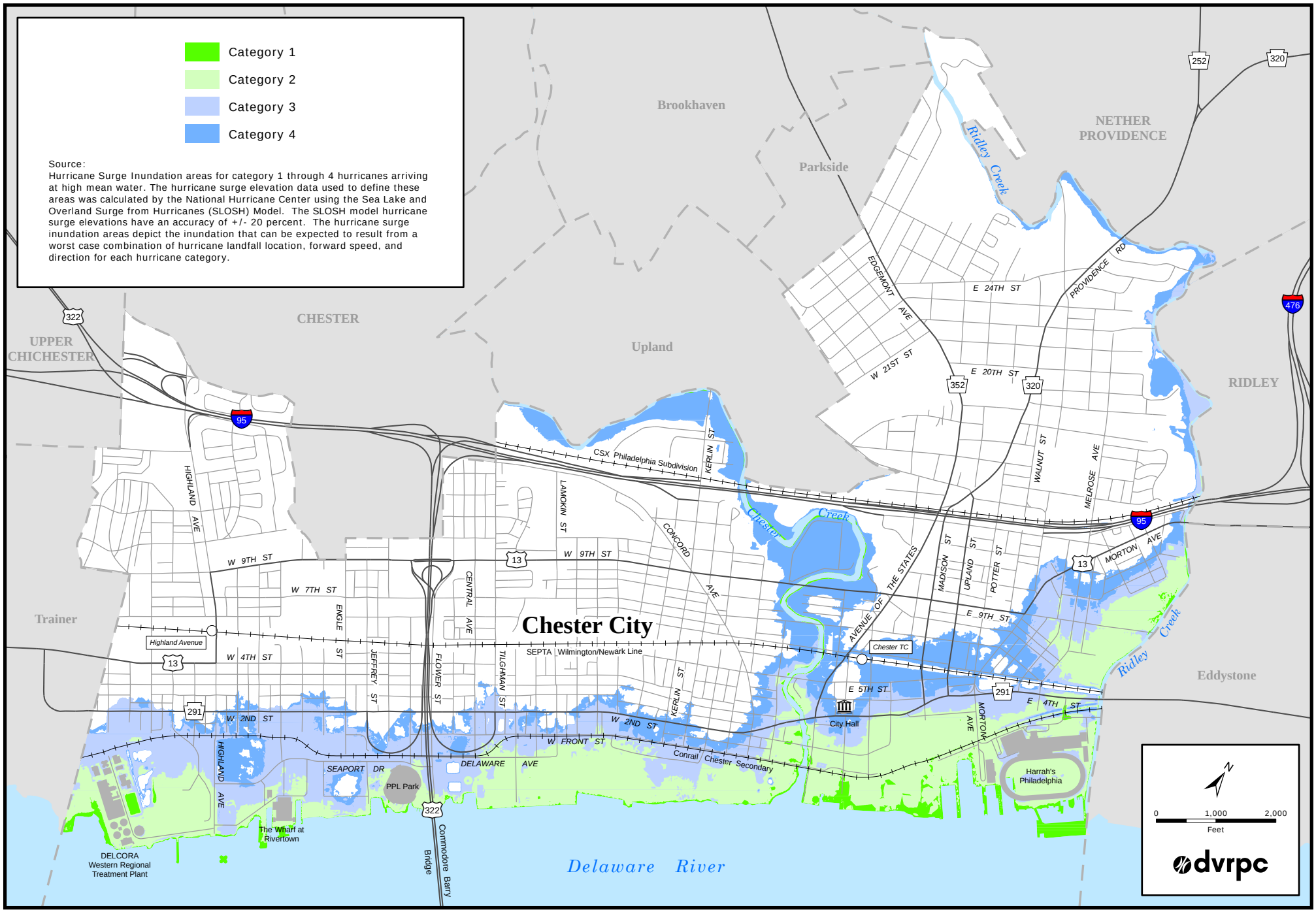
dvrpc

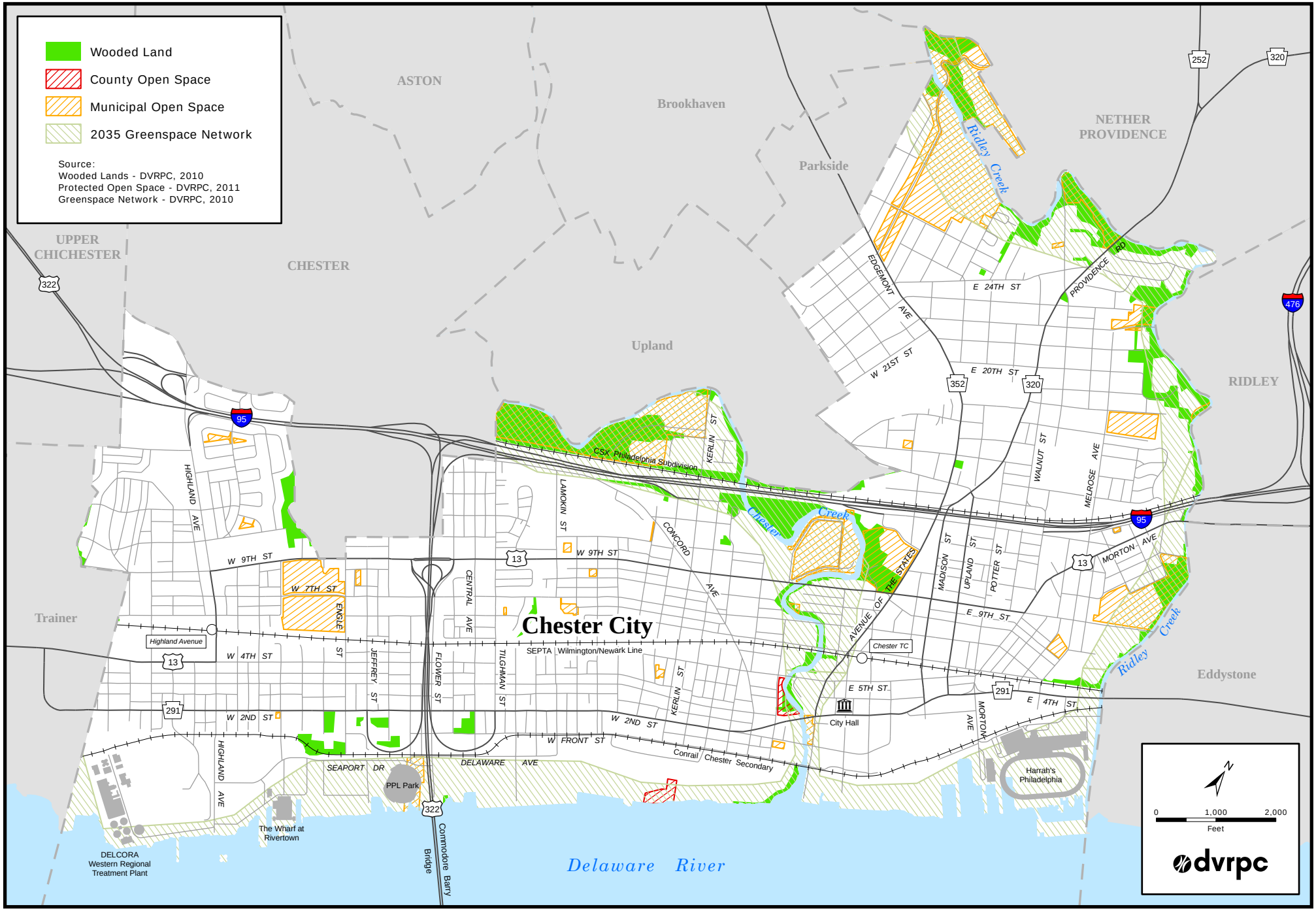
Floodplains and Wetlands



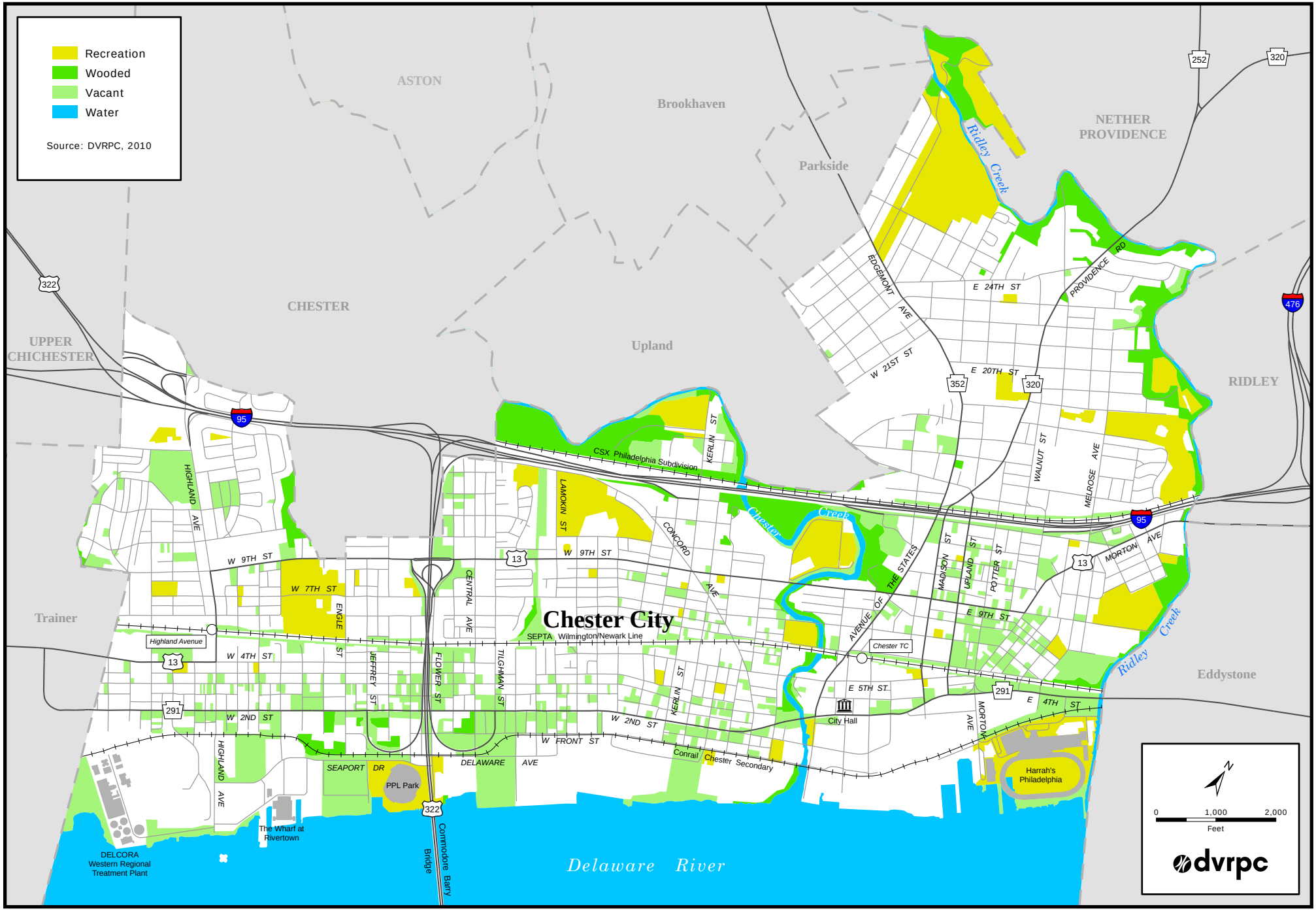
Hurricane Surge Inundation



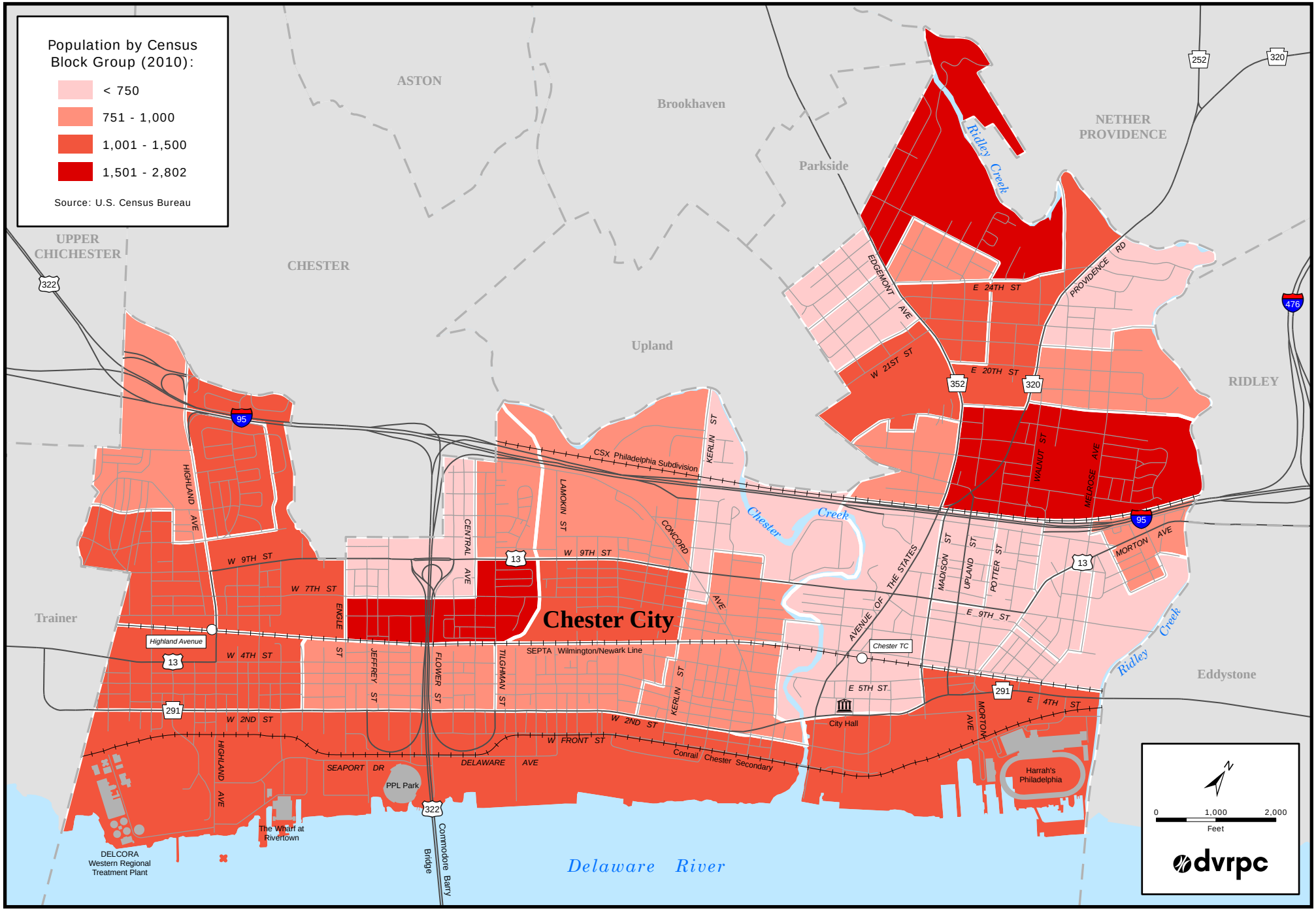
Wooded Lands and Open Space



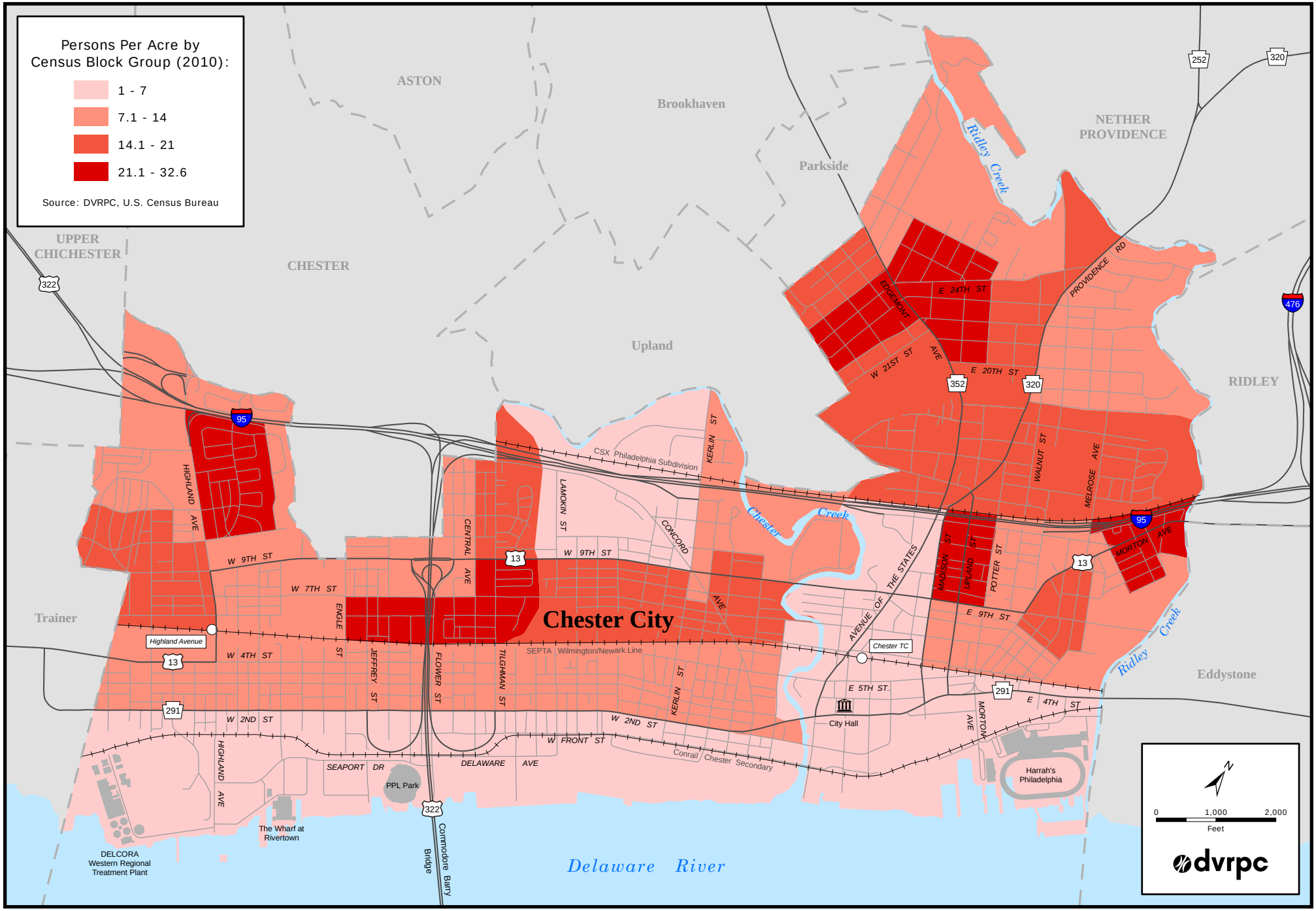
Adaptation Opportunity Areas



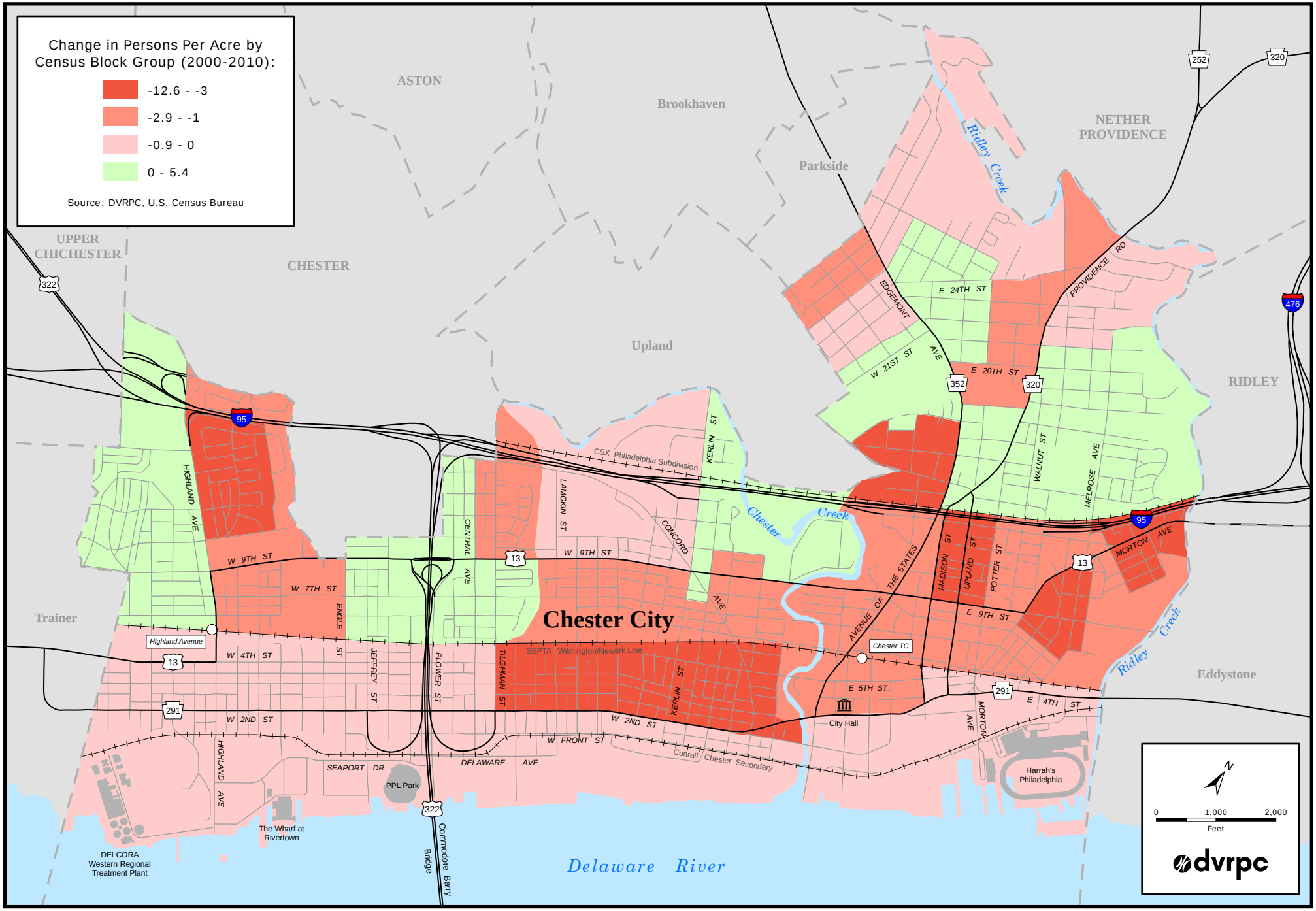
Population


Population by Census Block Group (2010):
< 750
751 - 1,000
1,001 - 1,500
1,501 - 2,802
Source: U.S. Census Bureau
ASTON
Brookhaven
Parkside
NETHER PROVIDENCE
UPPER CHICHESTER
CHESTER
Upland
RIDLEY
Trainer
Eddystone
Chester City
Ridley Creek
Chester Creek
CSX Philadelphia Subdivision
SEPTA Wilmington/Newark Line
Conrail Chester Secondary
Delaware River
Commodore Barry Bridge
DELCORA Western Regional Treatment Plant
The Wharf at Rivertown
PPL Park
Harrah's Philadelphia
City Hall
Chester TC
Highland Avenue
E 24TH ST
W 21ST ST
E 20TH ST
W 9TH ST
W 7TH ST
W 4TH ST
W 2ND ST
W FRONT ST
E 9TH ST
E 5TH ST
E 4TH ST
SEAPORT DR
DELAWARE AVE
PROVIDENCE RD
EDGEMONT AVE
HIGHLAND AVE
CENTRAL AVE
LAMOKIN ST
KERLIN ST
CONCORD AVE
WALNUT ST
MELROSE AVE
MADISON ST
UPLAND ST
POTTER ST
THE STATES AVENUE OF
MORTON AVE
ENGLE ST
JEFFREY ST
FLOWER ST
TILGHMAN ST
322
95
476
252
320
352
13
291
0
1,000
2,000
Feet
dvrpc

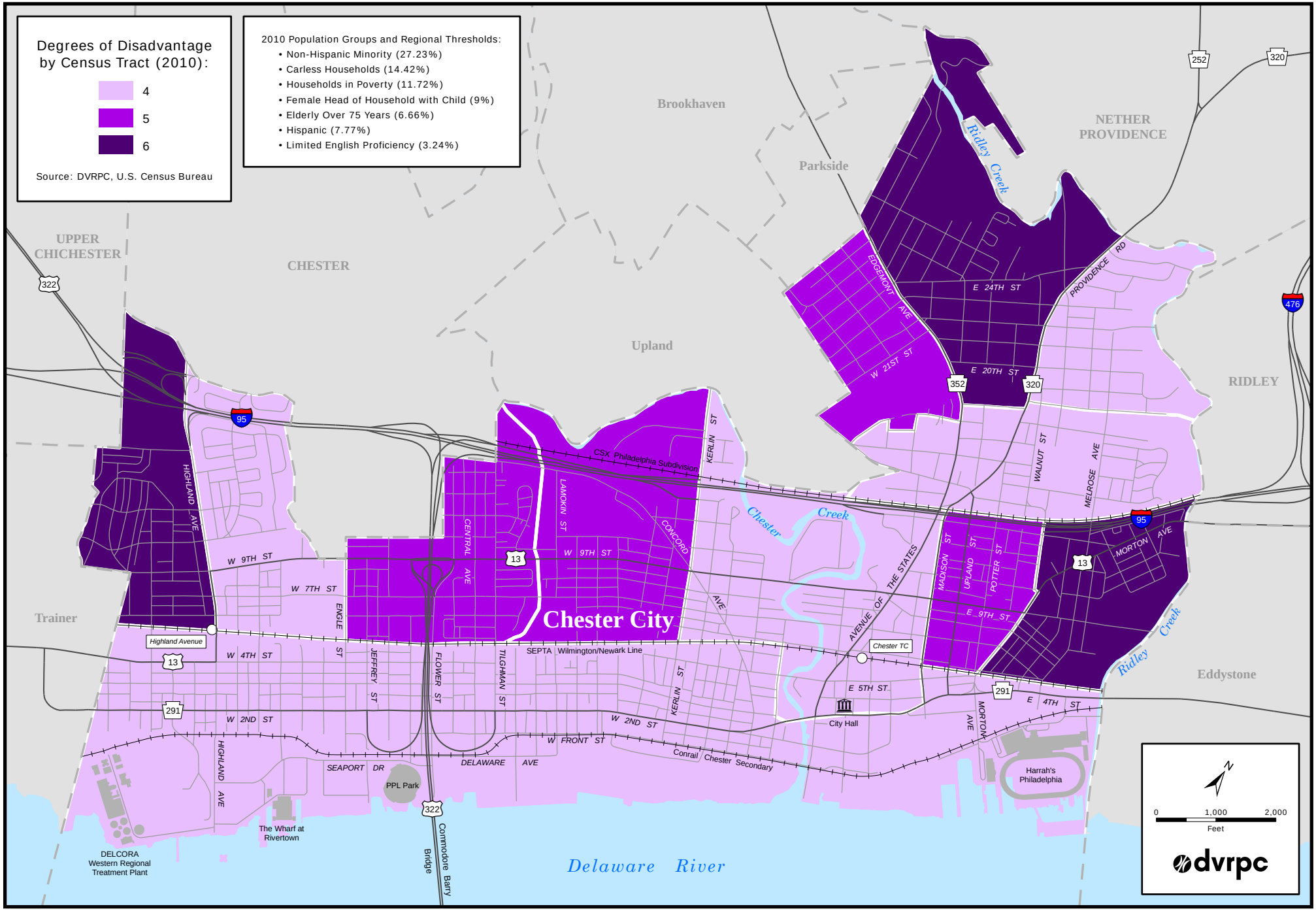
Population Density



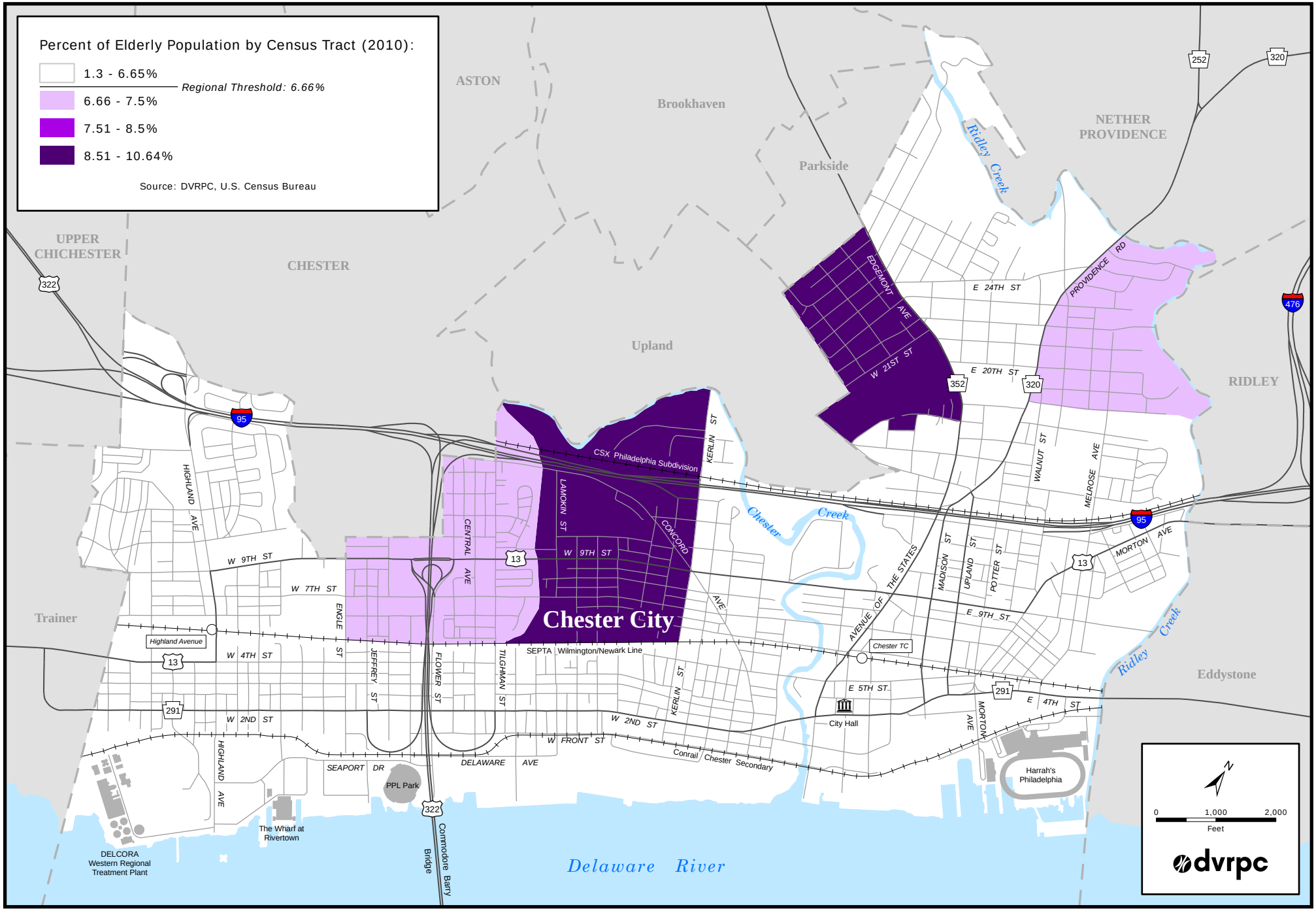
Population Density Change



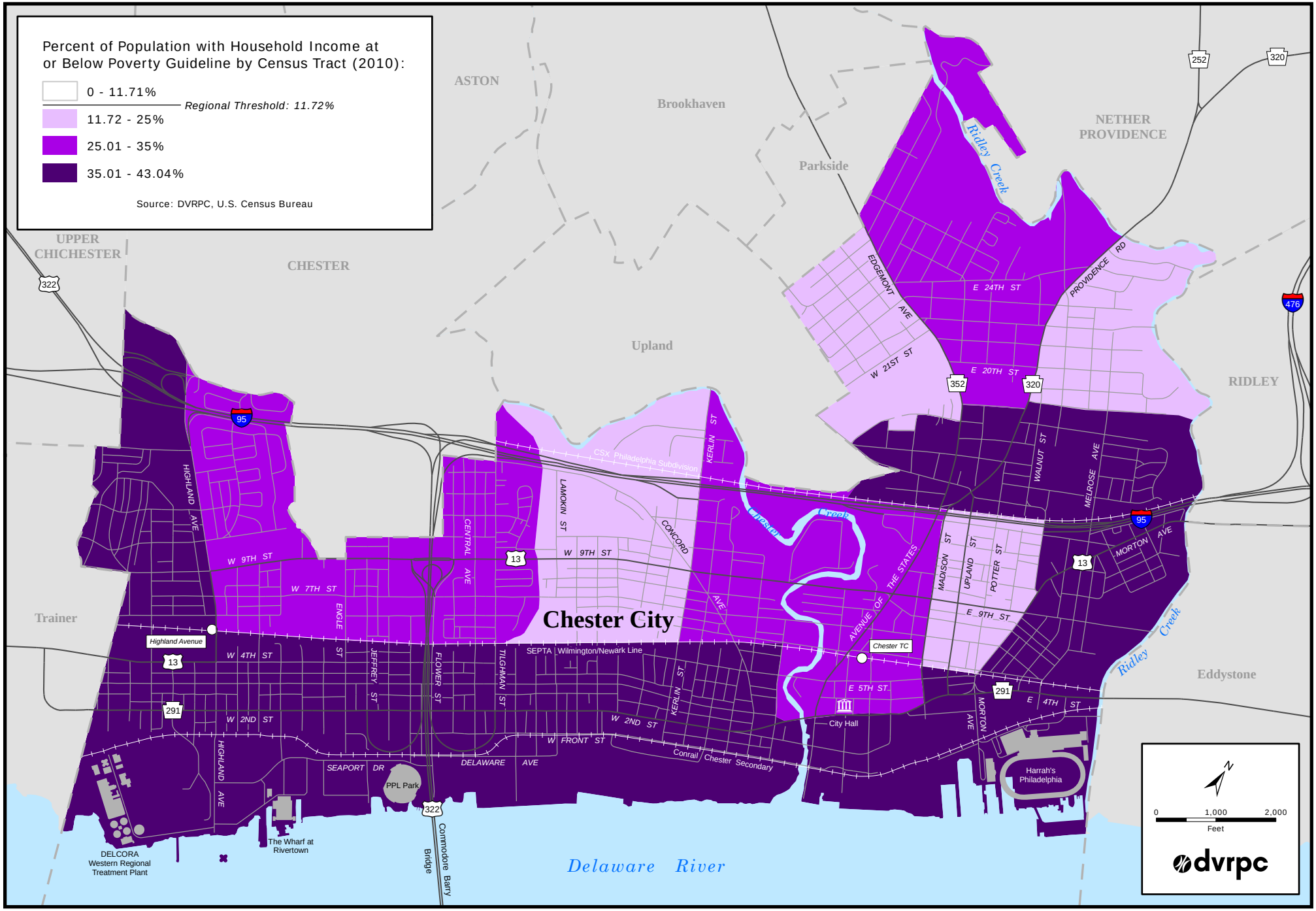
Degrees of Disadvantage



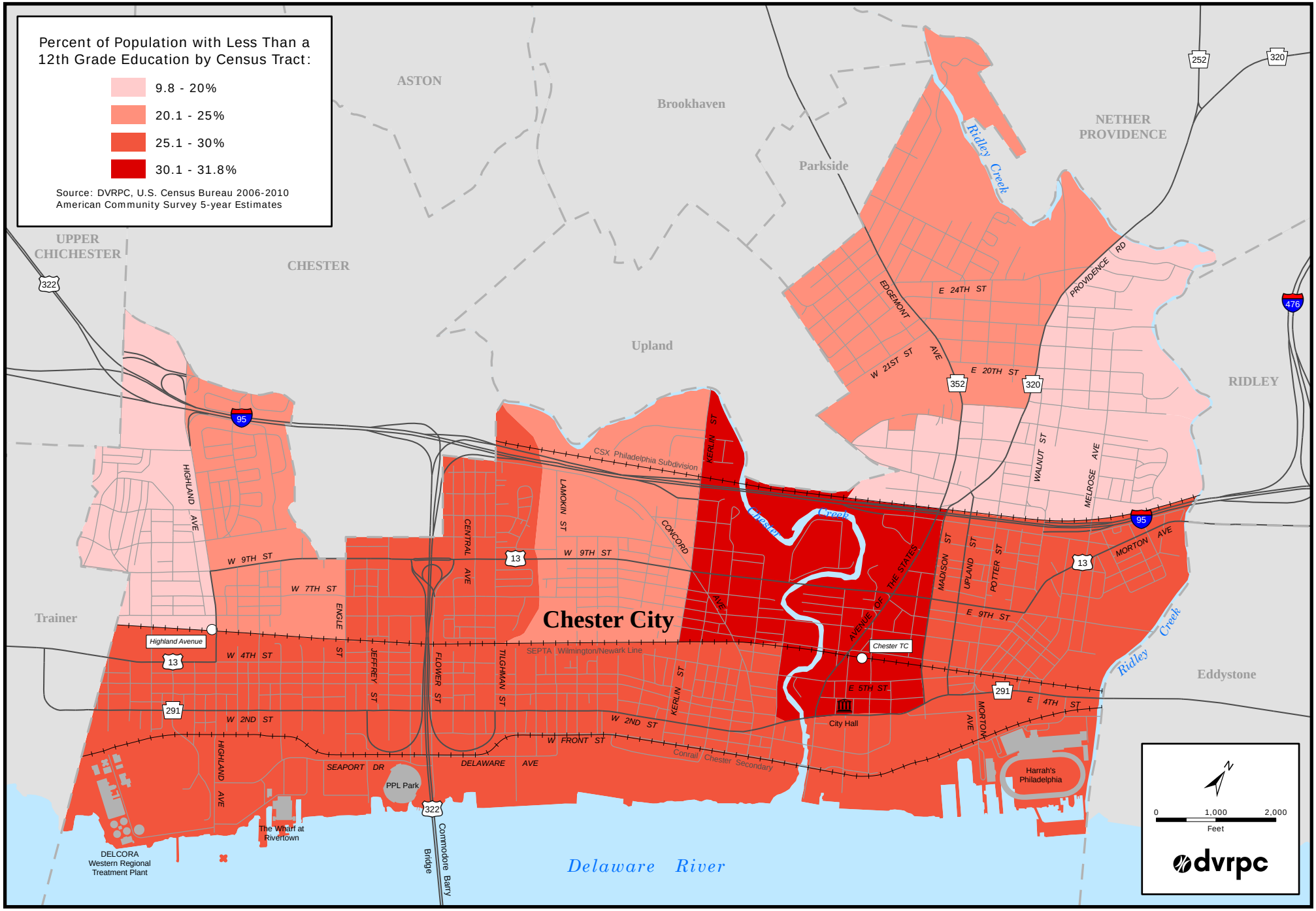
Elderly (75 Years and Over) Population Concentrations



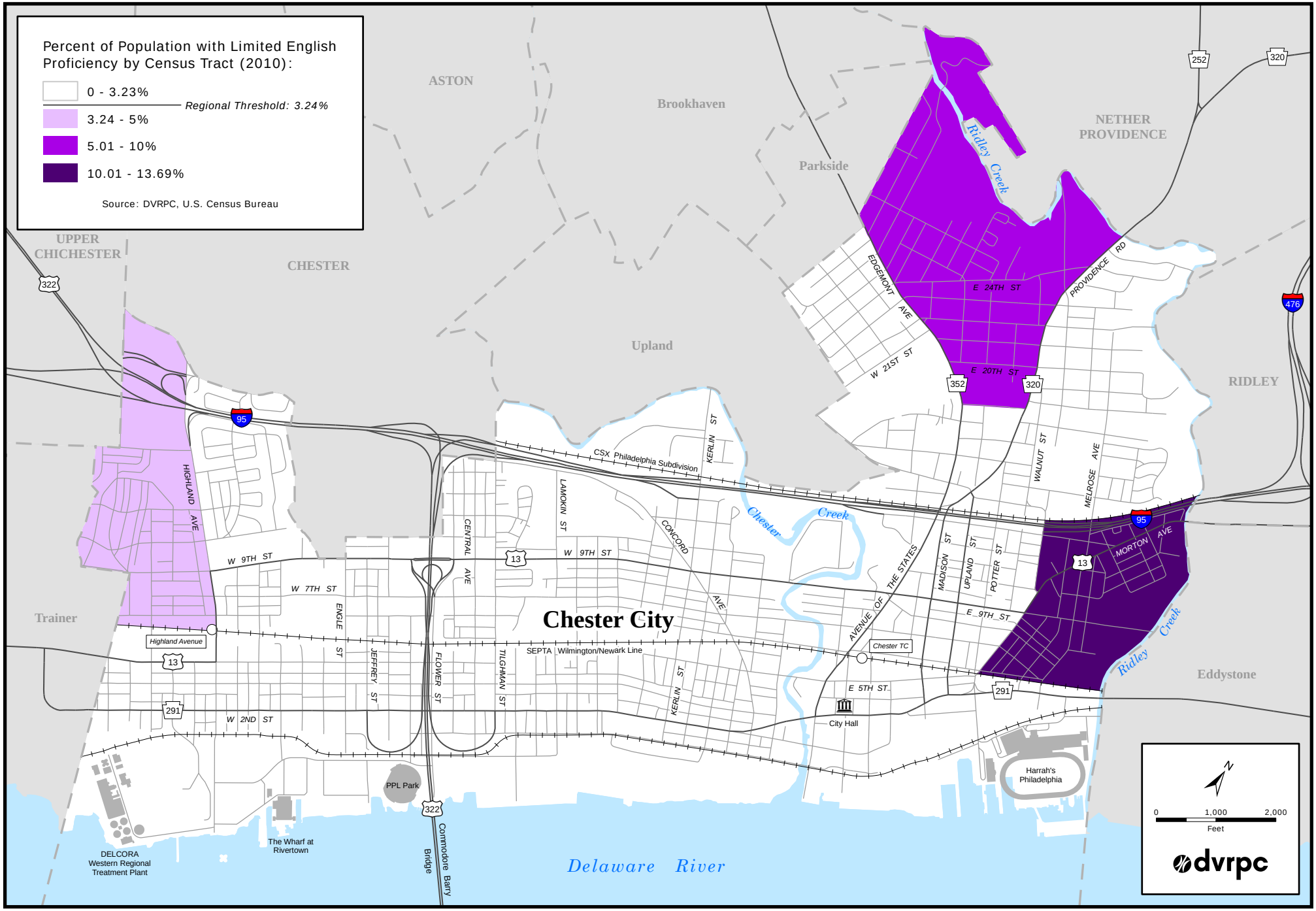
Concentrations of Households in Poverty



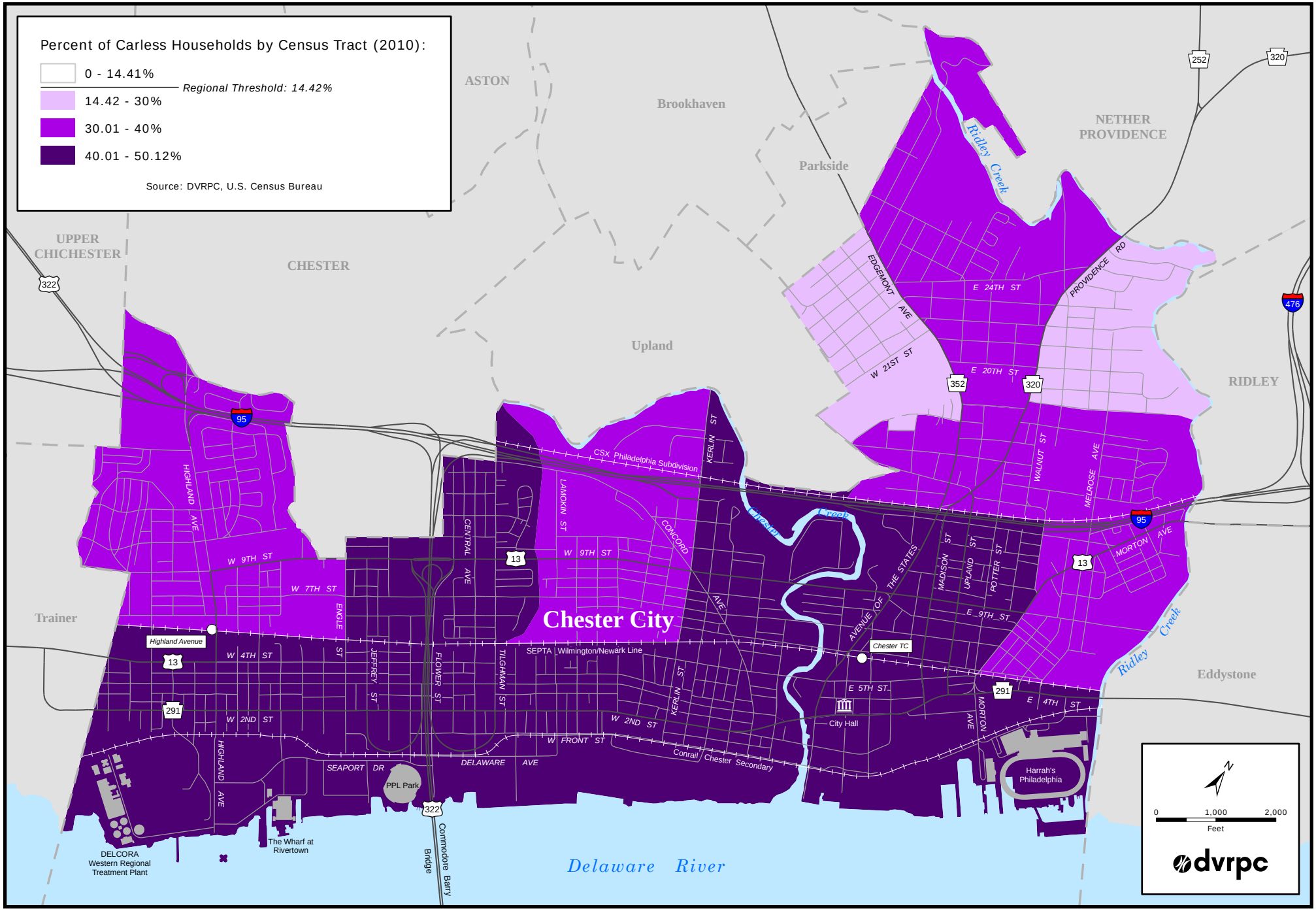
Population with Less Than a 12th Grade Education



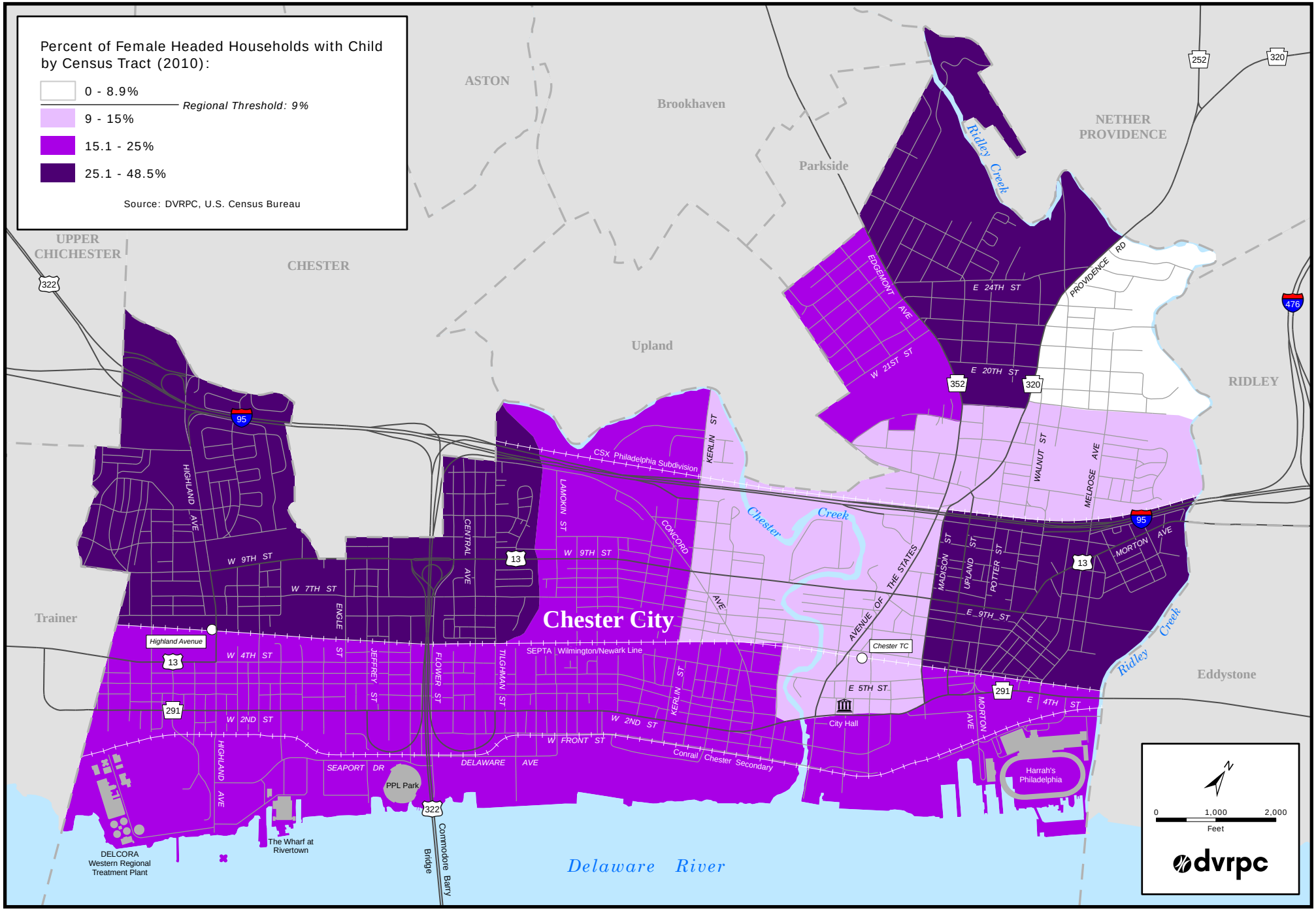
Limited English Proficiency Population Concentrations



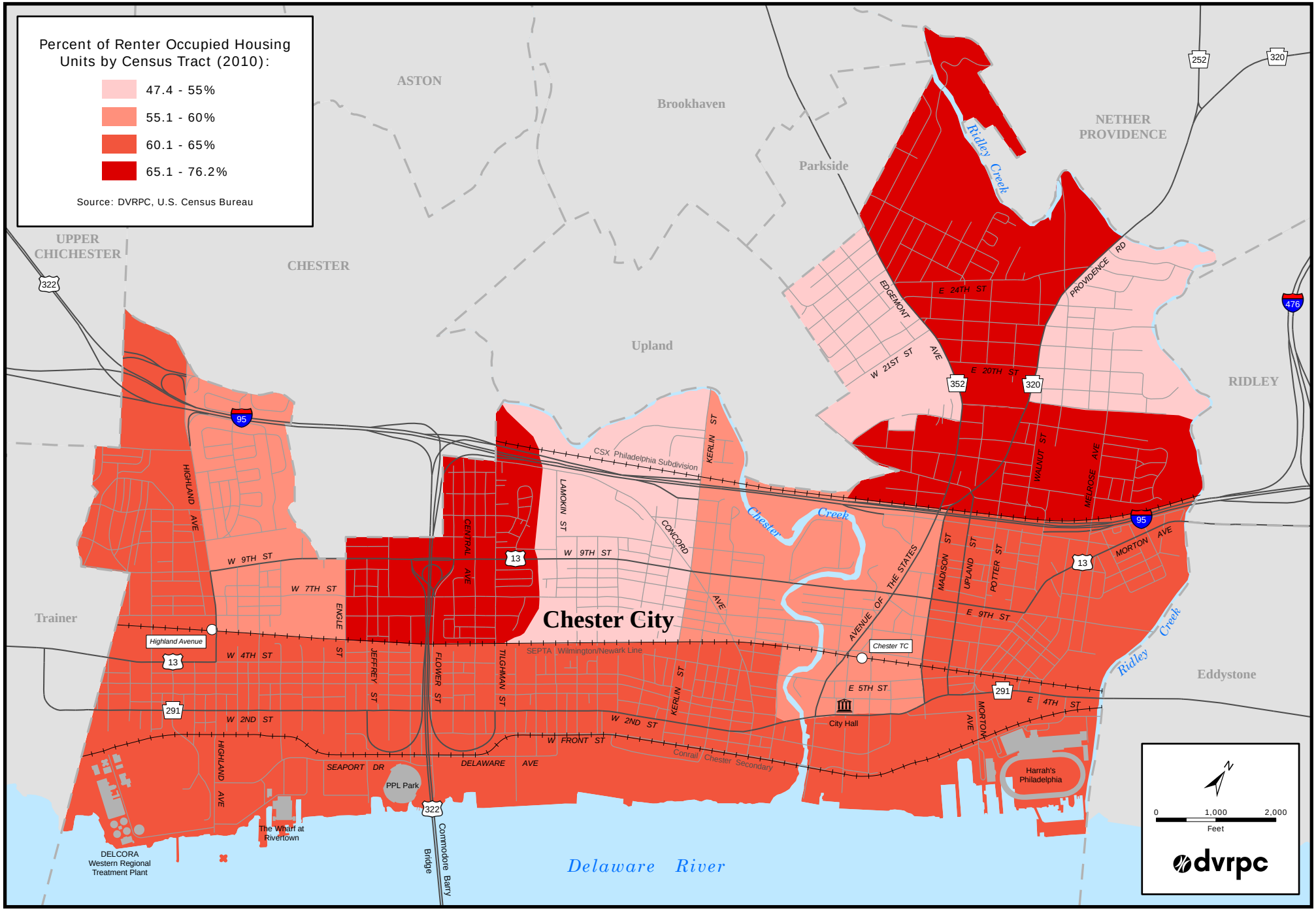
Carless Household Concentrations



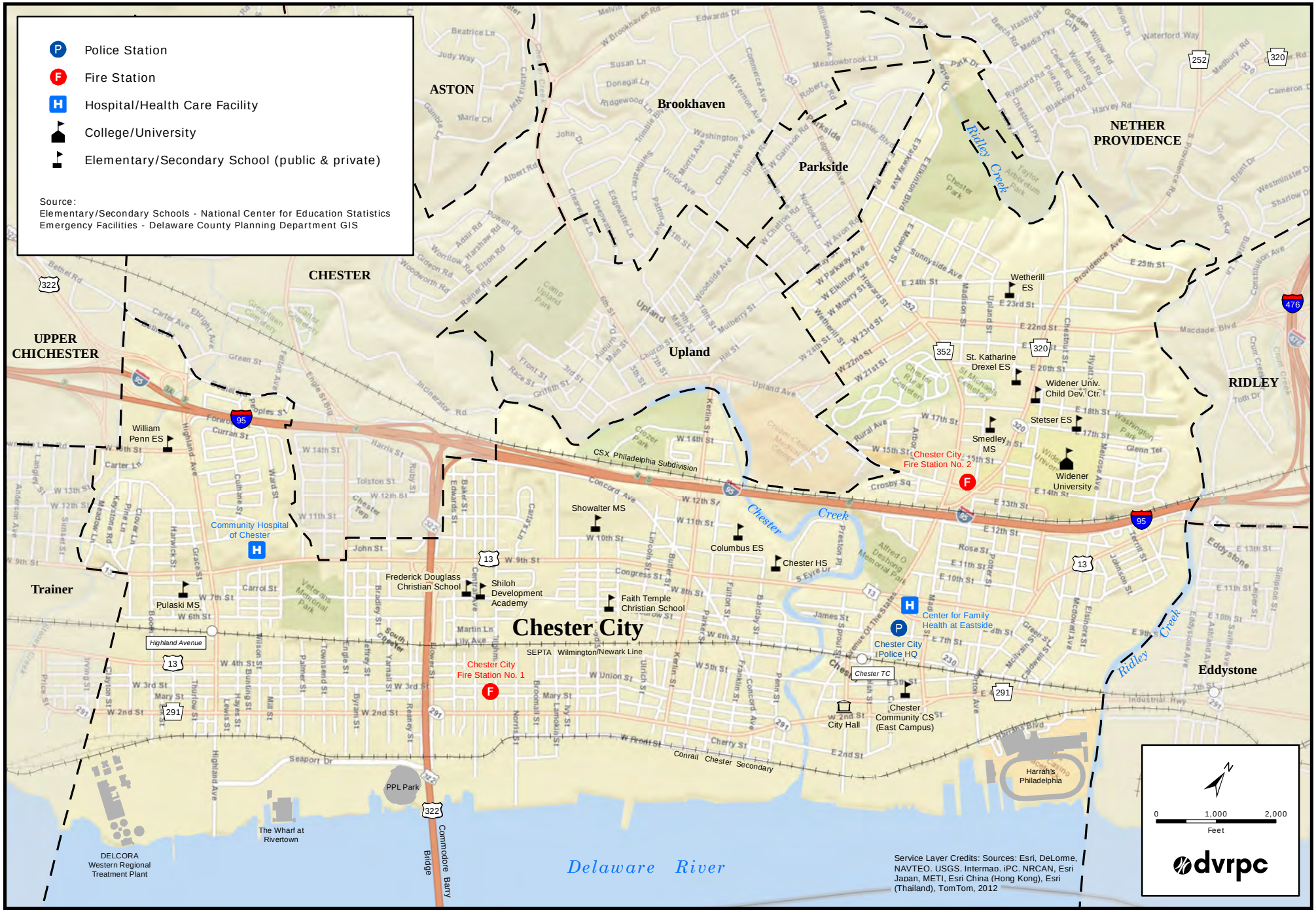
Female Heads of Household with Child Population Concentrations



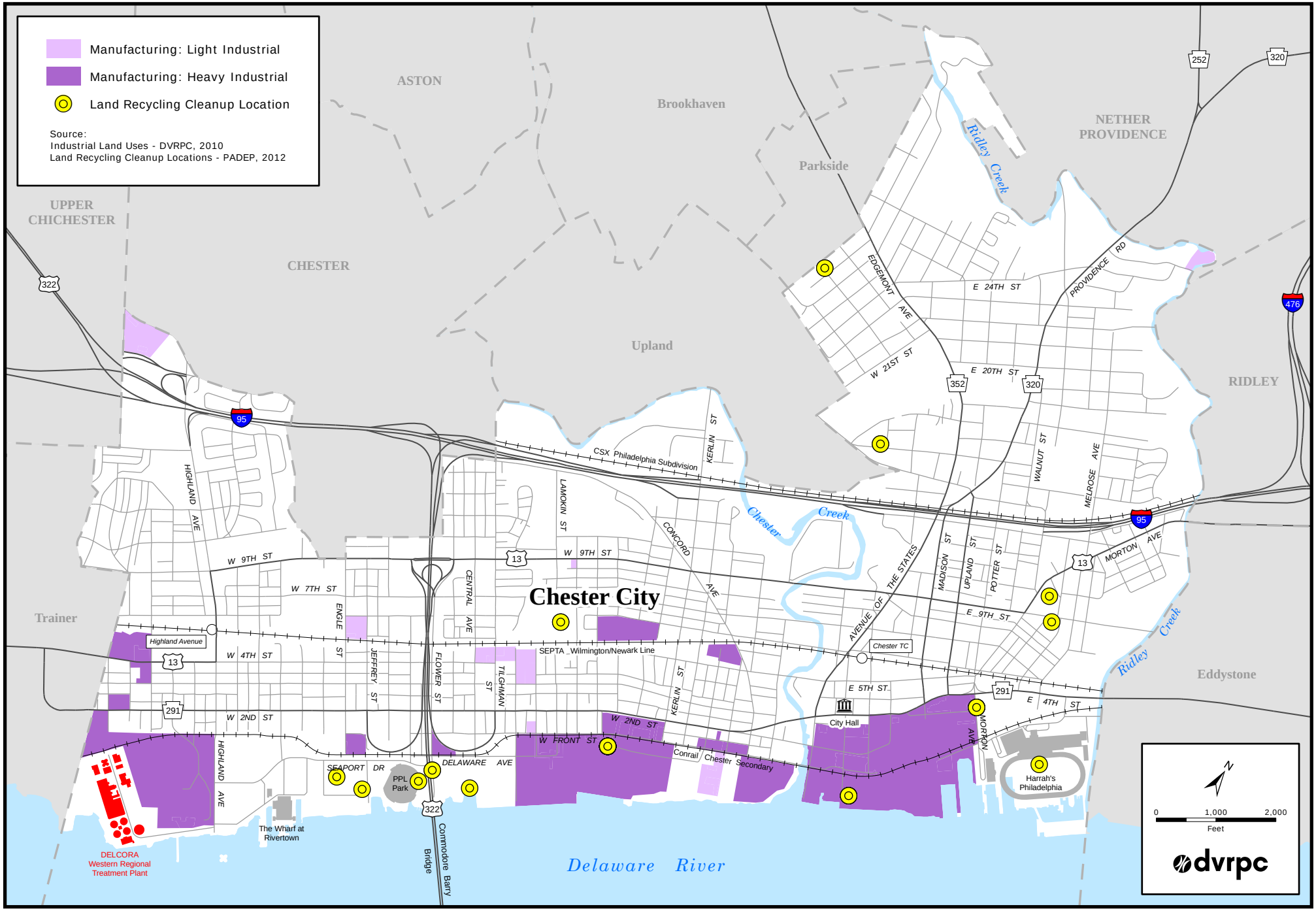
Renter Occupied Housing Units



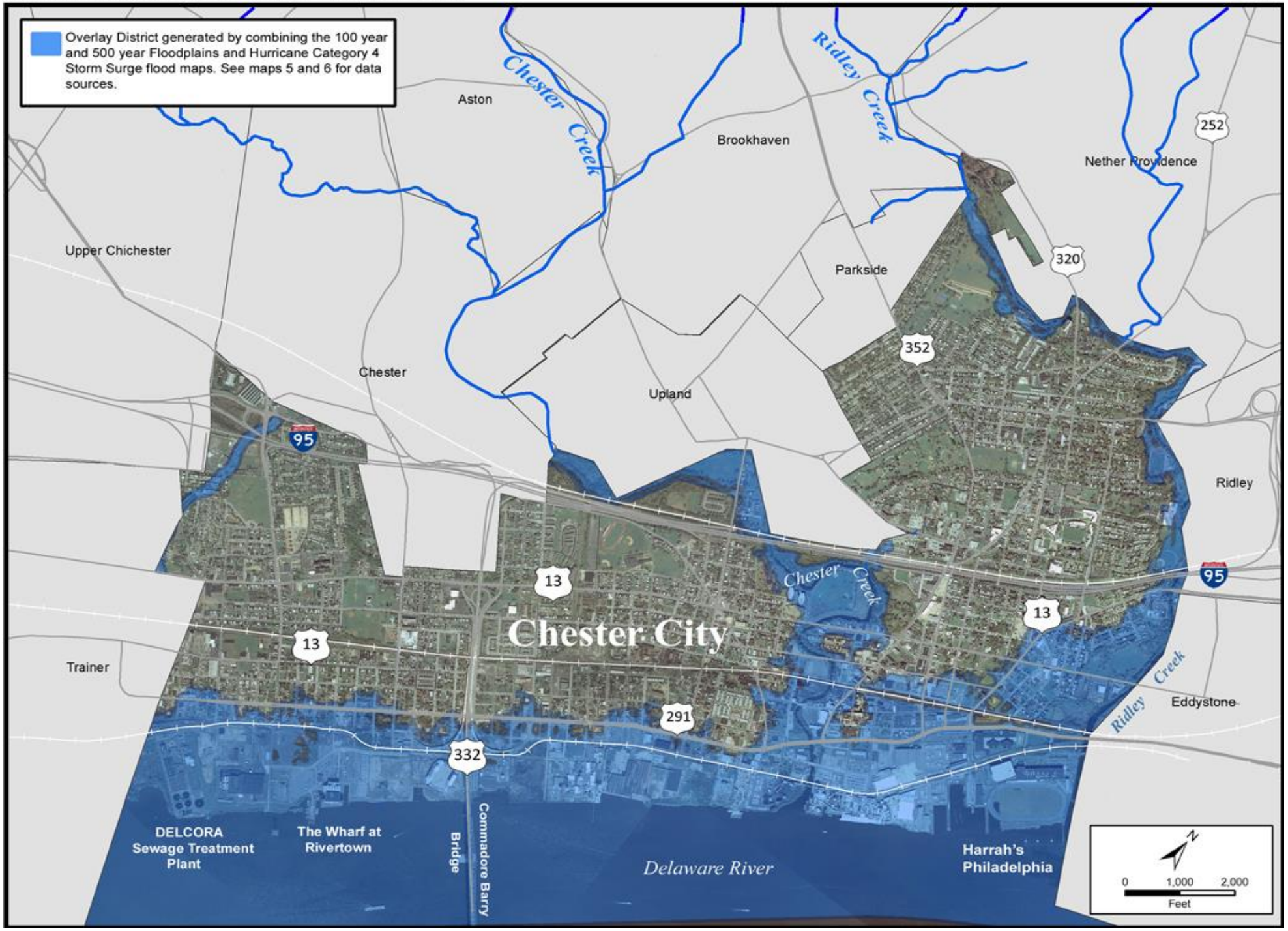
Emergency Facilities and Schools



Industrial Sites and Cleanup Locations



Sample Flood Protection Overlay District



APPENDIX C: Project Maps