CLIMATE RESILIENT COMMUNITIES PROJECT

Addressing the compounding risks of industrial and contaminated sites and climate vulnerability in Southeast Pennsylvania.



Summer 2026

PREPARED FOR:

CLEAN AIR COUNCIL

PREPARED BY:

OLIN

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EXECUTIVE SUMMARY

For decades, Southeastern Pennsylvania communities overburdened by industry's harms to public health and the environment have advocated for justice. In 2022, Clean Air Council established the Climate Resilient Communities Project to help address climate change and its impacts on some of the most industrialized and climate-vulnerable communities in this region. As part of this project, the Council partnered with OLIN LABS to analyze regional climate, environmental, and community data. They built upon previous studies by refining the data through a series of meetings with community members and leaders. Community feedback was then paired with a review of best practices from other community resilience planning efforts to inform a climate resilience toolkit with a range of local, regional, and policy recommendations.

The toolkit is intended to cater to the specific needs of each community—building on an extensive review of each community's existing planning—to create a unifying set of strategies that can help address the shared challenges of climate change and environmental injustice. Lastly, small early action projects were developed and built in collaboration with each community to foster social resilience and demonstrate the types of green infrastructure and other physical improvements needed to build more physically resilient communities.

The Climate Resilient Communities Project was conceived as three distinct but overlapping stages. The first, Analyze and Envision, which focused on data gathering, community prioritization, visioning, and recommendations. The second, Advocate and Support, helped identify and move forward community priorities and early action projects. The third, Advancing the Planning, resulted in the creation of this final report, intended as a tool for the Clean Air Council, community planners, local groups, and residents participate to continue pursuing resilience and environmental justice through grassroots organizing, local planning, and regional advocacy.

Analyze and Envision

The first phase began with data compilation and review, establishing a comprehensive, publicly accessible baseline of community, industrial, environmental, and climate risk data for tidal Philadelphia and Delaware County. That task also involved partnering with Drexel University's Sustainable Water Resource Engineering Lab to model past storms with sea level rise added to analyze specific risks to active industrial sites and brownfields as well as transportation and utility infrastructure.

Community prioritization involved selecting and partnering with five communities: the Grays Ferry and Eastwick neighborhoods of Philadelphia and Chester, Trainer, and Marcus Hook in Delaware County—all communities with extensive existing industry and flooding risk, and also communities where Clean Air Council had long standing



partnerships with existing community groups. All the data compiled in this stage was reviewed, edited, and communicated back to the public to ensure that regional data aligned with the lived experiences of residents.

The primary outcome of this phase was a data analysis summary presentation that bridged technical climate modeling with community-identified priorities. This collaborative process ensured that the subsequent visioning and recommendation phases were rooted in the specific concerns and needs of the frontline populations most affected by industrial and environmental hazards.

Advocate and Support

The next phase of the project focused on supporting communities in prioritizing local climate resilience strategies, land use preferences, and ultimately implementing local resilience and community benefit projects. Through a series of in-person meetings with each focus community, projects and strategies were selected from a collectively developed Climate Resilience Toolkit.

Of the planned projects, sites for early action were identified where a small investment in tree planting, green infrastructure, and community amenities could help transform an existing community space.



Figure 1. High tide at the Marcus Hook Terminal. Source: OLIN

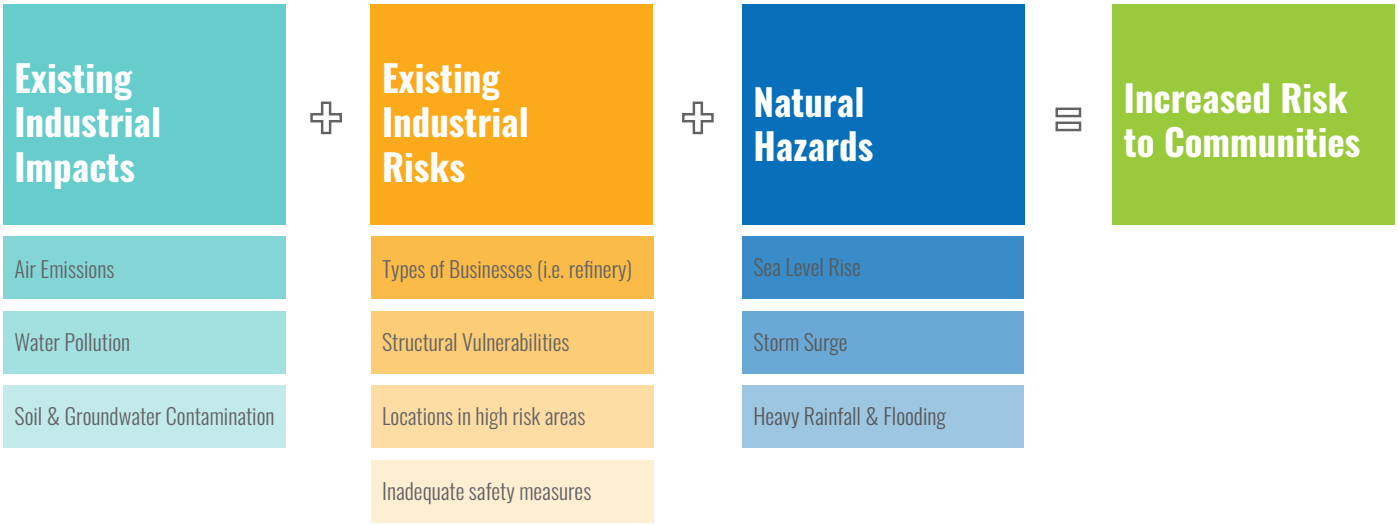


Figure 2. Diagram outlining how industrial impacts, risks, and natural hazards can compund to create conditions of increased risk to communities. Source: OLIN

The report is structured around a simple but unacceptable equation: existing industrial impacts and risks + worsening natural hazards = increased risk to communities.

Advancing the Planning

In the final phase of the project, the consultant team worked with Clean Air Council to develop this public facing report to further advance the planning and support longer-term advocacy efforts. The report is written for a wide audience, with the intent of influencing state and municipal policy makers, researchers and academics, and most importantly, supporting the work of environmental and community groups active on these issues and in these communities. In addition to the regional overview, the report includes specific Community Profiles, meant as standalone documents that can be used locally by each community. The report is structured around a simple but unacceptable equation: existing industrial impacts and risks + worsening natural hazards = increased risk to communities.

The first half of the report analyzes the existing and legacy industrial impacts from active industrial and past brownfield sites, existing and future risks from natural hazards like sea level rise, and the communities that are adjacent to these risks and hazards, highlighting hot spots where the compounding risk to communities from industrial and natural hazards are greatest. The second half of the report offers recommendations in the form of a Community Resilience Toolkit, that includes local, regional, and policy recommendations. The Project's focus communities are then each profiled with specific local recommendations using the Community Resilience Toolkit. The report concludes with next steps and a call for continued collective advocacy and coalition building.

SUMMARY FINDINGS

The following high level themes summarize findings from this study:

1. Compounded Risk and Natech Events in Vulnerable Communities

Climate hazards have become a growing concern for communities, yet the compounded risks from Natural Hazard-Triggered Technological Accidents (Natech) events need greater recognition, especially in already vulnerable communities. This document presents an overview of the unique challenges posed by these risks, focusing on high-vulnerability areas in Southwest Philadelphia and Delaware County, particularly Delaware Riverfront communities facing intensified exposure to industrial accidents, coastal flooding, and structural vulnerabilities due to sea level rise.

2. Social Capital as the Foundation for Adaptation

Effective adaptation requires immediate action, beginning with efforts to recognize, build, and strengthen the social capital within communities. This report emphasizes the critical need for empowering residents through collaboration and capacity-building, to ensure they are resilient and prepared to address challenges at the local level.

3. Policy Strategies Across the Adaptation Process

Policy makers must align their support with where communities currently stand in terms of capacity and their adaptation journey. This document outlines a broad spectrum of policy strategies tailored to various stages of resilience, emphasizing flexible, community-centered approaches that evolve with the needs and readiness of each community.

4. Connecting Regional Recognition to Local Impact

This document is not an isolated analysis; it's rooted in a broader regional effort to acknowledge local issues and achieve actionable, on-the-ground results alongside longer advocacy and planning efforts. The relevance of these findings hinges on a cooperative process in which planners and policy makers actively involve community members, advancing shared solutions alongside strategic, long-term approaches.

5. Pathways for Adaptive Change: Building Awareness, Mapping Benefits, and Tailored Frameworks

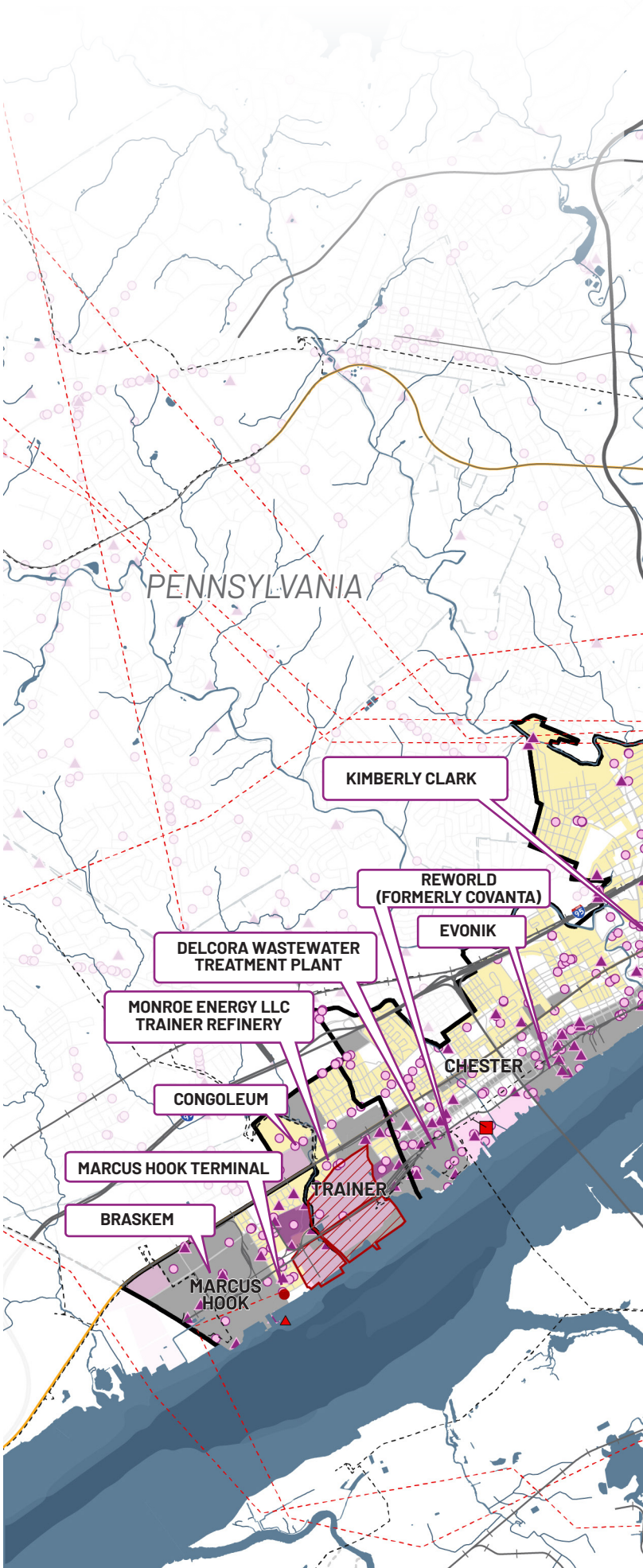
Successful adaptation pathways rest on frameworks that foster awareness, unite communities, and provide accessible data for assessing progress and benefits. Pathways must be customized to each community's social fabric, infrastructure, economic status, and environmental conditions. The policy recommendations in this report lays out actions across scales, encompassing local and regional strategies to mitigate risks and enhance community outcomes.

The following pages outline chapter summaries of the report (chapters 2-7). Chapter 1 is an introduction and chapter 8 outlines next steps.

02 INDUSTRIAL RISK

The industrial landscape of Southeast Pennsylvania is characterized by a dense concentration of facilities, including over 558 industrial and brownfield sites within the study area. These sites, regulated by federal and state programs, pose direct environmental risks through toxic air emissions as well as soil and water contamination. The region's industrial history dates back to the 19th-century oil revolution, which transformed Philadelphia and Delaware County into a national oil hub. This legacy continues in the form of hundreds of brownfields and Superfund sites, such as the Metro Container Corporation and Lower Darby Creek Area, which require rigorous, long-term remediation.

Risks at these facilities are categorized into three main threats: fires and explosions, leaks and spills, and air pollution. Specific hazards are tied to facility types; for instance, tank farms are susceptible to explosions and tank dislodgement during floods, while pipelines risk acute spills that can contaminate local waterways. Managing these risks is complicated by a fragmented data landscape where contamination datasets are siloed across different agencies, making it difficult for community members to fully understand the environmental and health risks they face.



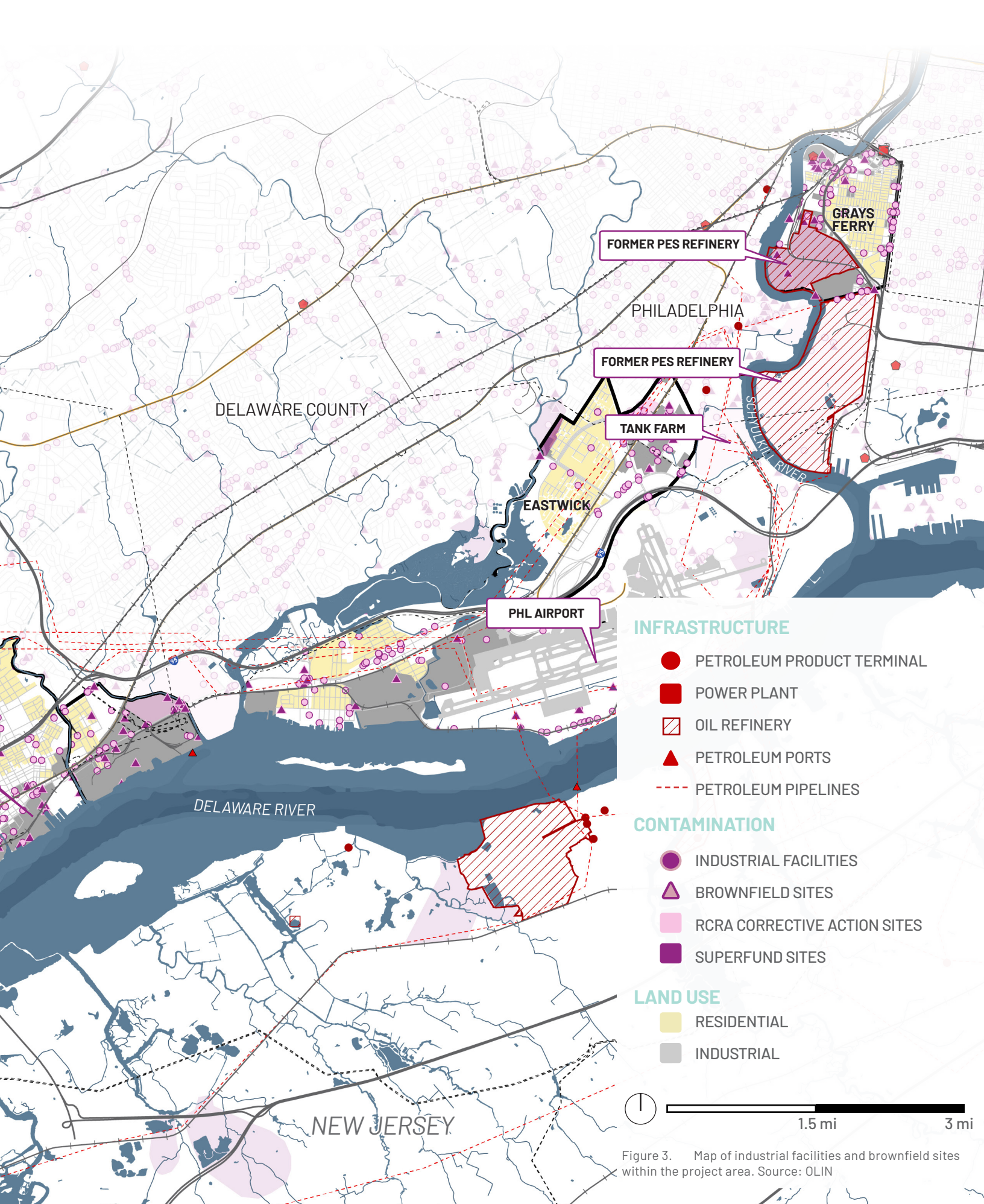


Figure 3. Map of industrial facilities and brownfield sites within the project area. Source: OLIN

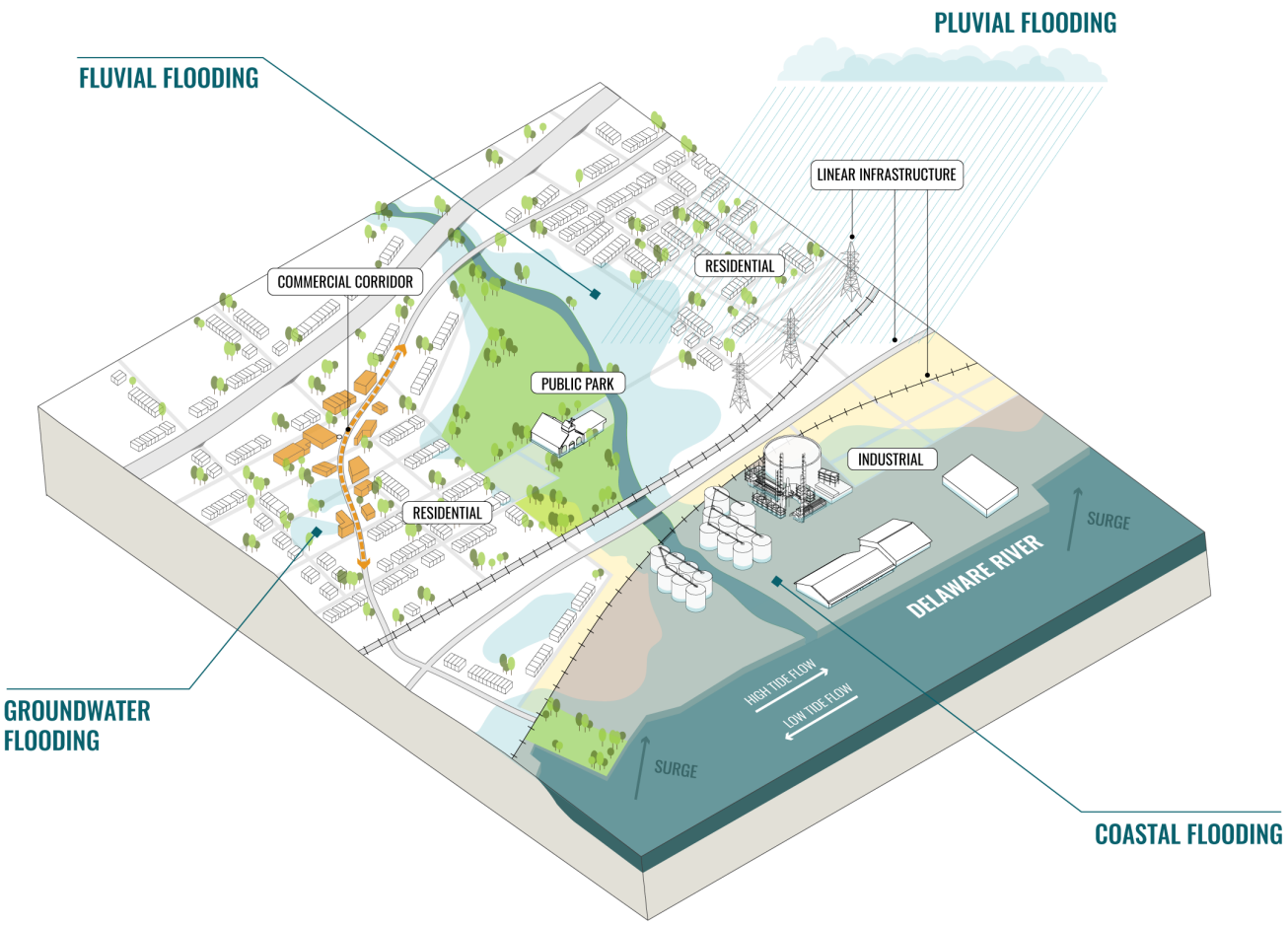


Figure 5. Diagram showing compound flooding processes. Source: OLIN

03 NATURAL HAZARDS

Communities along the Lower Schuylkill and Delaware Rivers are facing a mounting hazard as natural disasters increasingly intersect with industrial zones. The area is threatened by multiple types of flooding: fluvial (river), coastal (tidal), and pluvial (inland rain). These risks are expected to intensify significantly due to climate change, which is driving both sea-level rise and more frequent extreme rainfall events.

Beyond flooding, heat waves and the urban heat island effect present severe public health challenges. In areas like Chester, the combination of sparse tree canopy and vast impervious surfaces causes local temperatures to remain higher than the regional average. These natural hazards do not act in isolation; they are compounding factors that increase the likelihood of both industrial accidents and community risk while further straining the region's aging infrastructure.

Focus Community Engagement Meeting Series #1

Focus Community Engagement Meeting Series #2

Focus Community Engagement Meeting Series #3

Client Presentations, Stakeholder Advisory Meeting, Technical Advisory Meetings

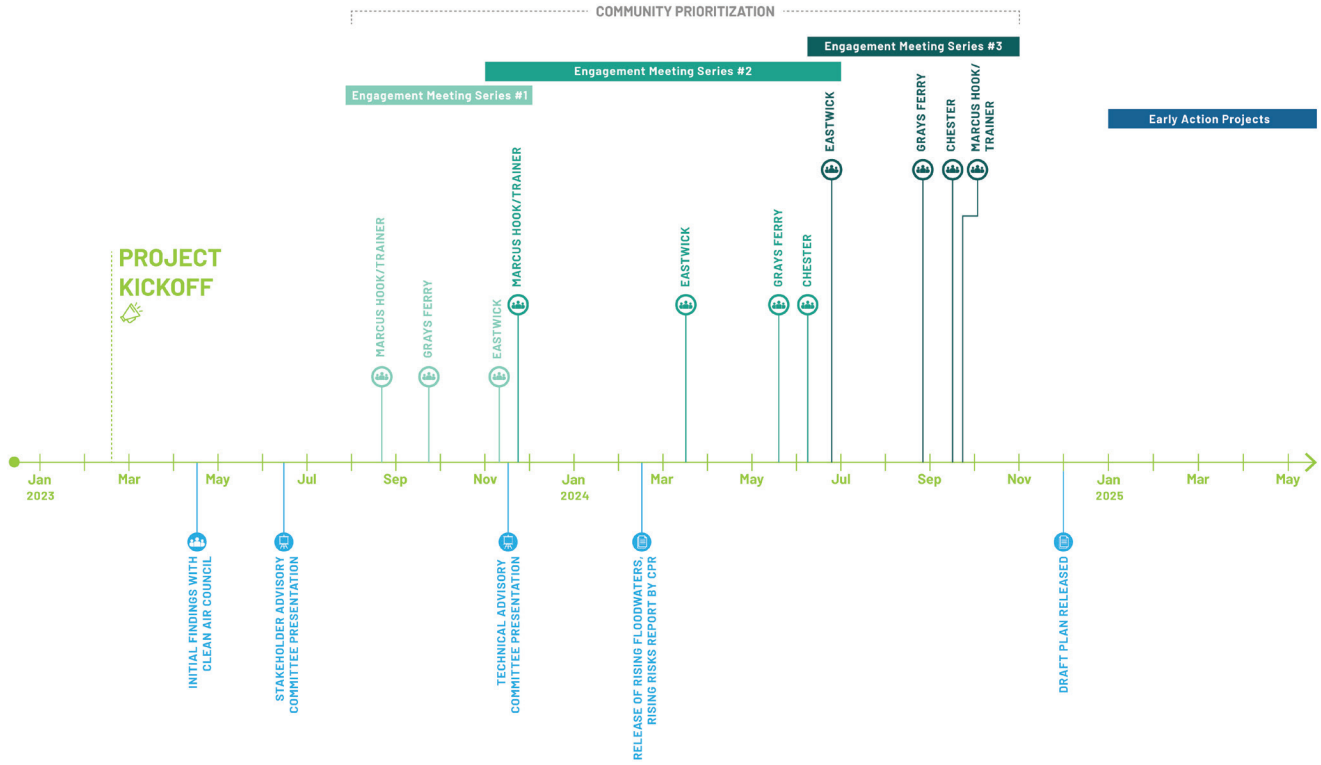


Figure 6. Diagram showing engagement timeline.
Source: OLIN

04 COMMUNITY OVERVIEW

The project study area focuses on seven communities: the Grays Ferry and Eastwick neighborhoods in Philadelphia, and the municipalities of Chester, Trainer, and Marcus Hook in Delaware County. These areas were selected based on their high levels of social vulnerability and their proximity to both heavy industry and recurring flood zones. For generations, residents here have lived in the shadow of industry, providing the labor that powered the regional economy while bearing the brunt of its environmental impacts.

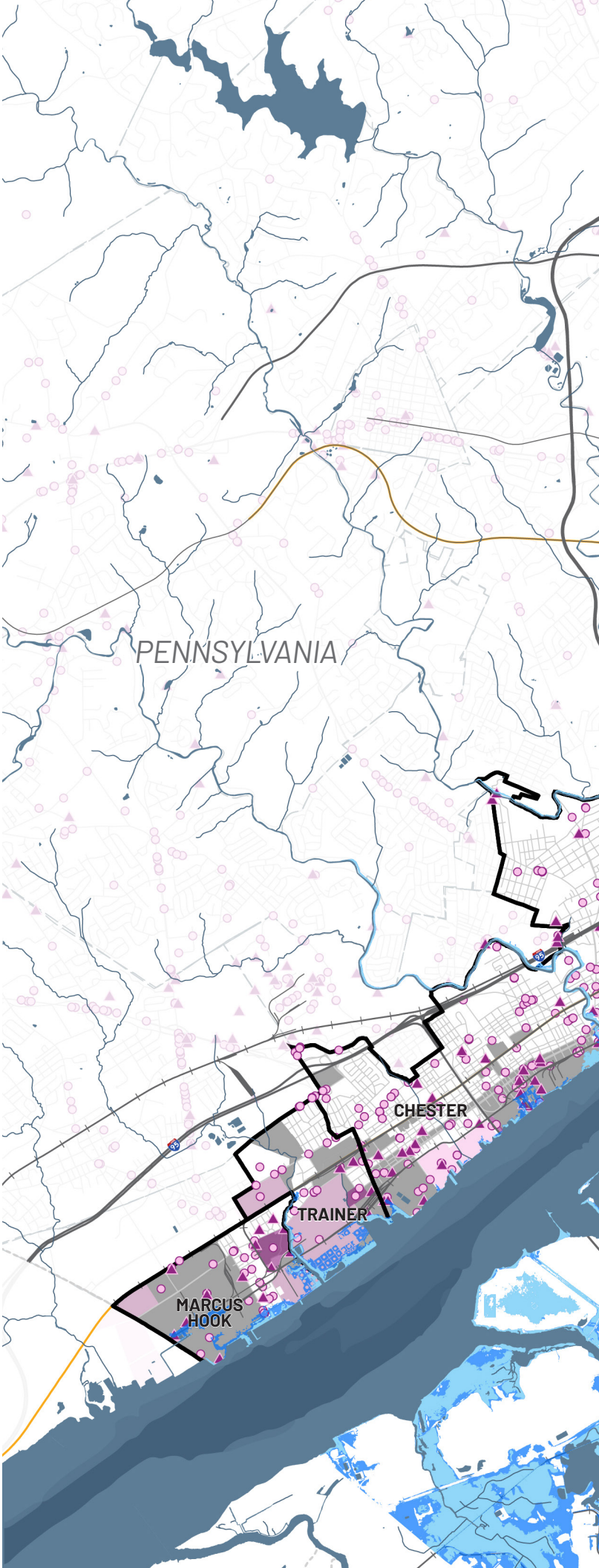
Community engagement revealed that most residents are already experiencing the effects of these hazards, with many reporting recurrent flooding in their homes and streets. Feedback highlighted a strong desire for early warning systems, improved emergency preparedness, and better access to community open spaces like parks and gardens. This study also acknowledges that these communities are situated on the traditional territory of the Lenni-Lenape, emphasizing the need for future adaptation efforts to collaborate with indigenous partners.

05 INCREASED COMMUNITY RISK

Increased risk is driven by the intersection of social vulnerability and environmental exposure. Using the CDC/ASTR Social Vulnerability Index, the report identifies communities with limited resources—due to factors like poverty, lack of transportation, or language barriers—that face the greatest difficulty in responding to and recovering from disasters. These vulnerabilities are often a result of historical discrimination and disinvestment, leaving these populations with the least adaptive capacity.

A critical concern is the emergence of Natural Hazard-Triggered Technological (Natech) events. Of the 556 industrial sites in the area, 49 toxic sites are considered flood-exposed to potential river flooding or storm surges. This means that a natural disaster, such as a hurricane, could trigger a secondary technological disaster, such as a chemical leak or refinery fire, creating a double disaster for already vulnerable fenceline communities.

Using flood modeling of historic storms plus a two-foot sea-level rise by Drexel's Consortium for Climate Risk in the Urban Northeast (CCRUN), this map highlights compounding climate and industrial risks. It shows the intersection of environmental and social vulnerability, where 160 of the region's 556 industrial and brownfield sites lie within highly vulnerable census tracts.



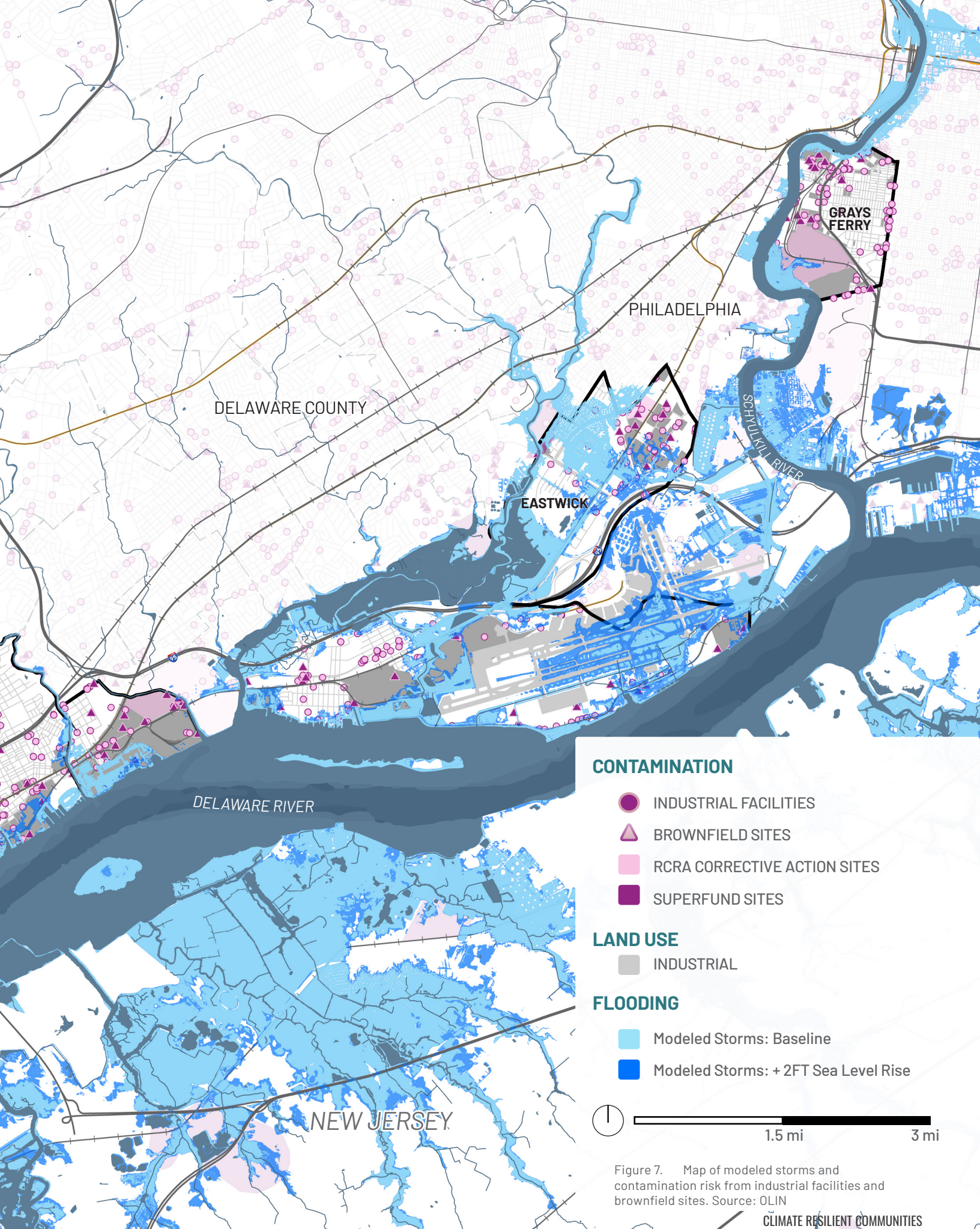


Figure 7. Map of modeled storms and contamination risk from industrial facilities and brownfield sites. Source: OLIN



Figure 8. Diagram illustrating scales of recommendations. Source: OLIN

06 RECOMMENDATIONS

The recommendations are organized into three scales: community toolkit, regional interventions, and policy recommendations. No single approach is sufficient to address the complexities of these challenges; instead, the report advocates for layered solutions.

Community Resilience Toolkit: Near-term, local actions such as expanding tree canopy, implementing green stormwater infrastructure, and creating social spaces to strengthen the networks residents rely on during crises.

Regional Interventions: Larger-scale hard infrastructure projects like levee systems and nature-based solutions like watershed restoration as well as the centralization of climate data into a public platform to ensure coordinated emergency responses.

Policy Recommendations: Regulations to ensure facility-specific protection, such as requiring industrial sites to anchor floatable equipment and elevate critical infrastructure, as well as municipal ordinances to preserve affordable housing to prevent displacement in at-risk areas.



Figure 9. (Left to right) 3rd Street/Wilcox Street Garden at Trainer, Sun Village Park at Chester, Community Meeting at Eastwick, Growing Together Garden at Grays Ferry. Source: OLIN, CAC.

07 COMMUNITY PROFILES

Each community profile provides a localized analysis of specific risks and tailored recommendations. For example, the Chester profile highlights the city's risk from fluvial flooding from the Delaware River and Chester Creek, as well as the urban heat island effect. It identifies high-priority assets at risk, such as the Chester Community Charter School and the Eddystone Fire Department.

The Marcus Hook and Trainer profiles focus heavily on the Natural Hazard-Triggered Technological (Natech) risk, given the dense concentration of oil refineries and terminals along the waterfront. For communities like Eastwick, which is bordered by landfills and tank farms, the recommendations emphasize both physical flood protection and social resilience, aiming to build on existing community advocacy to build resilient living environments.

The chapter also outlines three Early Action Projects. In Trainer, the 3rd Street/Wilcox Street Park project activates an underutilized neighborhood lot with an accessible nature storybook walk and native pollinator plantings. In Chester, the Sun Village Park project improves park connectivity by linking existing recreational areas with a new ADA-accessible storybook path, alongside the management and planting of native trees. Finally, in Grays Ferry, the Growing Together Garden project introduces a new native plant garden and picnic gathering space sited to accommodate localized stormwater drainage. Together, these projects represent near-term steps toward building climate-adaptive, accessible community amenities.



01 INTRODUCTION



Figure 11. Marcus Hook Borough. Source: OLIN.

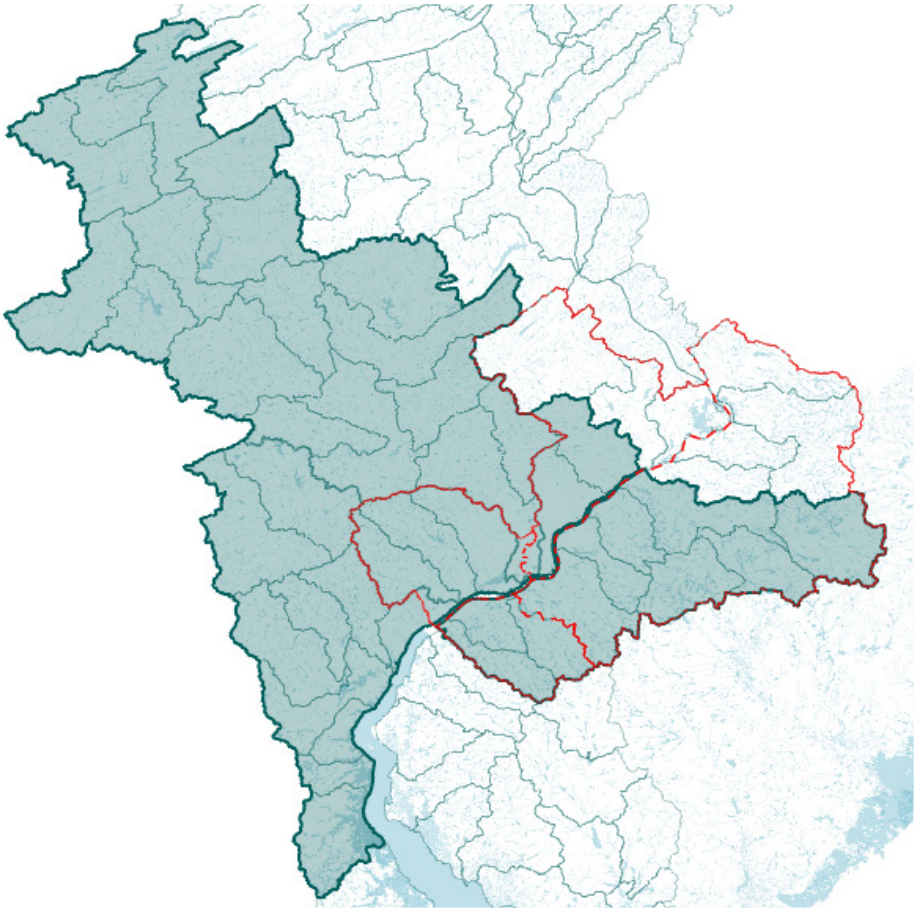


Figure 12. Map of the Lower Delaware River watershed with the lower Delaware River Estuary highlighted in red for reference. Source: OLIN

PROJECT INTRODUCTION

Residents of Pennsylvania's Lower Schuylkill and Delaware River communities are confronting mounting hazards on multiple fronts. For decades, these hardworking communities have been essential to the economies of Philadelphia and Delaware Counties, living and working literally in the shadow of industry, transportation corridors, and beside the Delaware and Schuylkill Rivers. Today, they face "natech hazards"—the compounded risks of natural disasters and industrial exposure that come from being located near both heavy industry and recurring floodwaters.

Over its two-year duration, the Climate Resilience Communities initiative - led by the Clean Air Council and funded by the William Penn Foundation - has delved deep into harnessing collective expertise, tapping into local knowledge, and pioneering innovative strategies to address environmental challenges. Beyond protection, the vision driving this initiative is transformative and empathetic. It aspires to rethink our relationship to community, industry and natural systems, harnessing the power of social capital and science-driven outcomes to ensure Lower Schuylkill and Delaware River communities are more resilient to climate change and its many impacts.

This study recognizes that resiliency planning does not happen in a vacuum; it aims to build on past and ongoing resiliency efforts in the region from various resiliency and adaptation experts, planning and design firms, government agencies, nongovernmental organizations, and frontline groups and residents. These include the the Sea Level Rise Impacts in the Delaware Estuary of Pennsylvania

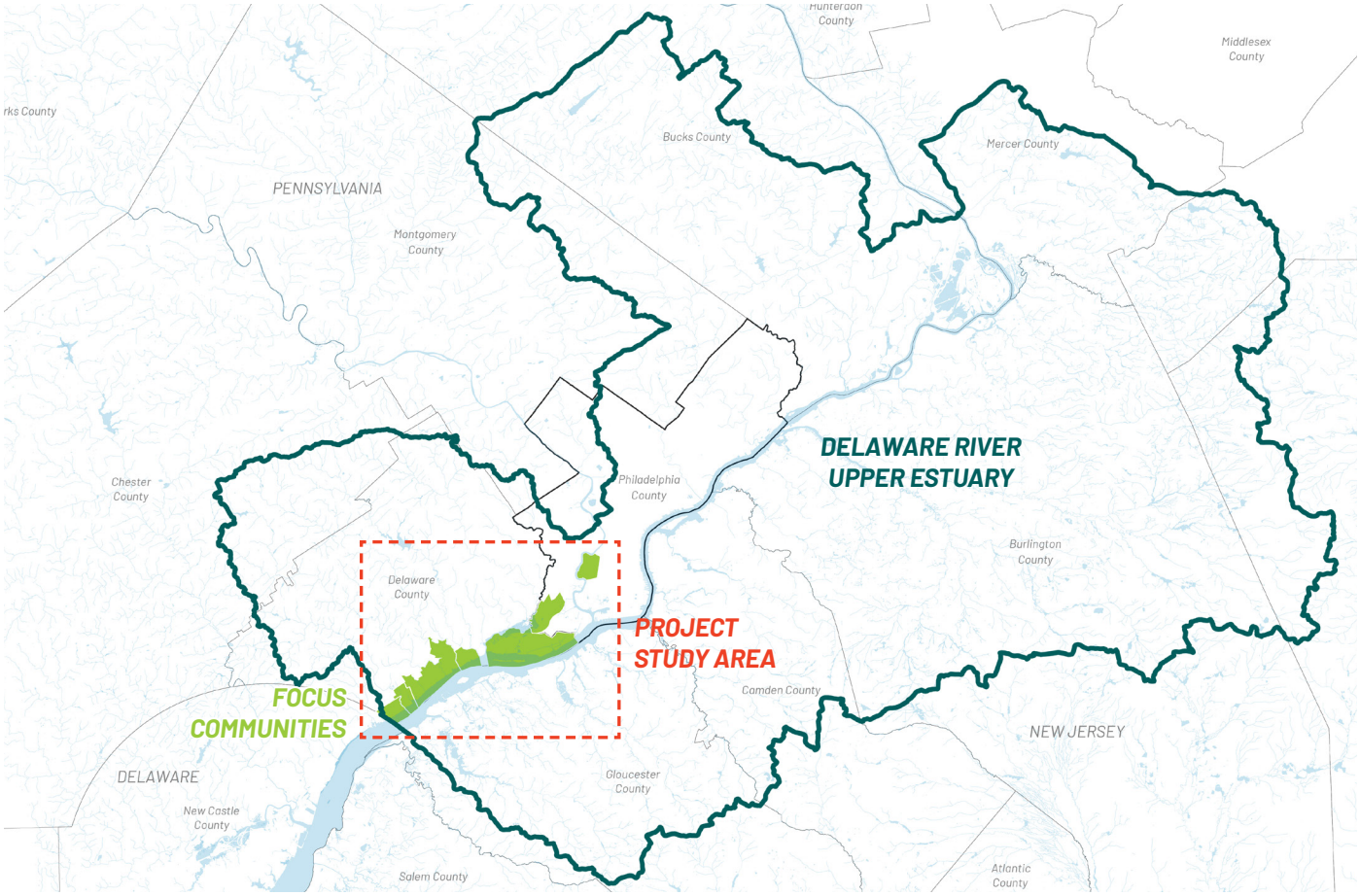


Figure 13. Map of the Delaware River Upper Estuary. Source: OLIN

study (2004), the the Philadelphia Climate Action Playbook (2021), the Delaware County Climate Action Plan (2022), the Coastal Resilience Assessment of the Delaware Bay and Coastal Watersheds (2019), and the Eastwick Flood Resilience Strategy (ongoing). The research into these planning efforts forms the basis of understanding for this study of what has been done, what has been studied, and what overall goals and visions are for the region.

Chapter 1 introduces the study area, while chapters 2-6 provide an overview of the regional analysis, and shared climate resilience toolkit and recommendations. Chapter 7 includes more localized analysis and recommendations for each of the studies focus communities. Chapter 8 concludes with broad suggestions for next steps.

PROJECT STUDY AREA

The study area for the Climate Resilient Communities project includes seven communities in Southwest Philadelphia and Delaware County in Pennsylvania along the Lower Schuylkill River and the Delaware River. These communities include: the Grays Ferry and Eastwick neighborhoods of Philadelphia, Chester, Trainer, and Marcus Hook in Delaware County.

These communities were identified based on their combination of social vulnerability, vulnerability and exposure to industrial accidents, pollution, and contamination, flooding, and the worsening impacts of climate change such as coastal flooding due to SLR.

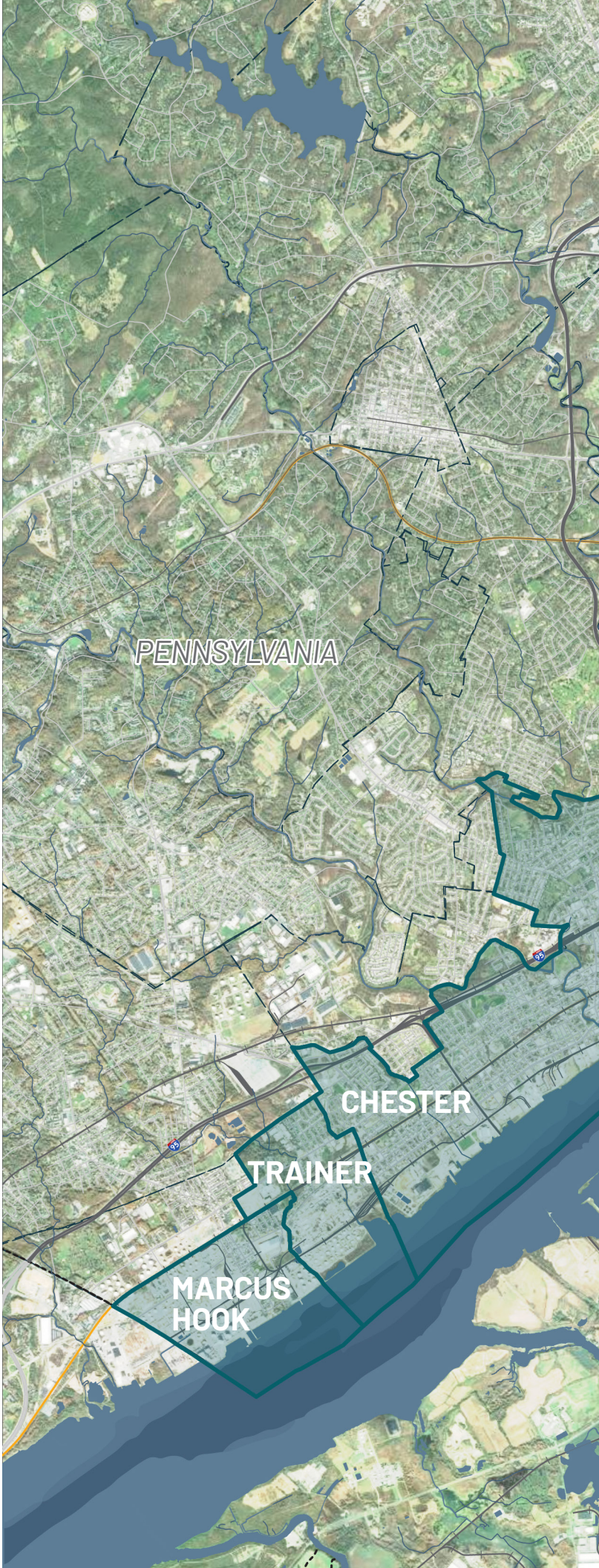




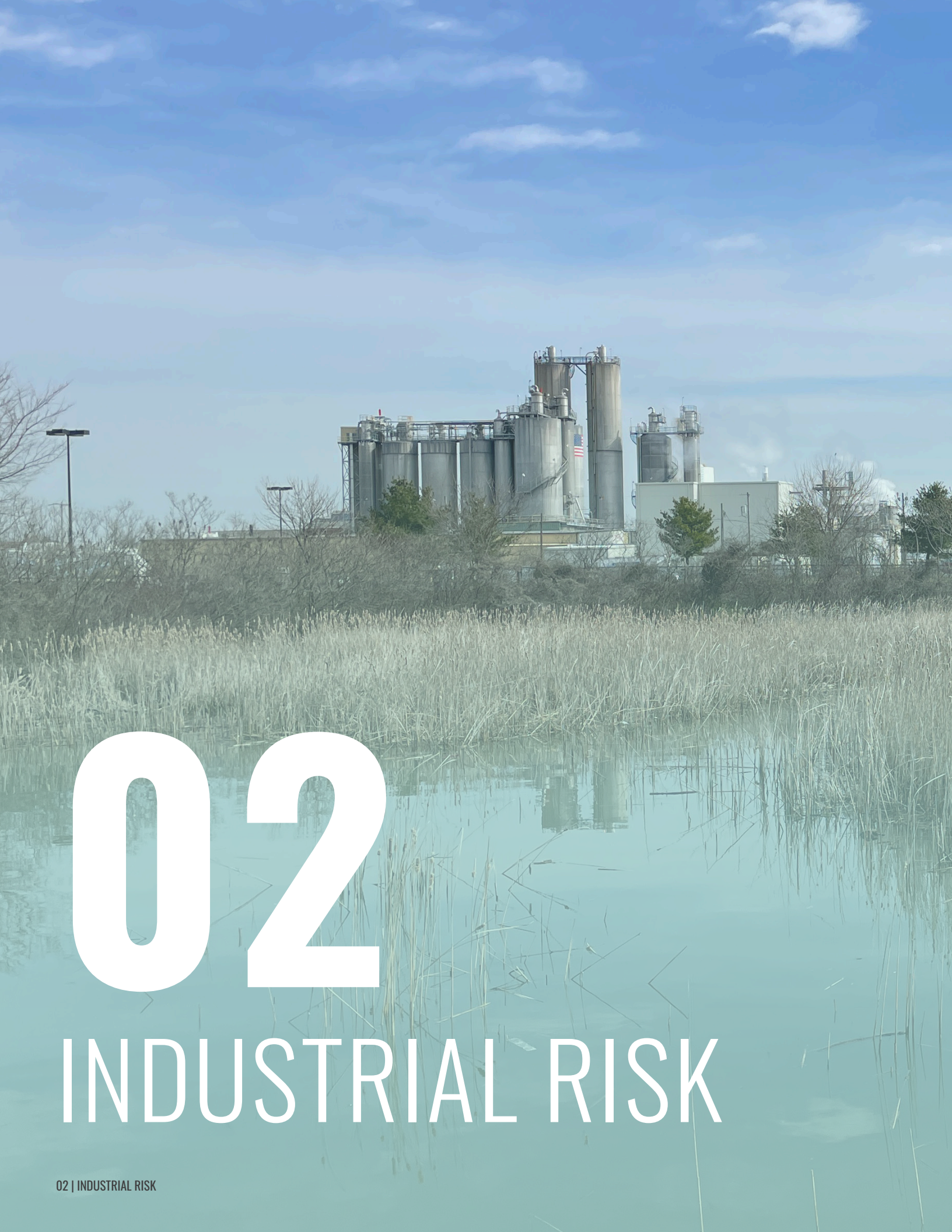
Figure 14. Map of the focus community neighborhoods. Source: OLIN

LAND AND WATER ACKNOWLEDGEMENT

We acknowledge that the present day communities of this region rest on land that is the traditional territory of the Lenni-Lenape, and we recognize their original name for this region–"Lenapehoking". The Lenni-Lenape are the original people of Philadelphia and Southern Delaware County and they continue to care for this land and the Delaware River, called "Lenapewihittuk" or the "Lenape Sipu".

During the colonial era and early federal period, many Lenape were displaced west and north, but some also remain here and continue to share their history and culture and advocate for recognition within the state of Pennsylvania. Residents across the region are encouraged to learn more about the Lenape and their historic and ongoing impact.

On-going and future efforts to advance environmental justice and adapt communities to climate change should seek to connect and collaborate with indigenous partners and integrate indigenous knowledge.



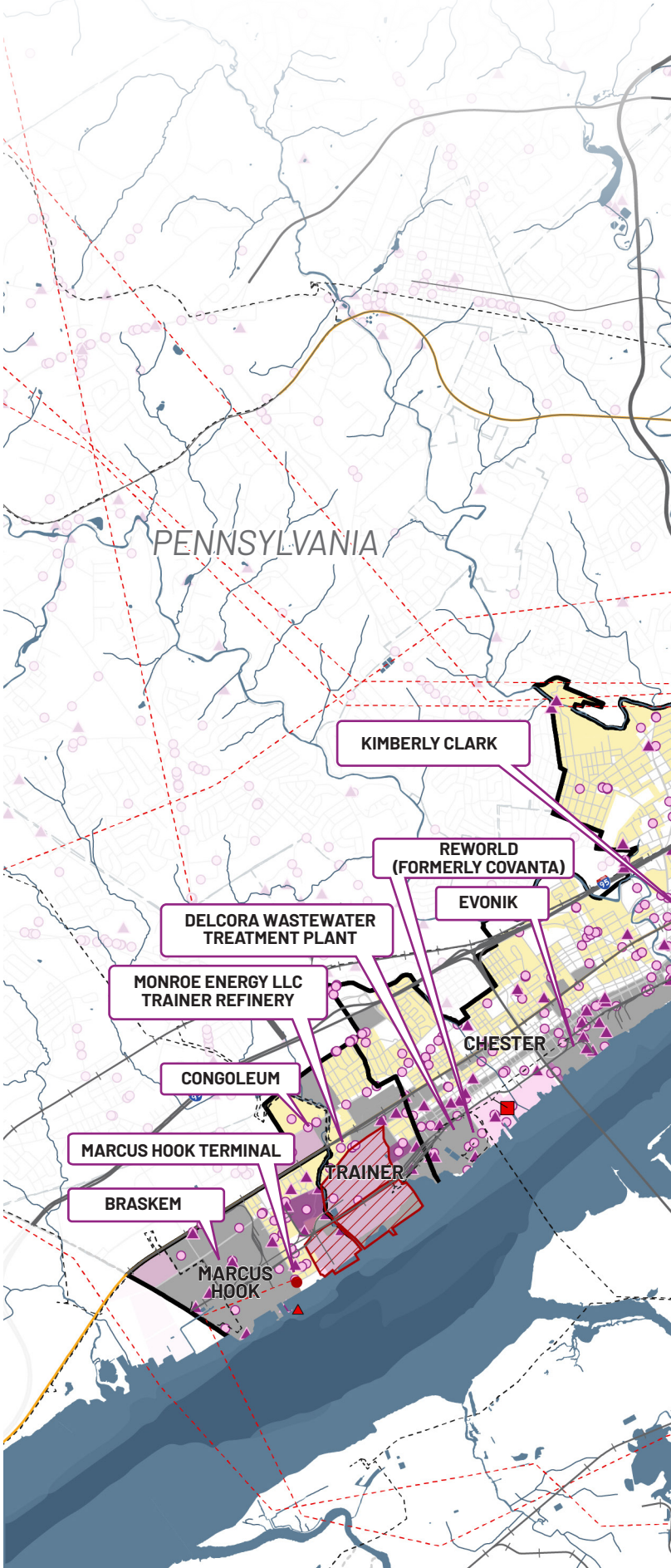
02 INDUSTRIAL RISK



Figure 15. Example of an industrial shoreline in the project study area. Source: OLIN

EXISTING INDUSTRIAL IMPACTS

Within the study area focus communities, there are over 556 industrial facilities and brownfield sites regulated by federal and state programs for the use, manufacturing, processing, presence, or storage of toxic and hazardous chemicals. These sites impact the surrounding communities directly through exposure to toxic air emissions, water and soil contamination.



INDUSTRIAL FACILITIES

For this study, industrial sites were categorized as facilities that are actively operating and under the oversight of various federal programs under the U.S. Environmental Protection Agency (EPA) or state programs under the Pennsylvania Department of Environmental Protection (DEP). These include but are not limited to: Risk Management Program, National Pollutant Discharge Elimination System , Toxic Release Inventory, Captive Hazardous Waste Facilities, Air Emission Plants, and Water Pollution Control Facilities.

BROWNFIELD SITES

Brownfield sites are classified as sites that were previously active industrial facilities and have a high likelihood of past or continued pollution to the environment. These include the Assessment, Cleanup, and Redevelopment Exchange System and National Priorities List Superfund program, but also sites within the Resource Conservation and Recovery Act program and underground and aboveground storage tanks.

See data glossary table on page 40 for more information on each program and dataset.

See Chapter 7 for a more detailed description of industrial and brownfield sites in each focus community and those that are most vulnerable to flooding.

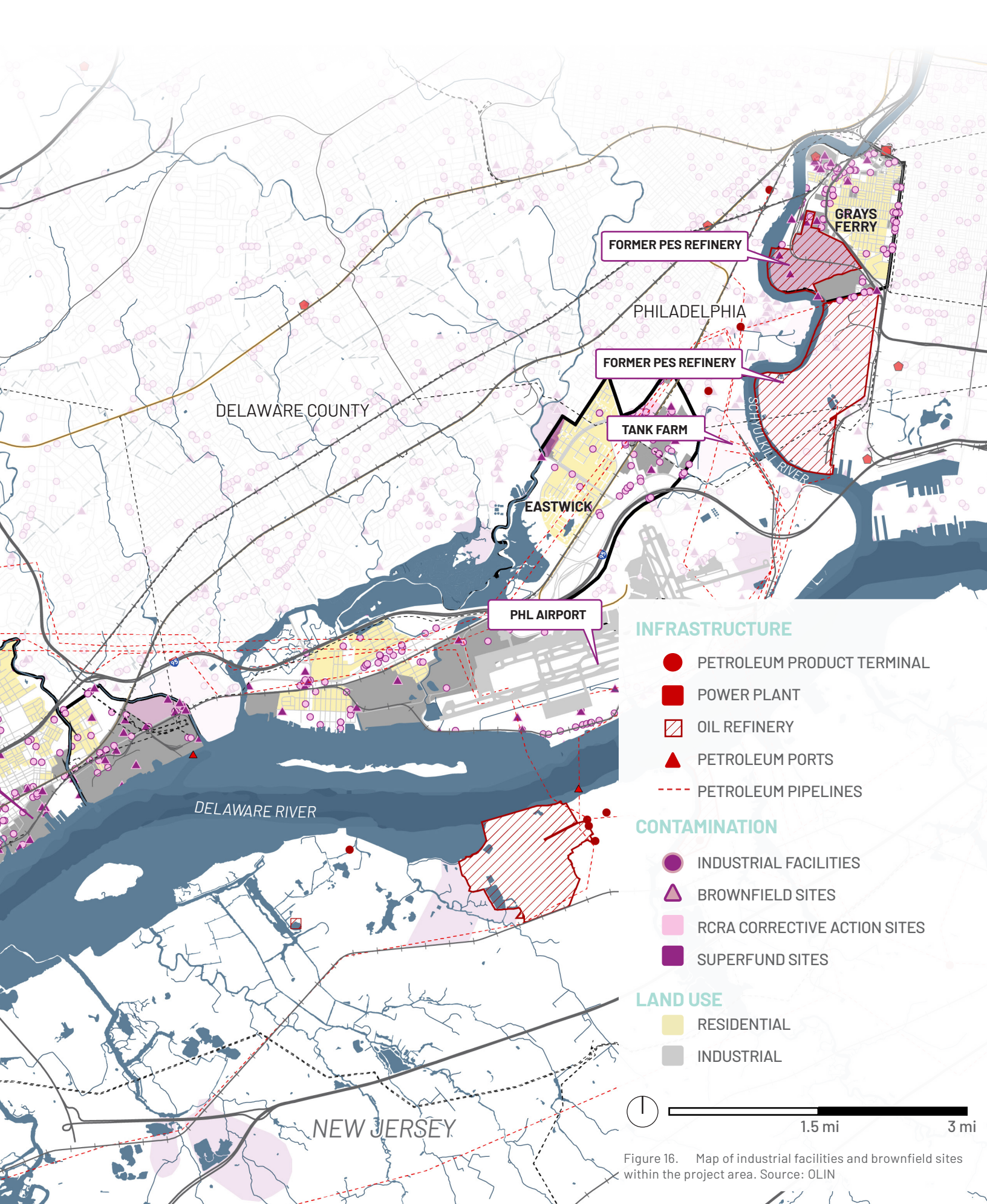


Figure 16. Map of industrial facilities and brownfield sites within the project area. Source: OLIN

HISTORY OF INDUSTRY IN THE REGION

The presence of industry and industrial facilities defines much of Philadelphia and Delaware County's waterfronts and neighborhoods, reaching back to the 19th century with the Industrial Revolution. In particular, the petrochemical industry has a strong presence within the study area, adding significant environmental concerns around emissions, waste disposal, and industrial incidents or disasters.

Below is a brief overview of the history of industry in the project area and its impact on surrounding neighborhoods in the 19th and 20th centuries. This is by no means comprehensive; instead, this section looks to provide context for the present-day realities of the project focus areas and to ground the work of the Climate Resilient Communities Project.

RISE AND FALL OF INDUSTRY

Industrial development on the Schuylkill and Delaware Rivers began in the mid-19th century, alongside the development of railroads and other freight and passenger transportation complexes. Around this time, the discovery of oil in Titusville, Pennsylvania and the first successful drilling in 1859 opened the pathway for a major oil revolution for Philadelphia, Delaware County, and nationwide.[1]

Oil refining and transportation made the Philadelphia region a national oil hub. Standard Oil controlled up to 90% of the U.S.'s refining capacity in the late 19th century and in 1891, 35% of all U.S. petroleum exports came from Atlantic Oil's refinery in Point Breeze (now the former Refinery).[2] Continued demand for oil led to the Marcus Hook Refinery from Joseph Pew, co-founder of Sun Oil, for refining and resale of Texas crude oil. The need for crude oil byproducts like gasoline, paraffin, and tar in factories, as well as technological advancements like gasoline-powered automobiles, further spurred industrial development and increased the demand for oil production.

The first long-distance transmission pipeline was built in 1865 in the early 20th century, oil lines became public utilities, opening up the oil market and allowing for the increase of crude oil production.[3][4] Both World Wars were pivotal in the shaping of the industrial landscape in the region. The waterfronts of Delaware County came to be defined by the many industrial and manufacturing facilities that grew and contributed to both World War efforts after securing national defense contracts. Companies like Sun Oil located their shipbuilding facilities in Chester to serve the World War I effort; other facilities included the Baldwin Locomotive Works in Eddystone, Ford Motors' company assembly plant in Chester, American Viscose Company in Marcus Hook, and various oil refineries.[5] Roads and railways were built to support this new economy, further establishing the area as an industrial hub.

The trajectory of industry in this area somewhat mirrors industry growth in similar areas around the country. Due to advancements in technology, the emergence of competitive markets, and other factors, industry and manufacturing declined and devastated neighborhoods. Chester, once home to various manufacturing industries, suffered from steady economic decline. However, proximity to pipelines and the inertia of specialized storage and distribution infrastructure has ensured that the petrochemical industry has been able to stay in operation in the Philadelphia region with sites like the Trainer refinery still active today.

INDUSTRIAL COMMUNITIES

The growth and decline of industry in the region also defined its many adjacent neighborhoods, including areas in Marcus Hook, Trainer, Chester, and South and West Philadelphia. Compact industrial neighborhoods first originated near industrial facilities when there was a lack of public transportation, making it necessary for workers to live near where they worked. Communities nearby grew as thousands of workers got jobs, like in Marcus Hook where the borough's population peaked at 5,234 during the height of the industrial boom in the 1920s.[6]

Generations of working-class families grew up in the shadow of these industries; however, during industrial decline in the second half of the 20th century, these same neighborhoods faced multiple socio-economic challenges and disinvestment.

In many ways, the deep industrial history of the region remains today and appears indistinguishable from the history of the neighborhoods in the project area. Municipalities like Marcus Hook and Trainer are embedded

in the landscape of the fossil fuel industry while Grays Ferry lives in the shadow of it. Other focus neighborhoods like Eastwick may not present as industrial neighborhoods, but they live in near proximity to industrial facilities like tank farms and brownfield sites, dealing with the same concerns of environmental pollution.

PRESENT-DAY SCARS: BROWNFIELDS AND SUPERFUND SITES

While the vast conglomerate of industrial facilities across the nation and in the Philadelphia region brought about immense technological advancements, they have also left deep scars in the environment and in the communities that lived nearby and helped shape this growth. Lingering brownfield sites and Superfund sites necessitate rigorous cleanup. The complex regulatory environment, funding, timing associated with remediation, and potential community involvement all add challenges to this process.

Given the age of these industrial sites, for decades many industrial facilities, chemical companies, and oil refineries were able to discard their toxic wastes into the air and waters at harmful levels and with little consequence. In the late 20th century, discoveries of toxic waste dumps like Love Canal in New York led the EPA to create the Superfund program, which identifies highly contaminated sites and imposes legal penalties and remediation costs on responsible parties. Highly contaminated sites that would classify as a Superfund include sites like landfills, chemical plants, metalworking facilities, and former military grounds. Around the time that the EPA started the Superfund program, the Philadelphia region had some of the nation's highest concentrations of Superfund sites and by 2015, there were more than 200 registered sites in the area. There are several Superfund sites near the project area, including the Metro Container Corporation site in Trainer, PA, and the Lower Darby Creek Area near Eastwick.

Following the Superfund program's inception in 1980, the EPA began designating brownfield sites in the late 1990s to address vacant land and former industrial sites with legacy contamination. The EPA designates brownfield sites as those with contamination less severe than Superfund sites and with a remediation process that is selected through various federal and state programs. Since many of these former industrial sites were located proximally to transportation routes (rail, highways, waterways), they have become areas for potential redevelopment, post remediation, into residential or commercial uses. Of the 335 total brownfields in the project area, 203 of them are clustered in Delaware County. Active industrial sites will be the brownfields of the future and will require clear guidance on remediation, especially for formerly heavy industry facilities. The former PES Refinery site is an example of this as the largest remediation and redevelopment effort in the study area.

REGULATORY BODIES

FEDERAL AGENCIES

At the federal level, the EPA is involved with permitting, monitoring, and enforcing various pollution programs related to the environment (air, water, soil). Major 20th century environmental laws enacted by Congress led to the formation of these programs today, of which the EPA has primary implementation authority. These laws include the Clean Water Act (1948, 1972),[7] the Clean Air Act (1970, 1977, 1990)[8], Toxic Substances Control Act (1976),[9] Resource Conservation and Recovery Act (1976),[10] and the Comprehensive Environmental Response, Compensation, and Liability Act (1980).[11]

STATE AGENCIES

At the state level, the PA DEP oversees, coordinates, and manages EPA grants. The PA DEP is also responsible for enforcing regulations for various facilities under the different programs, such as the Hazardous Waste Program (under the RCRA program), the Water Pollution Control Program (under NPDES), and the Storage Tank Program.

TYPES OF INDUSTRIAL RISK

The various industrial facilities found within the study area include tank farms, petroleum refineries, oil and gas pipelines, chemical facilities, hazardous waste facilities, sewage sludge incinerators, and railroads, roads, and ports acting as transport links for these hazardous materials. These facilities handle, transport, and store pollutants including petroleum products, toxic metals, wastewater, and various chemicals.

Inherent to any industrial facility is the risk of failure and sudden increased discharges of pollutants into the natural environment that have not been permitted. The types of risk can be broadly classified into three categories:

- Fires and explosions
- Leaks and spills
- Air Pollution

GENERAL RISK

1. Fires and Explosions

Fires and explosions pose a serious risk to the operation of industrial facilities and have the potential to cause much larger, long-standing issues like polluting the surrounding environment and severe injury and loss of life. One of the largest causes of these is combustible dust, which can be found across various facilities from chemical plants to food processing plants.[12] Dust, when combined with oxygen and an ignition source, can ignite and cause a larger explosion. Other causes include hot work (e.g. welding, soldering), interaction of flammable liquids and gases with an ignition source, faulty equipment or improper maintenance, and electrical hazards.[13]

A large amount of chemicals are released into the air and into adjacent neighborhoods as a result of fires and explosions. Such incidents also cause lingering air quality problems from smoke (see the 2019 Philadelphia Energy Solutions (PES) Refinery fire case study on page 24).[14]

2. Leaks and Spills

A leak or spill in an industrial facility involves the uncontrolled release of a hazardous substance, potentially resulting in harm to the environment and/or the public health.[15] Incidents may range in scale from small releases to large, major emergencies. Leaks and spills may also be "silent," where the leak goes undetected for a time, or be sudden and acute, triggering an emergency response (see the Bristol Township case study on page 22). Chemical leaks and spills can also result in fires and explosions as well as general contamination of soil and groundwater. Some main causes of spills and leaks are rough handling of storage and transport containers and corrosion of containers. Most chemical spill-related incidents occur at the interfaces of transport, storage, processing, and disposal of these chemicals, where one of the systems may be more vulnerable to failure or error.[16]

3. Air Pollution

Industrial air pollution poses serious risks to public health and the overall environment with the release of harmful substances into the air. There are two sources of emissions: 1) point-source emissions, and 2) non-point source. Point-source emissions are released at height or ground levels from an identifiable source such as an industrial facility, whereas non-point sources are not as easily identifiable and often derive from transportation and loading. Some examples of substances and pollutants that may be released from these sources include fine particulate matter, carcinogens, mercury, lead, arsenic, sulfur dioxide, and acid gases.[17]

An industrial accident runs the risk of suddenly releasing greater volumes of a permitted pollutant or the release of a substance that is typically contained and not a permitted pollutant.

FACILITY-SPECIFIC RISKS

Tank Farms

Tank farms store hazardous materials and are susceptible to explosions and fires. They contribute to continued air pollution while dislodgement of tanks from hurricanes, floods, or other natural hazards may cause catastrophic leaks.

Gas and Oil Pipelines

Pipelines carry hazardous liquids (like petroleum) and natural gasses; they can have both acute and long-term implications when a leak or spill occurs. Both gas and oil pipelines can contribute to air contamination in the event of a fire or explosion. They may also cause further environmental damage to waterways, soils, wildlife, and surrounding communities. While some pipelines are underground, those that are aboveground are also vulnerable to breakage with heavy rains and floods.

Petroleum Industries

Common hazards in the petroleum industry are fires and explosions due to the nature of the chemicals and chemical processes occurring in facilities. These fires can sometimes be deadly, or have far-reaching impacts on surrounding communities (see PES Refinery on page 9). Air and water pollution is of significant concern, and workers are also continuously exposed to health risks.

Railways, Roads,and Ports

Transportation of hazardous materials via road, train, or freight pose a risk of spillage and contamination if an accident occurs during transport. Trains are at risk of derailment, leading to ruptured tank cars, spills, and fires or explosions. Accidents like collisions or overturns of tanker trucks on roads pose a unique risk due to their often immediate proximity to other vehicles, particularly on highways or in densely populated areas. Freight poses a high risk to populated transport corridors and water bodies.

Chemical Facilities

Water contamination can occur at chemical facilities when chemicals leak or are not disposed of properly, while air pollution poses a significant risk to communities living near facilities due to continued exposure to toxic chemicals. Like petroleum facilities, chemical facilities are at high risk of explosions, which pose serious threats to human health and the environment.

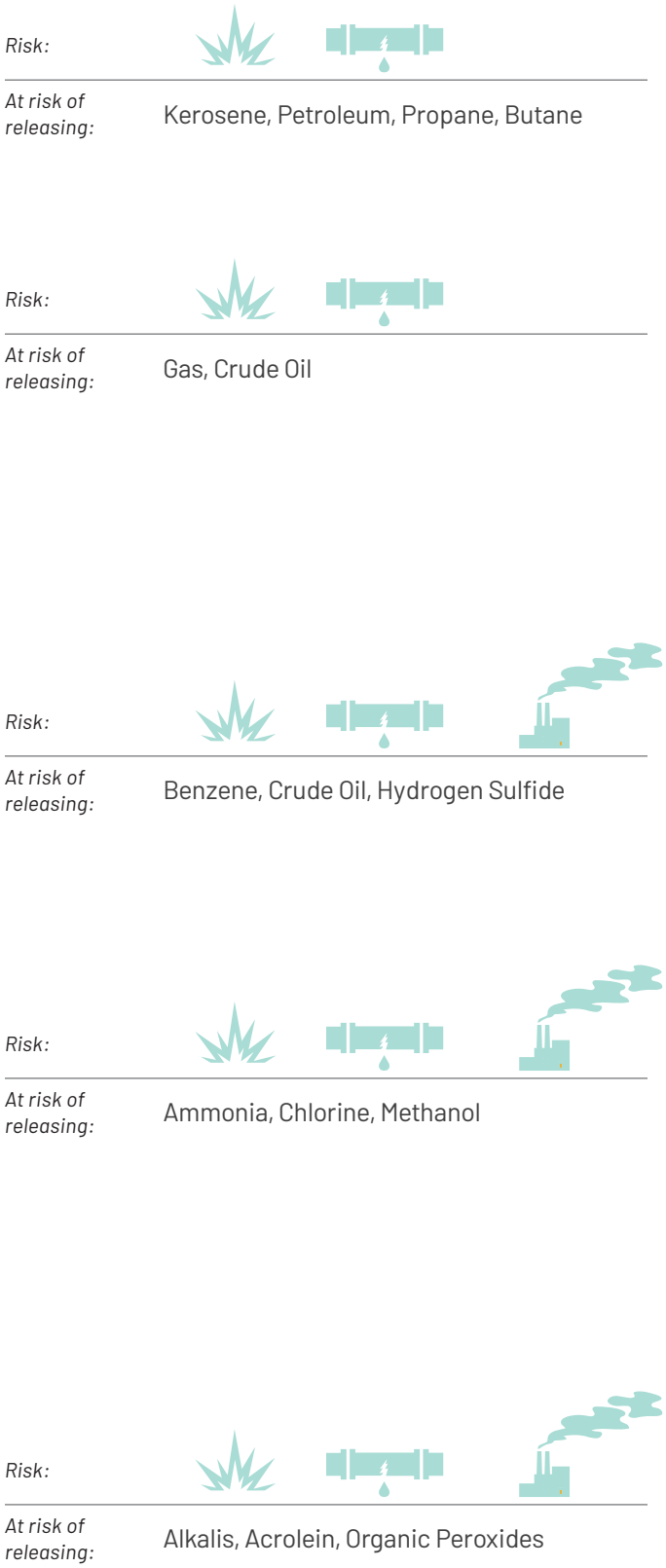


Figure 17. Chart showing selected examples of potential pollutants by source type. Source: OLIN



Figure 18. Cargo ship near Marcus Hook. Source: OLIN



Figure 19. Marcus Hook. Source: OLIN

SIGNIFICANT INDUSTRIAL ACCIDENTS IN THE REGION

Tinicum Crude Oil Spill 2000

A Sunoco pipeline located under the John Heinz National Wildlife Refuge developed a three-inch crack and created a 192,000 gallon oil spill.[18] Immediate cleanup in the impoundment area adjacent to the spill took more than a month and the overall total area of impacted habitat was about six acres.

Delaware River Oil Spill 2004

In 2004, a tank vessel spilled more than 260,000 gallons of crude oil into the Delaware River. Spilled oil was found on more than 280 miles of shoreline and a nearby nuclear power plant was shut down for a week to prevent oil in the river from impacting its water intake system. Recovery efforts took up to a year.[19]





Figure 20. Pipelines near Marcus Hook. Source: OLIN

Paulsboro Train Derailment 2012

In November 2012, a Conrail train derailed on the century-old Jefferson Street Bridge in Paulsboro, New Jersey, sending four rail cars containing vinyl chloride into Mantua Creek. One of the cars was punctured and released approximately 24,000 gallons of toxic gas into the air. The incident led to the evacuation of hundreds of residents and required dozens to seek medical attention due to exposure to the hazardous fumes.[20]

Bristol Township Chemical Spill 2023

A burst pipe at a chemical plant in Bristol, Pennsylvania in 2023 resulted in a leak of more than 8,000 gallons of chemicals into a tributary of the Delaware River.

Bartram's Garden Chemical Spill 2024

Former industrial properties near Bartram's Garden leaked chromium chemicals onto Bartram's Mile Trail, a publicly used access trail. The trail was shut down; however, there was a lack of public notification and information on how much of the chemical spilled.[21]



Figure 21. Gas pipelines run throughout Southwest Philly near the former PES Refinery site. Source: OLIN, 2021.

PES Refinery Explosion 2019

A fire and multiple explosions at the Philadelphia Energy Solutions (PES) Refinery in 2019 led to the release of 5,000 pounds of hydrofluoric acid and other chemicals into the air. There were multiple explosions and a resulting fire that burned for more than a day, forcing residents in nearby communities to shelter in place.

In the immediate aftermath, significant hazards remained present and personnel from the Philadelphia Fire Department and Office of Emergency Management remained on-site for more than three months. It was revealed that approximately 676,000 pounds of hydrocarbons were released during the event.

The refinery ultimately closed down with a loss of more than a 1,000 jobs and lasting impacts to the community's health outcomes.[22]



Figure 22. The PES Refinery site after the explosion and before the area had been cleared for new development. Source: OLIN, 2021.

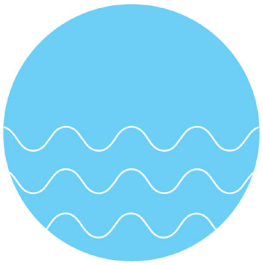
CONTAMINATION IN OUR AIR, SOIL, AND WATER

SOIL & GROUNDWATER CONTAMINATION



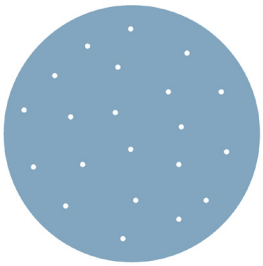
Soil and groundwater contamination can occur when chemicals or waste are released into the environment and migrate through the soil to the groundwater. Such contamination can come from aboveground spills, leaks from underground storage tanks, contaminated recharge water, or other underground structures. Without adequate barriers or protection,groundwater contamination can lead to poor water quality, loss of water supply, degraded surface water systems, high cleanup costs, high costs for alternative water supplies, and/or potential health problems. Several federal laws, including the Clean Water Act and the Resource Conservation and Recovery Act aim to protect groundwater from contamination by regulating pollutant discharges as well as hazardous and non-hazardous waste storage, treatment, and disposal.[24,25]

SURFACE WATER CONTAMINATION



Surface water contamination can be caused by any industrial, municipal, or agricultural waste discharged into water via point sources (e.g. a pipe, ditch,or a tunnel). Point source pollutants vary but include chemical waste, solid waste, dredged soil, radioactive waste, incinerator residue, and sewage. The EPA's National Pollutant Discharge Elimination System (NPDES) program permits point source pollutant discharges, but limits what can be discharged. Through NPDES, EPA can enforce monitoring and reporting requirements to ensure overall water quality and health.[26]

AIR EMISSIONS



Air pollution can come from both stationary sources, like power plants, and mobile sources, such as moving automobiles. Exposure to air pollution can lead to various respiratory and health issues and is of primary concern to anyone living near industrial facilities and major traffic corridors. Under the Clean Air Act of 1970, the EPA sets national standards and regulates 6 major pollutants: ozone, particulate matter , carbon monoxide, sulfur dioxide, nitrogen dioxide, and lead.[23]

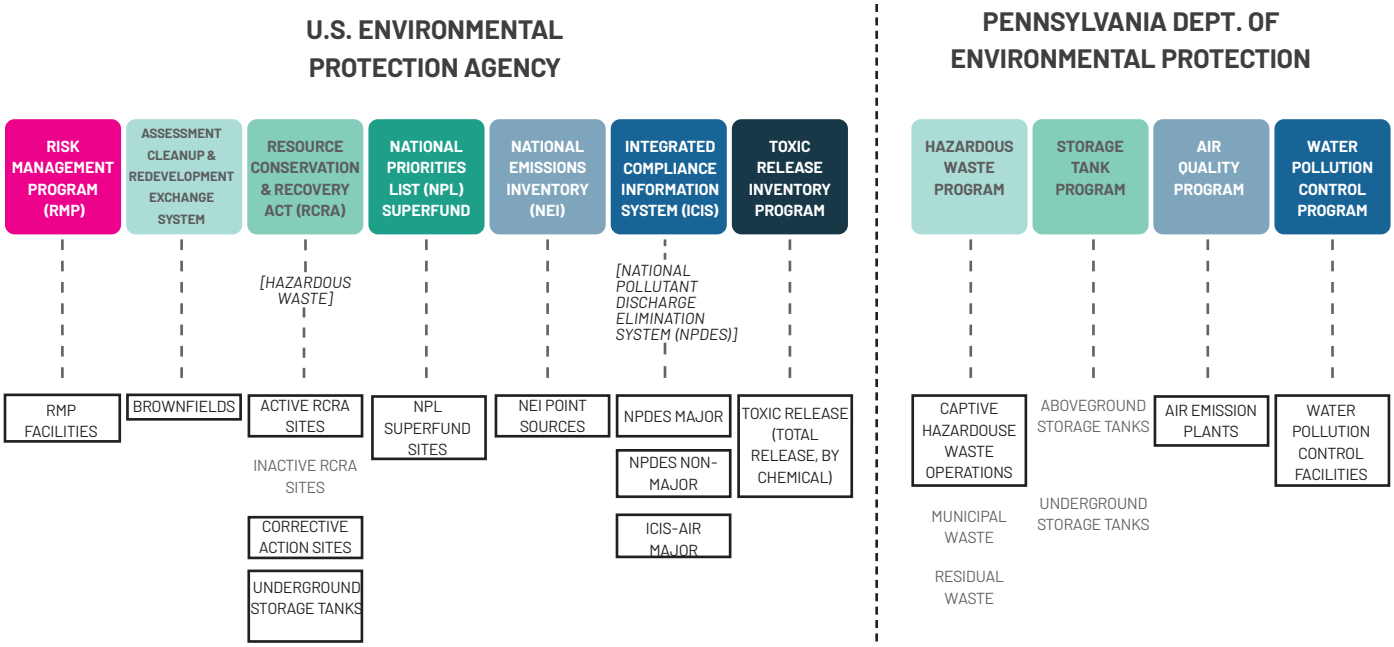


Figure 23. Diagram illustrating various sources of contamination datasets. Datasets highlighted in a black box indicate data used in this study's mapping and analysis. Source: OLIN

Sourcing of Contamination Data

Contamination data was collected from various federal and state programs that regulate facilities with a potentially significant presence of hazardous materials and/or substances. We classified industrial sites as facilities or sites that are currently active and hold active permits for various pollution sources. Brownfields are inactive sites that have the histories of industrial activities and may have presence of contaminants, pollution, or hazardous substances.

Navigating the Data Landscape

Contamination datasets are fragmented across different federal and state regulatory programs, creating a challenging data landscape. Different programs collect and store data in different datasets, where industrial facilities are often cross-listed, making comprehensive analysis of a facility's true contamination scope difficult to understand. The siloed and opaque nature of these datasets complicates research and policy planning, but it also creates substantial barriers for community members and others trying to understand the environmental and health risks that the data implies or engage in environmental accountability.

Data Classifications

Industrial Sites:

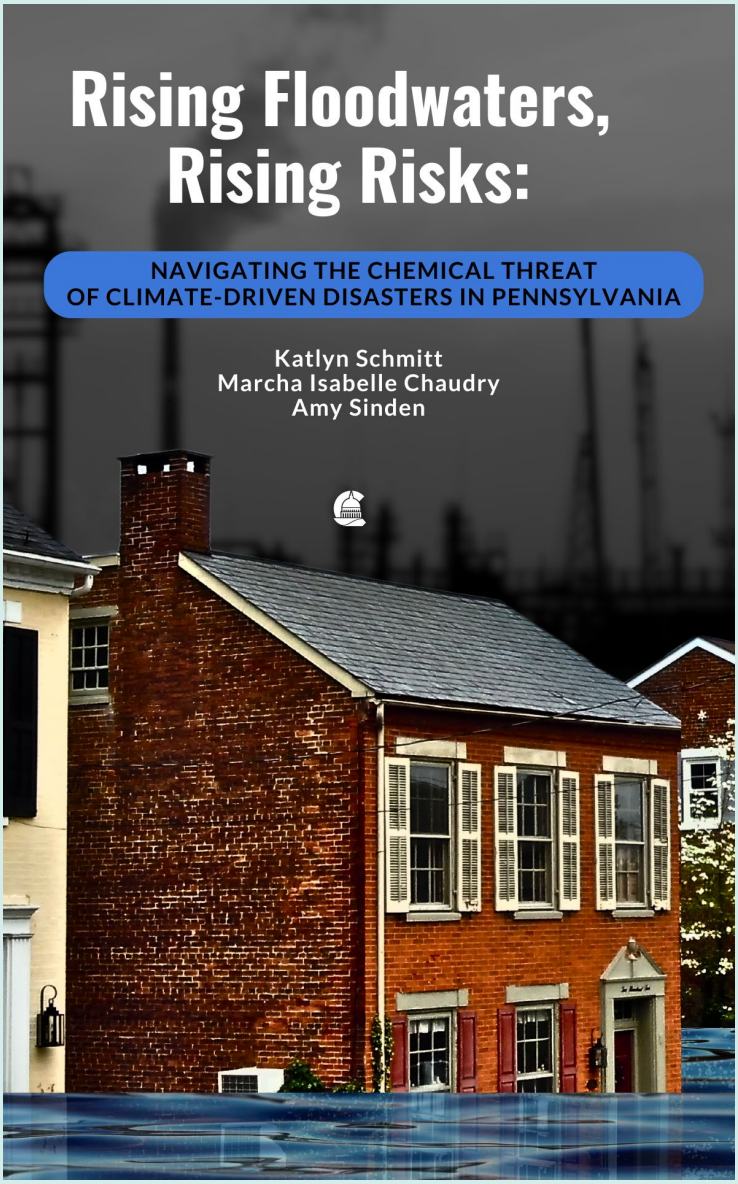
- Risk Management Program (RMP)
- Toxic Release Inventory (TRI)
- National Pollutant Discharge Elimination System (NPDES): Major, Non-Major
- National Emissions Inventory (NEI)
- ICIS-AIR Major
- Captive Hazardous Waste Facilities (PA)
- Air Emission Plants (PA)
- Water Pollution Control Facilities (PA)
- Solid and Hazardous Waste Facilities (NJ)
- Air Quality Permitted Facilities (NJ)
- Discharge to Surface Water Individual Major Facilities (NJ)
- New Jersey Pollution Discharge Elimination System Regulated Facilities (NJ)

Brownfield Sites:

- ACRES Brownfields
- Resource Conservation and Recovery Act (RCRA): Active Sites
- RCRA Corrective Action Sites
- Underground Storage Tanks
- National Priorities List (NPL) Superfund Sites
- Active Storage Tanks (PA)
- Known Contaminated Site List (NJ)
- Immediate Environmental Concern Sites (NJ)

See appendix for definition of datasets.

RISING FLOODWATERS, RISING RISKS:
NAVIGATING THE CHEMICAL THREAT OF CLIMATE-DRIVE DISASTERS IN PENNSYLVANIA



In April 2024, the Center for Progressive Reform (CPR) released "Rising Floodwaters, Rising Risks: Navigating the Chemical Threat of Climate-Driven Disasters in Pennsylvania." The report looks at industrial facilities within Pennsylvania's Upper Estuary watershed boundary that pose toxic floodwater threats to communities, with a focus on those that are already socially vulnerable, and recommends various policies at the local, state, and regional levels.

OLIN worked with CPR to help map the various industrial facilities at the watershed scale and to identify which of these sites were both susceptible to flooding and in socially vulnerable communities (see Figures 3 and 4). The focus was on sites with high risk of toxic exposure listed at the federal and state level, such as Risk Management Program facilities, hazardous waste facilities listed through the PA DEP Superfund sites, and active storage tanks.

The report's findings revealed that there are over 15,754 industrial facilities and operations, brownfields, and chemical storage tanks, and that, in 2021, these facilities reported releasing over 825,400 pounds of toxic chemicals (not including air pollution). Of these facilities, 18 % are located in the most socially vulnerable census tracts and 6% are flood-exposed.[24]

Figure 24. Rising Floodwaters, Rising Risks cover page. Source: Center for Progressive Reform

The full report can be found here:

» **https://progressivereform.org/publications/rising-floodwaters-rising-risks**

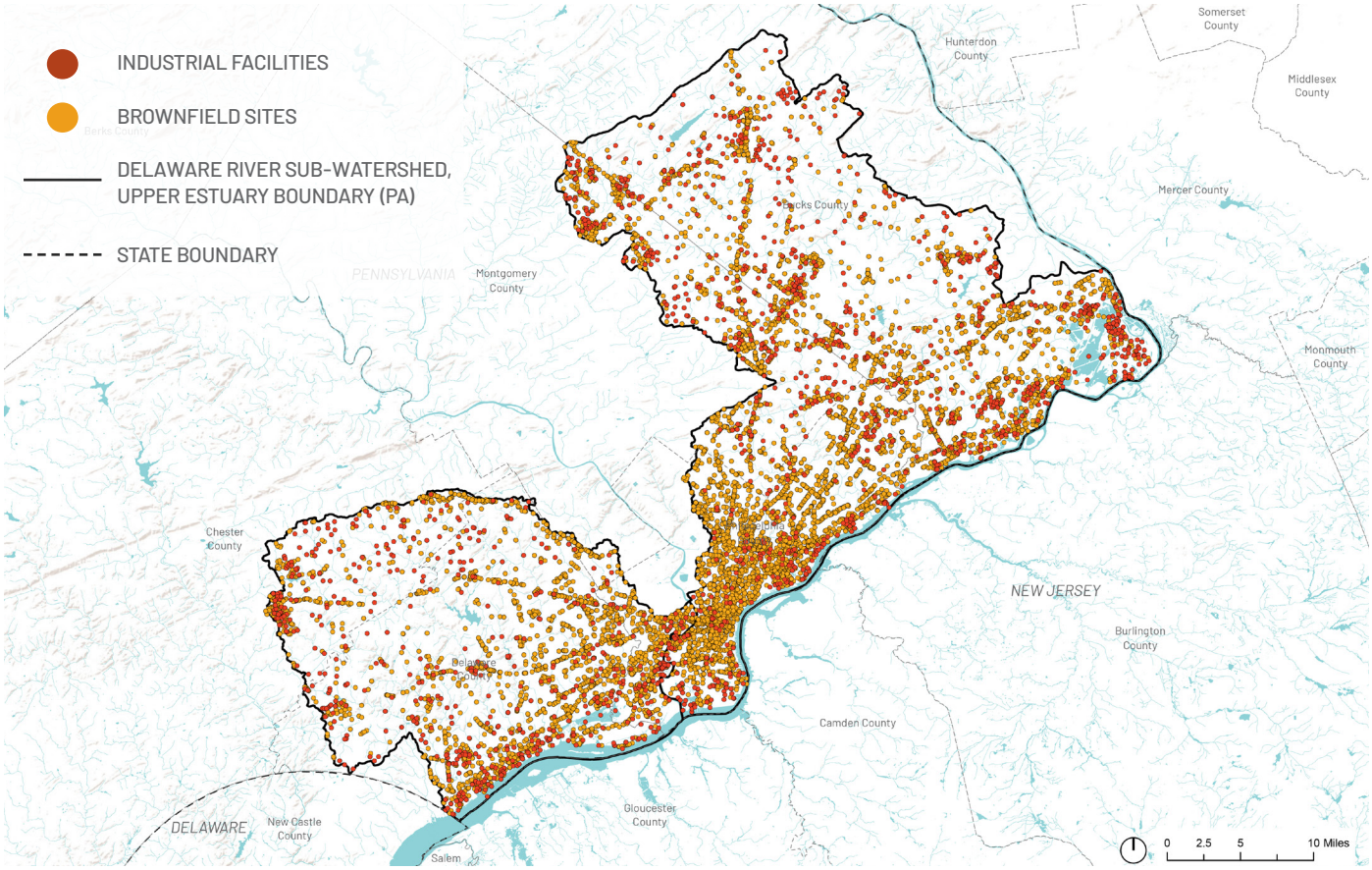


Figure 25. All industrial and brownfield sites within the PA Upper Estuary Region of the Delaware River. Source: OLIN

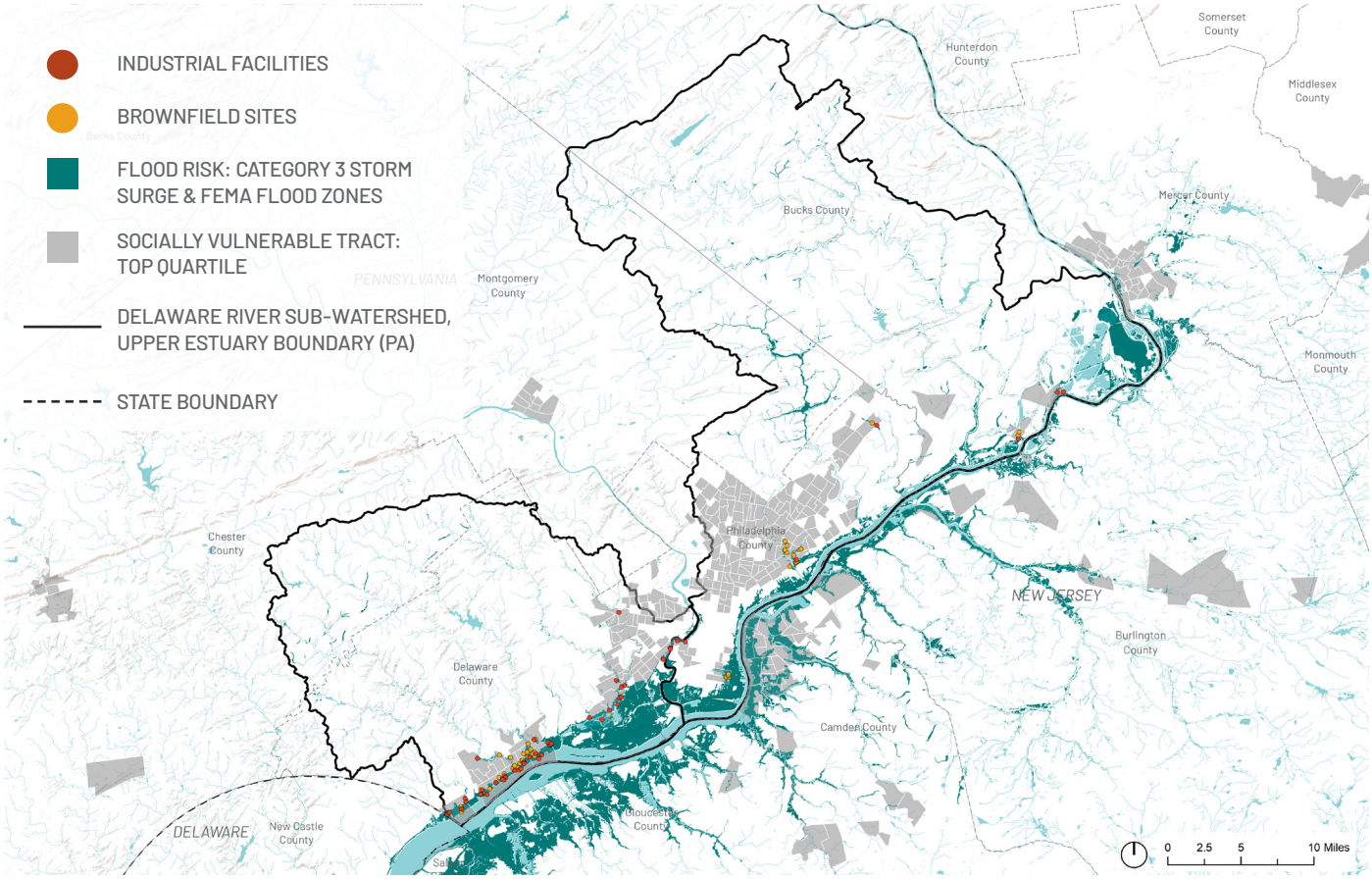


Figure 26. All industrial and brownfield sites that lie within areas of flood risk (based on Category 3 storm surge and FEMA 1% (100-year) and 0.2% (500-year) FEMA floodplains within the top quartile of socially vulnerable tracts (based on the CDC Social Vulnerability Index). Source: OLIN

DATA GLOSSARY

INDUSTRIAL FACILITIES

PROGRAM/FACILITY	DESCRIPTION
RISK MANAGEMENT PROGRAM FACILITIES (RMP)	The dataset covers facilities holding more than a threshold quantity of a regulated (and extremely hazardous) substance and that are subject to a process in compliance with EPA's Risk Management Program regulations.
TOXIC RELEASE INVENTORY (TRI)	TRI tracks the management of certain toxic chemicals that may pose a threat to human health and the environment. U.S. facilities in different industry sectors must report annually how much of each chemical is released to the environment and/or managed through recycling, energy recovery, and treatment. (A "release" of a chemical means that it is emitted into the air or water, or placed in some type of land disposal.) Section 313 of the Emergency Planning and Community Right-to-Know Act created the TRI.
NPDES MAJOR/NON-MAJOR	The NPDES dataset provides outfall locations of various pollutants into water systems from facilities being monitored by the EPA. Major dischargers are defined as facilities with design flows equal to or greater than one million gallons per day, or that serve a population of 10,000 or more, or that cause significant water quality impacts.
NATIONAL EMISSIONS INVENTORY (NEI)	The National Emissions Inventory (NEI) is a comprehensive and detailed estimate of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants from air emissions sources. The NEI is released every three years based primarily upon data provided by state, local, and tribal air agencies for sources in their jurisdictions and supplemented by data developed by the US EPA.
ICIS-AIR MAJOR	ICIS-AIR contains compliance and permit data for stationary sources of air pollution (such as electric power plants, steel mills, factories, and universities) regulated by the EPA as well as state and local air pollution agencies. A facility is classified as a Major Discharger if: a) Actual or potential emissions are above the applicable major source thresholds, or b) Actual or potential controlled emissions are > 100 tons/year, or c) Unregulated pollutant actual or potential controlled emissions are > 100 tons/year.
PA DEP CAPTIVE HAZARDOUS WASTE FACILITY	A Captive Hazardous Waste Operation is a DEP primary facility type related to the Waste Management Hazardous Waste Program. Facilities included in the dataset are: Boiler/ Industrial Furnace, Disposal Facility, Hazardous Generator, Incinerator, Recycling Facility, Storage Facility, and Treatment Facility.
PA DEP AIR EMISSION PLANT	An Air Emissions Plant is a DEP primary facility type related to the Air Quality Program. Facilities included in the dataset are: Air Pollution Control Device, Combustion Unit, Fuel Material Location, General Administrative Location, Incinerator, Point of Air Emission, and Process.

PROGRAM/FACILITY	DESCRIPTION
PA DEP WATER POLLUTION CONTROL FACILITY	A Water Pollution Control Facility is a DEP primary facility type related to the Water Pollution Control Program. Facilities included in the dataset are: Agricultural Activities, Biosolids Treatment, Compost/Processing, Conveyance System, Discharge Point, Groundwater Monitoring Point, Internal Monitoring Point, Land Discharge, Manure Management, Outfall structure, Pesticide Treatment Area, Pipeline or Conduit, Production Service Unit, Pump Station, Septage Land Application, Storage Unit, and Treatment Plant.

BROWNFIELD SITES

PROGRAM/FACILITY	DESCRIPTION
ACRES BROWNFIELDS	This dataset provides location and facility information for sites found in the Assessment Cleanup and Redevelopment Exchange System (ACRES). ACRES stores information reported by EPA brownfields grant recipients on Brownfields assessed or cleaned up with grant funding, as well as information on Targeted Brownfields Assessments performed by EPA Regions.
RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)	This dataset provides location and facility information for active hazardous waste sites found in the Resource Conservation and Recovery Act Information System
RCRA CORRECTIVE ACTION	This dataset provides boundaries for those areas where cleanup activities are underway due to the release of hazardous waste or hazardous constituents from facilities into soil, groundwater, surface water, or air.
UNDERGROUND STORAGE TANKS	This dataset contains information about, and the locations of, leaking underground storage tanks, underground storage tank facilities, and underground storage tanks. Data is current as of 2018-2021.
NATIONAL PRIORITIES LIST (NPL) SUPERFUND	The National Priorities List (NPL) is the list of sites of national priority among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation.
PA DEP ACTIVE STORAGE TANKS	A Storage Tank Location is a DEP primary facility type, and the storage tanks at the facility are the sub-facilities. Active storage tanks are aboveground or underground tanks in a status of “currently in use” or “temporarily out of use," which means the tanks still exist in a regulated status. These tanks are currently registered to hold a regulated substance, which could be a petroleum product or a hazardous substance. Aboveground storage tanks with a capacity greater than 21,000 gallons, and aboveground storage tanks that contain highly hazardous substances, are removed from this layer.

ENDNOTES

1 Zrinski, Tara M. n.d. "Pipelines." Encyclopedia of Greater Philadelphia. Accessed November 12, 2024. https://philadelphiaencyclopedia.org/essays/pipelines/.

2 Dixon, Mark E. "Big Inch: The Local Oil Pipeline That Lead to World War II Victory." Main Line Today (blog), July 29, 2011. https://mainlinetoday.com/life-style/big-inch-the-local-oil-pipeline-that-lead-to-world-war-ii-victory/.

3 Ibid.

4

5 "History - At a Glance - Delaware County, Pennsylvania." Accessed November 12, 2024. https://delcopa.gov/departments/history.html.

6 "Borough History." Accessed November 12, 2024. https://marcushookboro.org/index.asp?SEC=13150BA2-FAEC-4FAB-8BB1-8E0DE1AB1960&DE=E911EDAD-D9F4-4988-ABFB-2C87177A7143&Type=B_BASIC.

US EPA, OLEM. "What Is Superfund?" Overviews and Factsheets, November 9, 2017. https://www.epa.gov/superfund/what-superfund.

Nepa, Stephen. "Superfund Sites." Encyclopedia of Greater Philadelphia. Accessed November 12, 2024. https://philadelphiaencyclopedia.org/essays/superfund-sites/.

Nepa, Stephen. "Brownfields Redevelopment." Encyclopedia of Greater Philadelphia. Accessed November 12, 2024. https://philadelphiaencyclopedia.org/essays/brownfields-redevelopment/.

7 US EPA. "History of the Clean Water Act." Overviews and Factsheets, February 22, 2013. Great Lakes. https://www.epa.gov/laws-regulations/history-clean-water-act.

8 US EPA. "Summary of the Clean Air Act." Overviews and Factsheets, February 22, 2013. https://www.epa.gov/laws-regulations/summary-clean-air-act

9 US EPA. "Summary of the Toxic Substances Control Act." Overviews and Factsheets, February 22, 2013. https://www.epa.gov/laws-regulations/summary-toxic-substances-control-act.

10 US EPA. "Summary of the Resource Conservation and Recovery Act." Overviews and Factsheets, February 22, 2013. https://www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act.

11 US EPA, OECA. "Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Federal Facilities." Other Policies and Guidance, August 20, 2013. https://www.epa.gov/enforcement/comprehensive-environmental-response-compensation-and-liability-act-cercla-and-federal.

12 "5 Ways to Prevent Industrial Fires and Explosions." Accessed November 12, 2024. https://www.hafcovac.com/5-ways-to-prevent-industrial-fires-and-explosions/.

13 Ibid.

14 Schmidt, Sophia. "The PES Refinery Caught Fire 5 Years Ago. Here's What Employees Experienced." WHYY (blog). Accessed November 12, 2024. https://whyy.org/articles/pes-refinery-explosion-five-years-former-employees/.

15 UNDRR. "Leaks and Spills | PreventionWeb." PreventionWeb, June 7, 2023. https://www.preventionweb.net/understanding-disaster-risk/terminology/hips/tl0030.

16 Ibid.

17

18 Southern Environmental Law Center. "Industrial Air Pollution in Our Communities," October 16, 2024. https://www.southernenvironment.org/topic/environmental-injustice-industrial-air-pollution/.

Office of Pipeline Safety. "Building Safe Communities: Pipeline Risk and Its Application to Local Development Decisions." U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration, October 2010.

19

20 NOAA. "2004 Athos I Oil Spill on the Delaware River." Accessed November 12, 2024. https://response.restoration.noaa.gov/2004-athos-i-oil-spill-delaware-river#slideshow-1.

Bucks County, PA. "Bucks County Monitoring Chemical Spill," March 26, 2023. https://www.buckscounty.gov/CivicAlerts.aspx?AID=663.

Read, Zoe. "A Deade after Paulsboro, N.J. Train Derailment, Questions Linger over Rail Safety and Public Health." WHYY (blog), April 6, 2023. https://whyy.org/articles/train-derailment-rail-safety-paulsboro-nj-norfolk-southern-east-palestine/.

U.S. Department of the Interior. "Tinicum Crude Oil Spill." Accessed December 13, 2024. https://www.cerc.usgs.gov/orda_docs/CaseDetails?ID=922.

21 Read, Zoë. "Questions Remain around a Chemical Contamination from a Former Industrial Site next to Bartram's Garden." WHYY (blog). Accessed December 13, 2024. https://whyy.org/articles/chemical-spill-bartrams-garden-department-environmental-protection/.

22 "Investigation Report: Fire and Explosions at Philadelphia Energy Solutions Refinery Hydrofluoric Acid Alkylation Unit." CSB U.S. Chemical Safety and Hazard Investigation Board, October 11, 2022.

US EPA, OAR. "Clean Air Act Requirements and History." Overviews and Factsheets, May 27, 2015. https://www.epa.gov/clean-air-act-overview/clean-air-act-requirements-and-history.

US EPA. "NPDES Permit Basics." Overviews and Factsheets, September 23, 2015. https://www.epa.gov/npdes/npdes-permit-basics.

US EPA. "Summary of the Clean Water Act." Overviews and Factsheets, February 22, 2013. https://www.epa.gov/laws-regulations/summary-clean-water-act.

23 US EPA. "EPA History: Resource Conservation and Recovery Act." Collections and Lists, January 29, 2013. https://www.epa.gov/history/epa-history-resource-conservation-and-recovery-act.

24 Schmitt, Katlyn, Marcha Isabelle Chaudry, and Amy Sinden. "Rising Floodwaters, Rising Risks: Navigating the Chemical Threat of Climate-Driven Disasters in Pennsylvania." Center for Progressive Reform, April 2024. https://progressivereform.org/publications/rising-floodwaters-rising-risks/.



03

NATURAL HAZARDS



EXISTING RISKS

Between 2020 and 2022, the Philadelphia region was significantly impacted by tidal flooding events, hurricanes (Ida, Henri, Fred, Elsa, Isaias), tornadoes, quick-hitting winter storms, tidal flooding events, nor'easters, and other forms of severe weather.[1]

According to the Federal Emergency Management Agency (FEMA), from 2011 to 2021, Pennsylvania declared a total of nine statewide "climate disasters", requiring approximately $630 million in federal emergency response funds. Of those nine disasters, Philadelphia County declared five and Delaware County three.[2]

Climate Events in the Region

While climate change is already changing the pattern and intensity of natural hazards, the Delaware River Valley region has long been exposed to the risks of recurrent flooding and extreme heat. The region's major cities, Philadelphia and Wilmington, were both founded where major rivers meet the tidal Delaware River. Many communities were settled along local high ground adjacent to the banks of the Delaware River or its tributaries. However, as development has spread outward into lower-lying areas, communities, infrastructure, and industry are increasingly exposed to the natural hazards of flooding.

The increased development has come with a decrease in natural areas, wetlands, and porous surfaces, limiting the ground's ability to absorb water and reducing the presence of trees and other plants that aid in water absorption. The paved, impervious surfaces of roads and parking lots are all too common in the region's industrial and waterfront communities. These exacerbate flooding as rainwater piles up in place or is too swiftly redirected to streams, rivers, and low-lying areas, impacting adjacent and downstream communities. Impervious surfaces, a lack of tree canopy cover, and increased air pollution also combine to worsen the impact of naturally occurring heat waves through the urban heat island effect. Surface temperatures in the region can vary by as much as 20°F between urban and more naturalized areas.[3]

Although Philadelphia's hottest day was actually recorded in 1918, the region has seen 8 of its 10 hottest years on record in just the past 15 years.[4] This general increase in heat, combined with the local impacts of the urban heat island effect, have led to an increase in heat emergencies where vulnerable populations—including children, the elderly, persons with disabilities, and those experiencing poverty or homelessness—are disproportionately impacted. These incidents are proportionally higher in communities that have seen societal divestment due to their racial and ethnic populations.

Severe precipitation and rain events have occurred throughout the region as well, commonly associated with coastal storms such as Hurricane Agnes (1972), Hurricane Floyd (1999), Hurricane Isaias (2020) and Hurricane Ida (2021). Ida brought historic rainfall with some areas receiving up to 10 inches of rain in less than 24 hours, causing the Schuylkill River to reach its highest level in more than a century at 16.35 feet.[5] This increased precipitation flooded the Vine Street Expressway, shutting it down, and disrupting the city and larger region. While increased precipitation from hurricanes and storms is expected, there have also been shorter cloudburst events in the area. Cloudburst events produce enormous amounts of rain in a short period of time, are sometimes accompanied by hail and thunder, and are capable of creating flash floods and overwhelming stormwater systems.

Philadelphia's location 100 miles inland from the mouth of Delaware Bay, along with the bay's narrowness and orientation, have largely spared the region from the potential full impacts of coastal storm surge. It is notable that the highest flood elevation recorded along the Delaware River at Marcus Hook occurred during Hurricane Sandy (2012) while the highest in Philadelphia occurred during a 2024 nor'easter.[6,7] A larger and more powerful storm, such as a Category 3 hurricane directly hitting Delaware Bay and producing both storm surge and heavy rain, remains a significant and unprecedented threat.

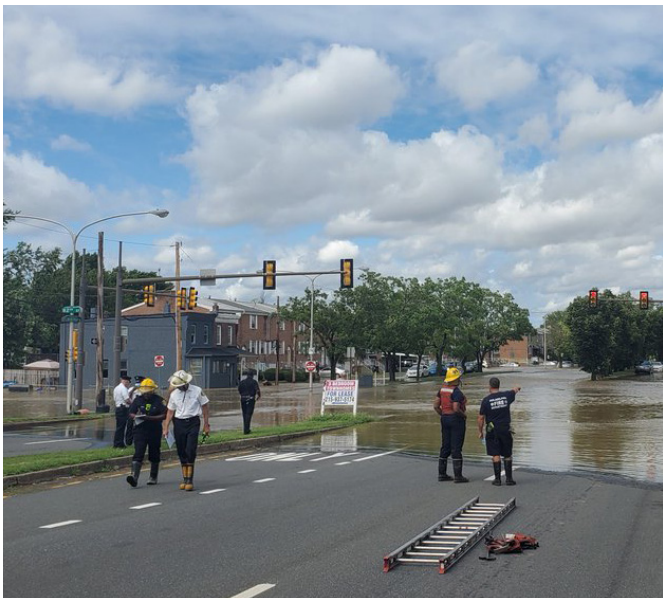


Figure 27. Flooding in Eastwick.
Source: Philadelphia Fire Department

Natural hazards are defined as environmental phenomena or events that have the potential to negatively impact or harm human communities. When these harms occur, they are referred to as natural disasters. While no single disaster or its impact is the same, natural disasters can be understood and generalized based on the underlying hazard that caused them.

Communities that are more exposed to these potential hazards are vulnerable and at a higher risk of experiencing a disaster. Climate change is expected to increase the frequency and intensity of natural hazards in this region, increasing the risks to communities along the Delaware River.[8]

EXISTING RISKS

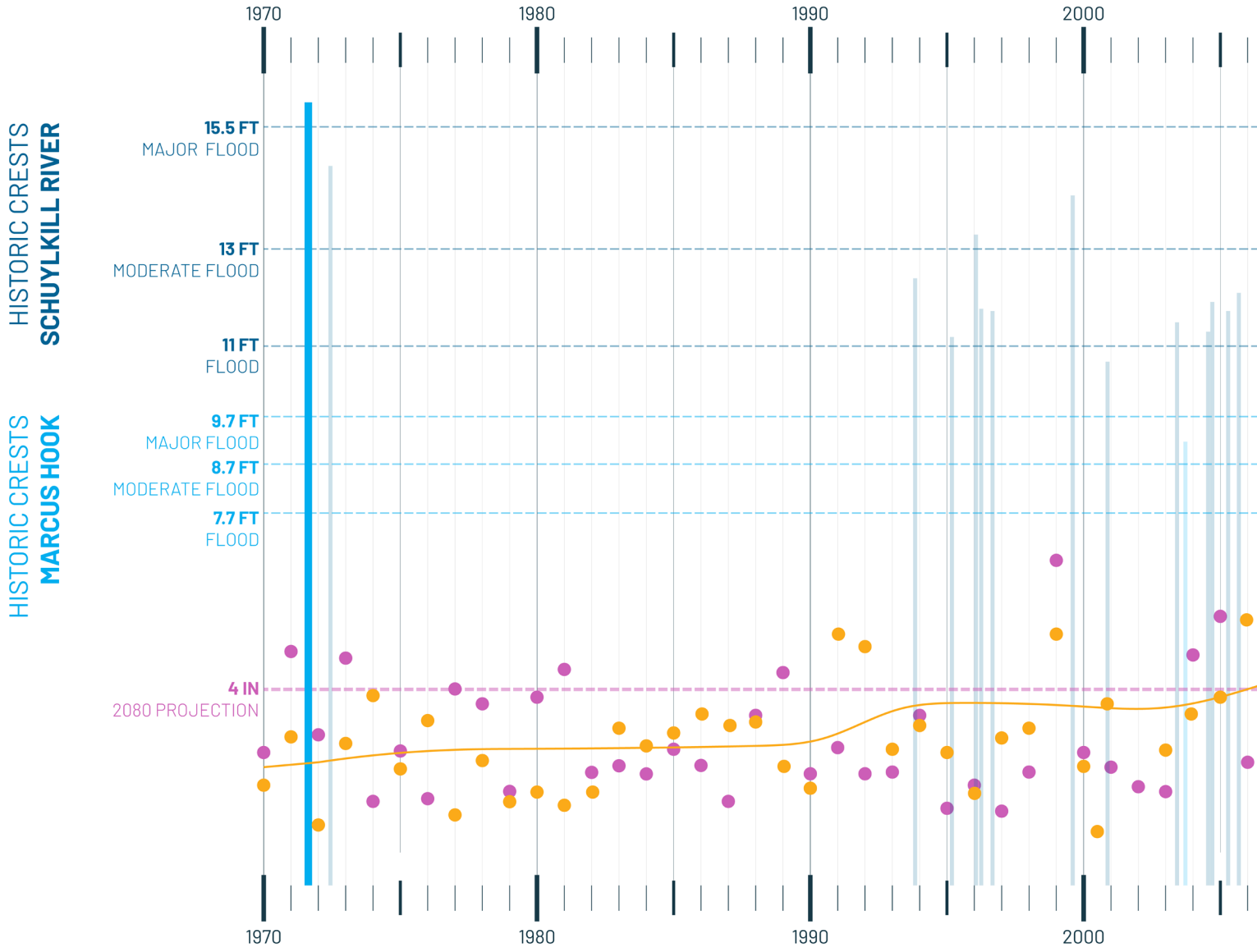
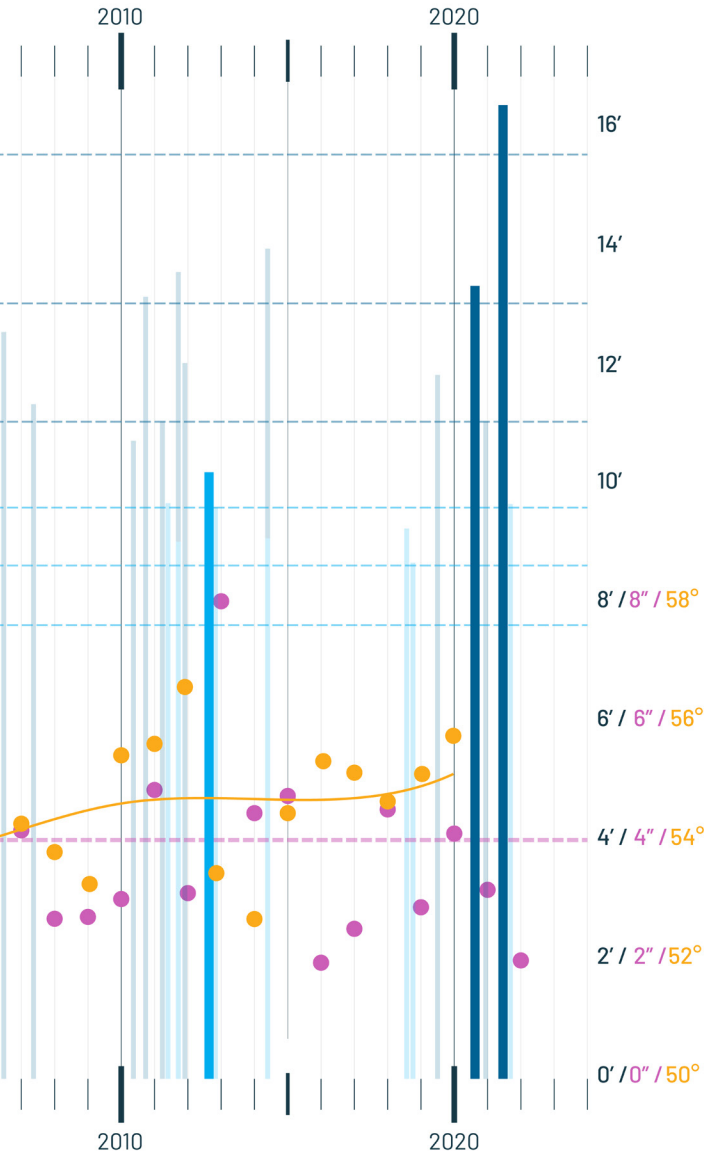


Figure 28. Chart of historic tidal gauge levels, precipitation levels, and temperature. Source: OLIN, Data from NOAA, Current Results



AVERAGE ANNUAL TEMPERATURE ° F

MOST PRECIPITATION IN ONE DAY

Historic Flooding in the Region

Both Philadelphia and Delaware County have faced a long and challenging history with flooding. One of the earliest dated and recorded major floods occurred in 1843 along the Schuylkill River, followed by the devastating "Great Flood" of 1869 which destroyed numerous bridges and key infrastructure.[9,10]

In the 20th century, one of the region's most significant flood events was Hurricane Agnes in 1972. The Schuylkill River crested at 23.5 feet in Philadelphia and the hurricane caused widespread damage in Delaware County, including in the municipalities of Chester and Marcus Hook. As a Category 1 hurricane, Agnes caused about $2 billion in damages to Pennsylvania and President Richard Nixon declared it to be "the greatest natural disaster in the history of the United States" at the time.[11,]

Other notable flood events in the 20th century include Hurricane Floyd in 1999, which caused extensive flooding, especially in Eastwick – up to 4 feet of water covered the neighborhood. More recent significant flooding came with Hurricane Irene in 2011 and Hurricane Isaias in 2020, which prompted evacuations and extensive damage across Delaware County.[12]

Figure 18 tracks historic crests at the Marcus Hook and Schuylkill River tidal gauge against the flood, moderate flood, and major flood levels. Average annual temperatures and precipitation levels are also shown, tracking all major climatic events in the region from 1970 to present day.

TYPES OF FLOODING

In the Philadelphia region, flooding can take many forms and has a variety of causes that drive where flooding occurs and at what depth and duration. While flooding is a natural occurrence along any river or coastline, it is particularly common in compound flood events that occur where rivers and the coastline (like the tidal Delaware River) converge.

Many communities along the Delaware River are also at the bottom of large tributary watersheds of the Delaware River, such as the Schuylkill River and Darby, Cobbs, Ridley, Chester, and Marcus Hook Creeks, making them also highly vulnerable to flash flooding from inland rain events.



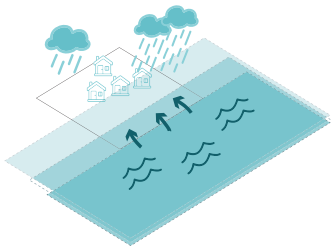
PLUVIAL

Pluvial flooding occurs when the intensity of precipitation exceeds the capacity of the land surface to infiltrate it and/or when the rate of runoff exceeds the conveyance capacities of natural and engineered drainage systems. Pluvial flooding is commonly described as "urban" flooding since it is a particularly important type of flooding in cities.



FLUVIAL

Flooding that occurs when the stage or water level of a river, creek, or stream exceeds the elevation of its banks. Given the close proximity between the region's creeks, river, and many of its communities, industries, and infrastructure, fluvial flooding is one of the more common flooding risks.



COASTAL

Coastal flooding is caused by high tides and storm surge in tidally influenced water bodies such as the Delaware River and Lower Schuylkill River. Wave action can also compound and worsen coastal flooding, but is generally less severe in tidal rivers than more open waterbodies. It is important to note that tidal flooding may recur more frequently due to land subsidence (where the ground sinks over time) and sea levels rise. This is increasingly leading to "sunny day flooding" events where flooding can occur without rainfall.



GROUNDWATER

Groundwater flooding is caused when the water table rises to levels that cause inundation of the land surface or subterranean property such as basements.

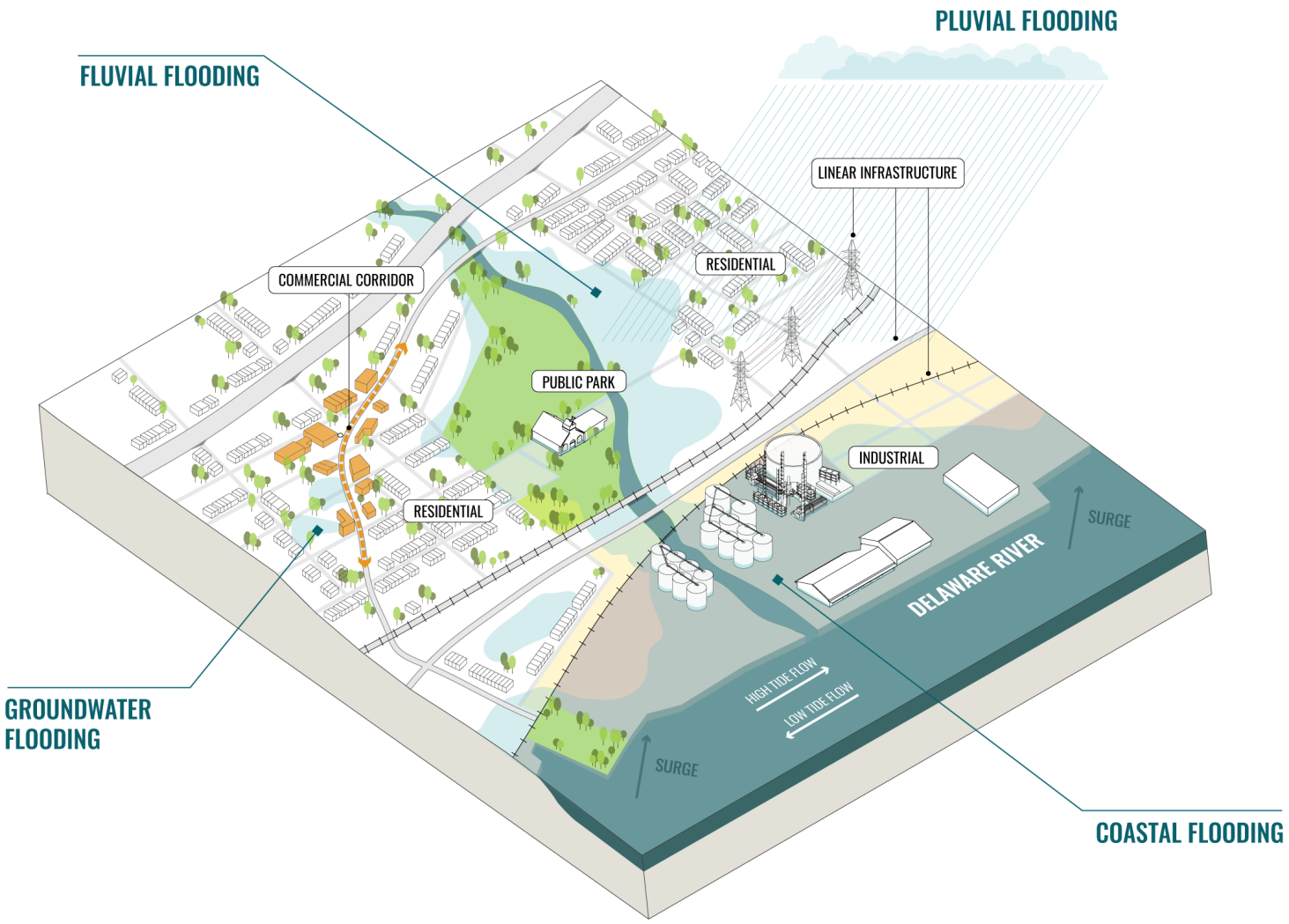


Figure 29. Diagram showing compound flooding processes. Source: OLIN

COMPOUND FLOODING

Compound flooding is caused by the combination of two or more flood drivers occurring simultaneously or in close succession. The most concerning potential example for the region is the combination of coastal flooding (storm surge) with fluvial and pluvial flooding also occurring due to a heavy rain event.

EXISTING FLOODING RISK

Flood hazards and their extents are commonly depicted using FEMA's National Flood Hazard Layer (NFHL) data and map products. The data incorporates both fluvial and coastal flooding, using past observations, studies, and hydrological models to categorize areas with a 1% (100-year) or 0.2% (500-year) annual chance of flooding.

It is worth noting that FEMA floodplains are based on historical data and their accuracy varies from location. Furthermore, existing and future flood risk levels are likely higher as climate change increases the frequency and severity of rain events and coastal storms. While FEMA floodplains may not most accurately depict flood risk, they remain the primary tool in the regulation of floodplains and flood insurance.

FLOODPLAINS

1% (100-year) FEMA floodplain

» Areas categorized as 100-year floodplains have a 1% or greater chance of their base flood elevation being exceeded each year. In other words, these areas have, on average, a 1% (or more) annual chance of experiencing a significant "100-year flood event." The occurrence of a 1% flood event does not reduce the chance of subsequent events, however. Two 1% events could happen in the same year.

0.2% (500-year) FEMA floodplain

» Areas categorized as 500-year floodplains have a .2% or greater chance of their base flood elevation being exceeded each year. In other words, these areas have, on average, a .2% (or more) annual chance of experiencing a significant "500-year flood event." The occurrence of a .2% flood event does not reduce the chance of subsequent events, however. Two .2% events could happen in the same year



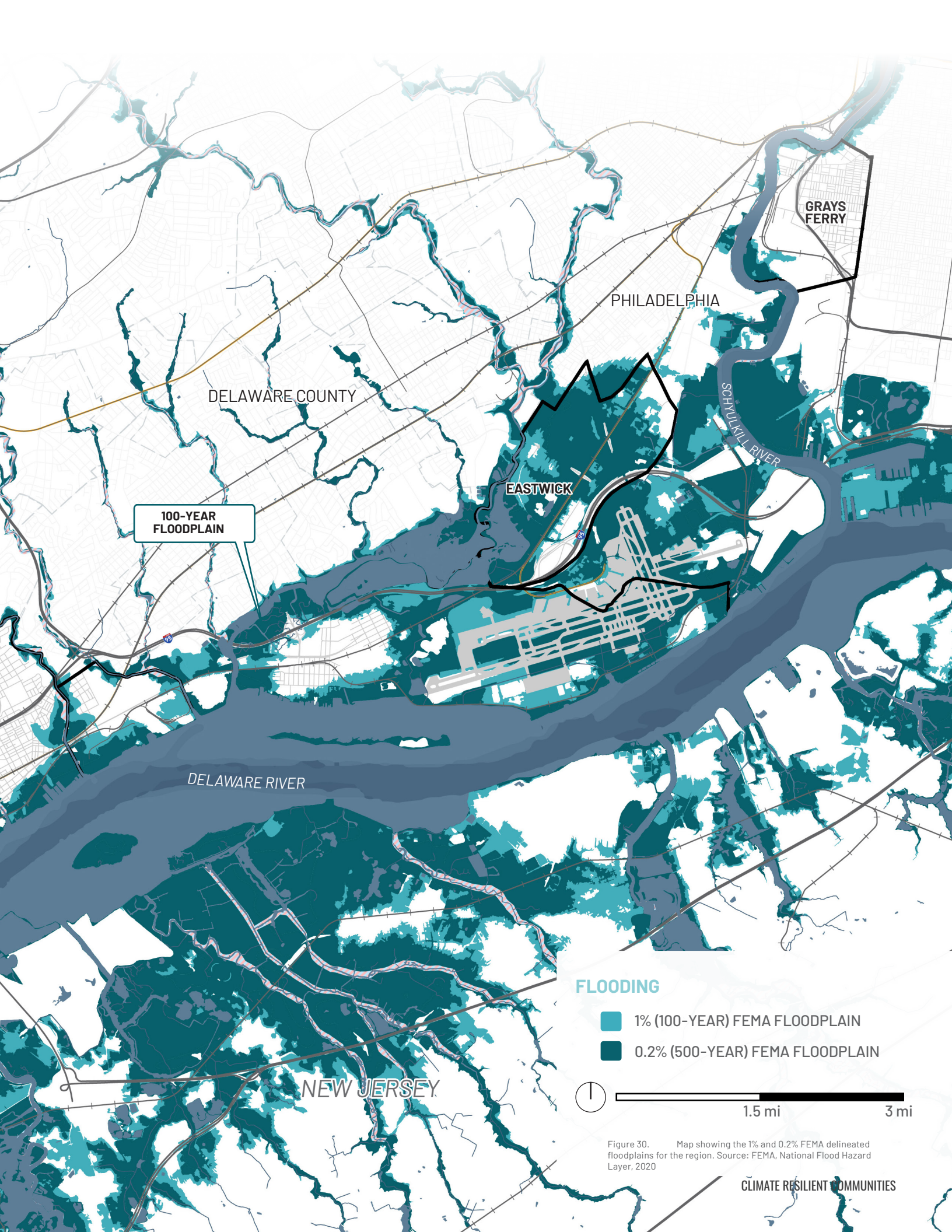


Figure 30. Map showing the 1% and 0.2% FEMA delineated floodplains for the region. Source: FEMA, National Flood Hazard Layer, 2020

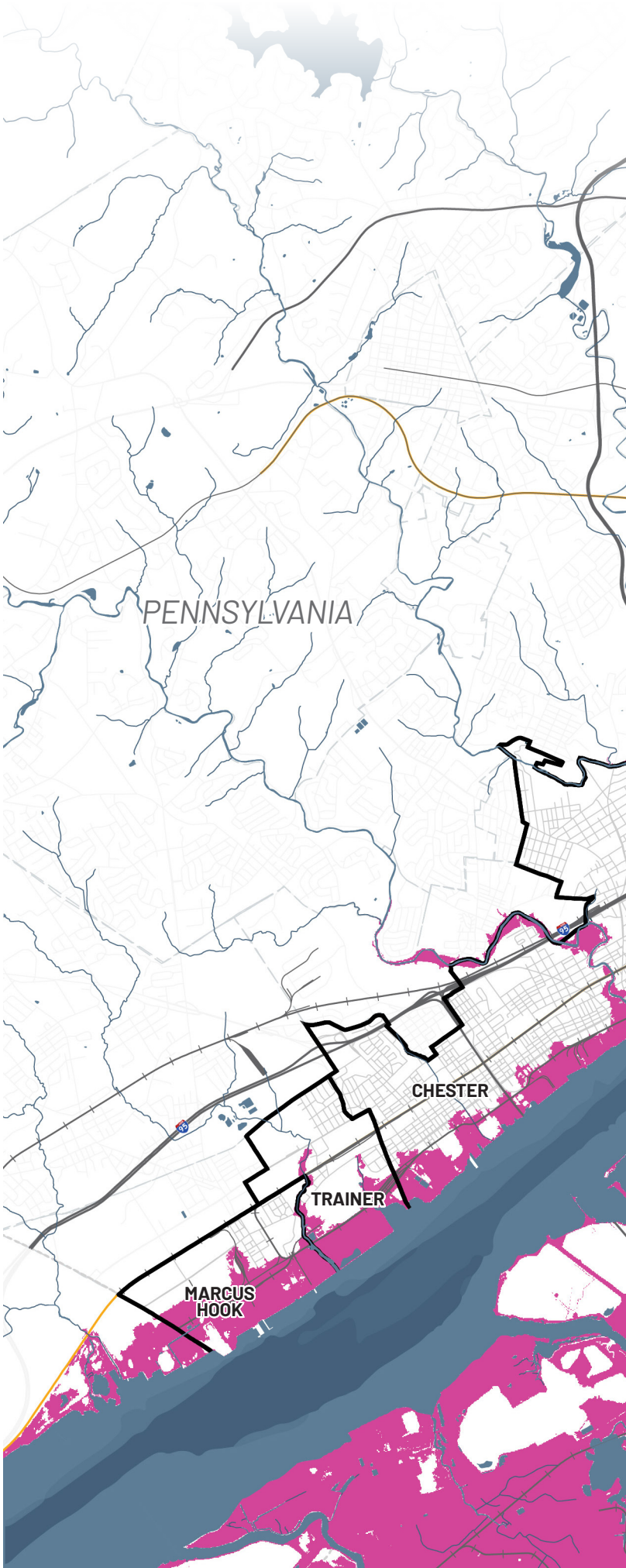
STORM SURGE RISK

The risks to communities from hurricanes, tropical cyclones, and nor'easters are significant, and the Philadelphia region and Delaware River Estuary have experienced repeated severe weather events over the years. Most recently, Superstorm Sandy (2012) raised the Delaware River to 10.14 feet in Marcus Hook, the highest recorded level since the gauge was installed in 1964.[13]

Coastal storms bring extreme winds, tornadoes, inland flooding, and storm surge. While all of these are destructive, storm surge is particularly harmful to life and property and is currently the leading cause of fatalities from hurricanes nationally. Storm surges are caused by the wind force of hurricanes and other coastal storms pushing water up rivers and creeks and onto land. When the surge coincides with high tides, storm surges can cause especially extreme flood damage inland. These surges are expected to worsen with continued sea level rise and increased incidents of recurrent flooding.

The National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service's National Hurricane Center, utilize the hydrodynamic Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model to simulate the worst-case scenario storm surge from coastal storm events. The modeling simulates numerous storms of varying speed, wind radius, intensity (Categories 1-5), landfall location, tide level, and storm direction to generate Maximum Envelopes of Water (MEOWs) and Maximum of MEOWs (MOMs) where the various simulated storms are aggregated together. While no single storm will produce the exact or extent of regional flooding depicted in the MEOWs, they represent an estimation of the maximum storm surge inundation possible at any given location.

NOAA has modeled storm surges for the Mid-Atlantic region for Category 1-4 storms. While a Category 4 storm may be possible in our region, it has never occurred before and is considered statistically unlikely.[14] A Category 3 storm simulation was used to evaluate the estimated maximum storm surge risk for the region. While there are no records of a hurricane of that strength making landfall in our region, there is significant evidence that climate change may make hurricanes more intense. Should a storm of this magnitude occur in the region, the SLOSH model predicts depths as high as 11-12 feet in Marcus Hook and as high as 8-9 feet along the Schuylkill River.



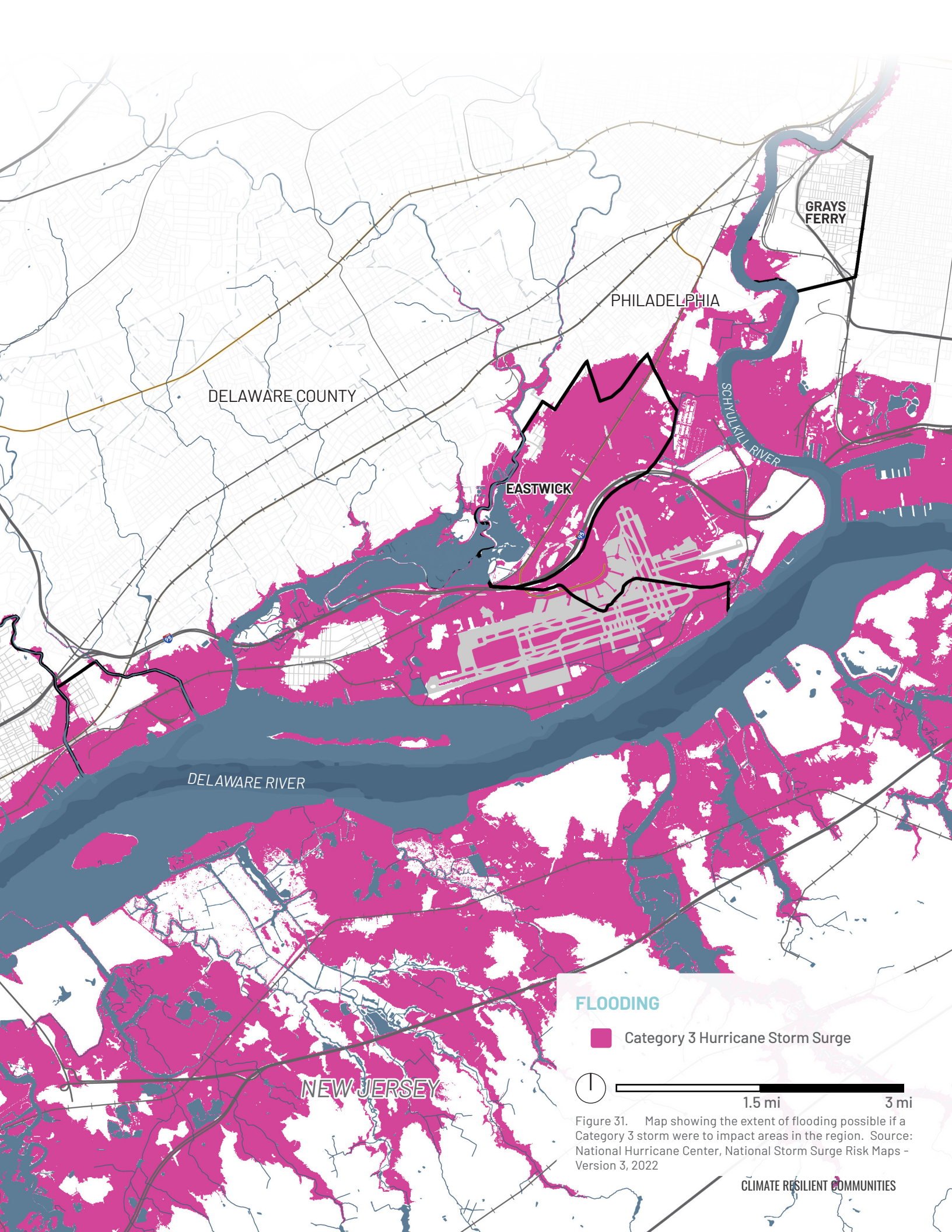


Figure 31. Map showing the extent of flooding possible if a Category 3 storm were to impact areas in the region. Source: National Hurricane Center, National Storm Surge Risk Maps - Version 3, 2022

HEAT WAVES

Over the past 82 years, the annual average temperature in the region has increased steadily, with the Philadelphia International Airport reporting that eight of the ten hottest years on record have occurred since 2000. From 1971 to 2000, on average, 4 days a year reached 100°F.[15]

Extreme heath, defined by the Centers for Disease Control and Prevention as weather that is much hotter and/or more humid than average for a particular time and place, can have significant health impacts on people and ecosystems. During heatwaves, vulnerable populations like children, pregnant women, lower-income residents, and older adults are at higher risk for heat-related illness and death. In an average year, heat kills more people in the U.S. than any other type of extreme weather.[16]

Locally, heat advisories are issued at the county level based on the National Weather Service. A heat advisory is issued if the heat index (a combination of air temperature and humidity) is expected to reach or exceed 100°F for 48 hours and an excessive heat warning is issued when the heat index reaches or exceeds 105°F for 48 hours.[17]

Philadelphia and Delaware County are two of the hottest counties in Pennsylvania, in part, because of the significant urbanization in the region. This contributes to the heat island effect, where urban areas tend to be hotter than the less urbanized areas surrounding them. Buildings, roads, and other paved surfaces absorb and re-emit the sun's heat more than natural landscapes such as forests and waterbodies. The human health hazards of extreme heat can also be exacerbated by local air pollution.[18]

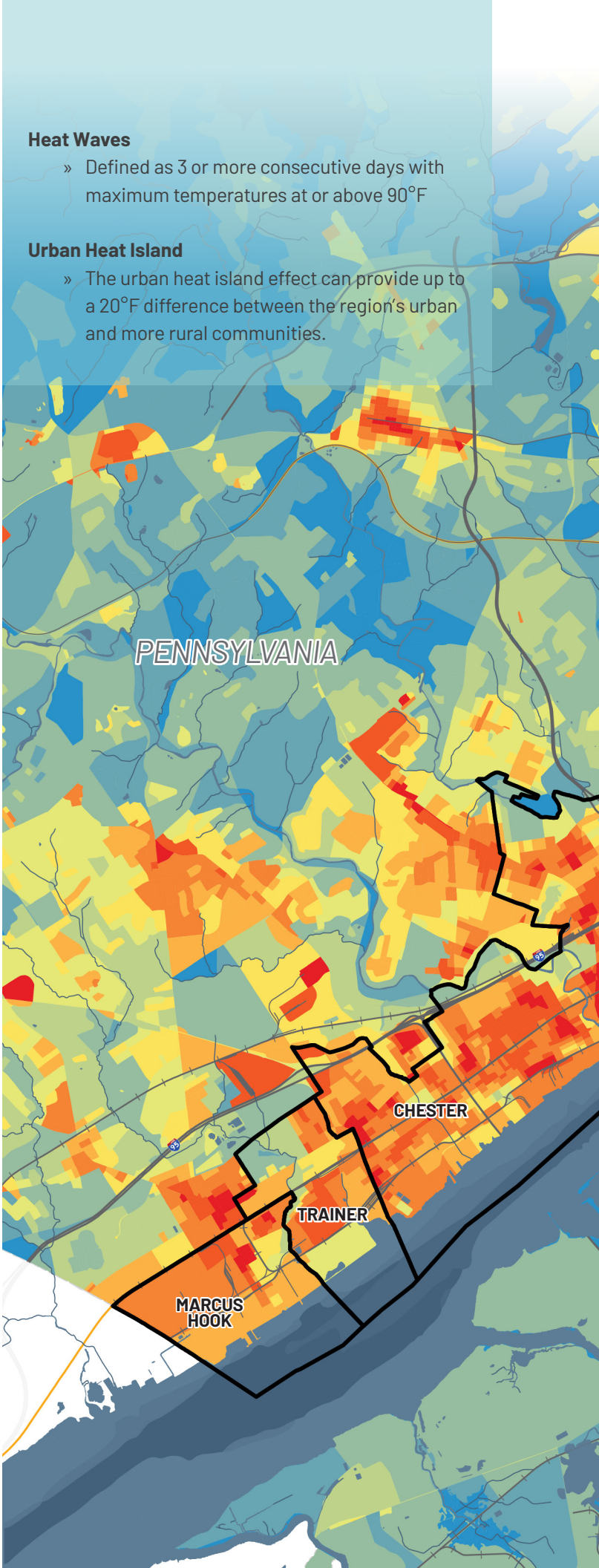
The Delaware Valley Regional Planning Commission, the City of Philadelphia, Delaware County, and a variety of regional organizations have been measuring existing heat disparities, tracking increasing heat over time, and developing short term and long term guidelines and strategies to mitigate the impacts of extreme heat.

Heat Waves

» Defined as 3 or more consecutive days with maximum temperatures at or above 90°F

Urban Heat Island

» The urban heat island effect can provide up to a 20°F difference between the region's urban and more rural communities.



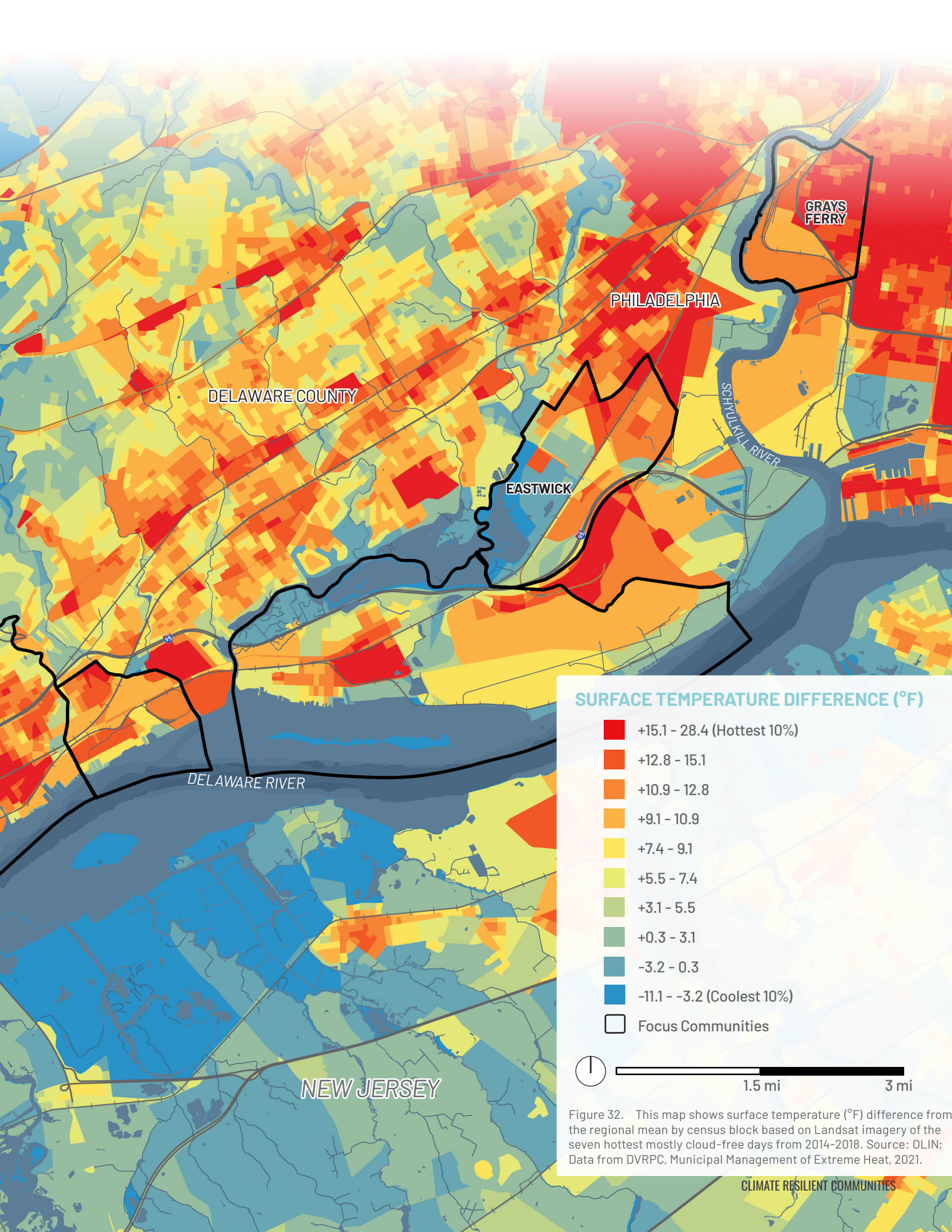


Figure 32. This map shows surface temperature (°F) difference from the regional mean by census block based on Landsat imagery of the seven hottest mostly cloud-free days from 2014-2018. Source: OLIN; Data from DVRPC, Municipal Management of Extreme Heat, 2021.

FUTURE RISKS

The communities along the Delaware and Lower Schuylkill Rivers are expected to become both hotter and wetter in the future through increased precipitation, rising sea levels, higher air temperatures, and more heat waves. In addition to these changes, extreme weather in the region is projected to continue to increase in frequency and severity, leading to increased riverine and stormwater flooding, among other impacts.[19]

1. STORM SURGE AND SEA LEVEL RISE

Extreme events, like hurricanes or nor'easters, will increase the depth of flooding and cause water to reach further inland. As a result of sea level rise, storm surges that occur today are about 8 inches higher than they would have been in 1900.

As seas and tidal rivers continue to rise, daily tidal flooding and storm surge baseline wave elevations will be dramatically amplified, translating into an increased risk and impact on coastal and tidal river communities. By 2100, it is very likely that sea level rise will be between 2 and 5.3 feet.[20]

2. INCREASED PRECIPITATION

Climate models indicate that rising temperatures will intensify the Earth's water cycle and increase evaporation, resulting in more frequent and intense precipitation and storms.

Extreme precipitation events have increased in frequency and intensity across the U.S. since the early 20th century and are projected to keep increasing, with a national average increase of 4% in annual precipitation between 1901 to 2015. The Northeast has experienced the strongest increases in heavy precipitation events.[21]

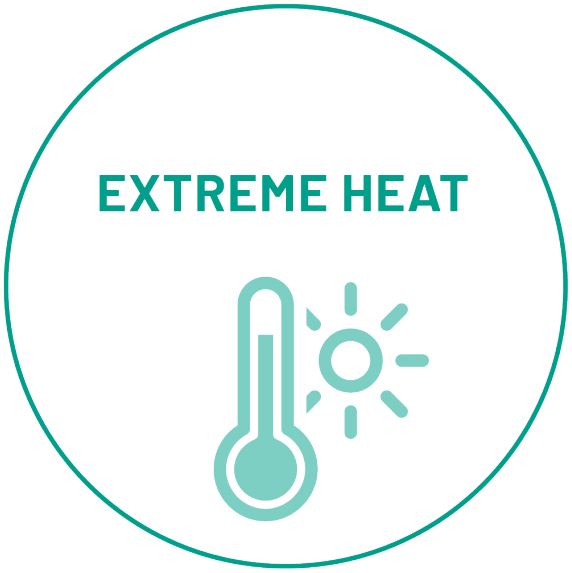
3. INCREASED HEAT

Extreme heat is increasingly a growing threat across the U.S. and in the Northeast. While extreme heat events have always occurred over the summer months, climate change has made these heat waves more frequent, severe, and longer lasting. The Northeastern climate is experiencing hotter days and longer heat waves. Between 1895 and 2011, temperatures rose by almost 2°F and projections indicate warming of 4.5°F to 10°F by the 2080s.[22]

The heat index, also known as apparent temperature, measures how hot a human body feels with relative humidity combined with air temperature. In Philadelphia, a hot day is considered to be a day above a "feels like" temperature of 104°F. There were 7 hot days in 2024 but there are projected to be 15 hot days above 104°F annually in 30 years from now[23] Humidity also reduces a body's ability to cool off.







By addressing the following climate threats together, we can create resilient solutions to ensure that our communities thrive for generations to come.

PROJECTED SEA LEVEL RISE

Sea and river level rise will result in daily tidal flooding. National Oceanic and Atmospheric Administration observations indicate that the tidal Delaware River has risen at a rate of about 1.2 inches per decade over the last one hundred years. These rises are projected to continue. By 2100, it is very likely that sea level rise will be between 2 and 5.3 feet.[24] The current range reflects the uncertainty of the pace of sea level rise.

For this report, the Consortium for Climate Risks in the Urban Northeast (CCRUN) Sea Level Rise Projections for the Philadelphia Region were used which are based on Coupled Model Intercomparison Projects (CMIP) 6 Projections for future sea level rise derived and downscaled from the Intergovernmental Panel on Climate Change's (IPCC) 6th Assessment Report. These projections are relative to the 1995 -2014 time period. Climate adaptation planning requires continually reviewing the latest local sea level rise projections.

Sea level rise alone is increasing the number of days that Philadelphia experiences high-tide flooding – flooding due to tide levels in the absence of a storm. Coupled with storm surges, sea level rise is causing increased coastal flooding, which is further exacerbated when accompanied by heavy precipitation events.

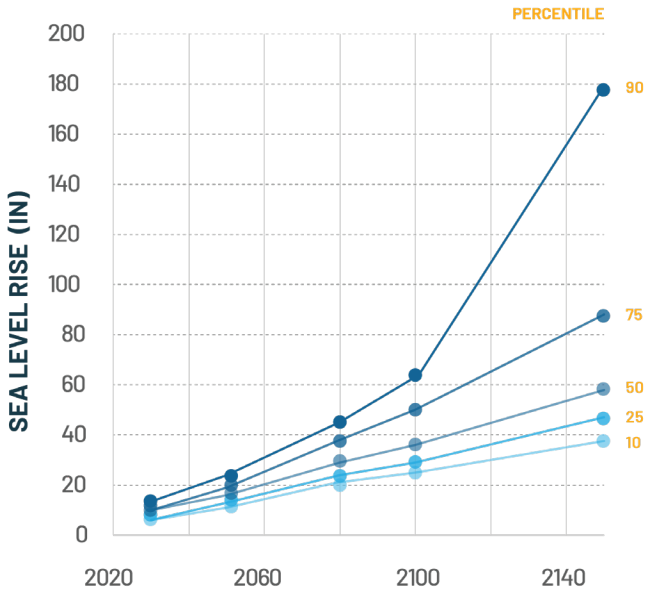


Figure 33. CCRUN Sea Level Rise Projections for the Philadelphia Region based on CMIP6 and derived from the IPCC's 6th Assessment Report. Projections are relative to the 1995-2014 time. Source: OLIN; data from CCRUN, The Climate Resilience Research agenda, 2022



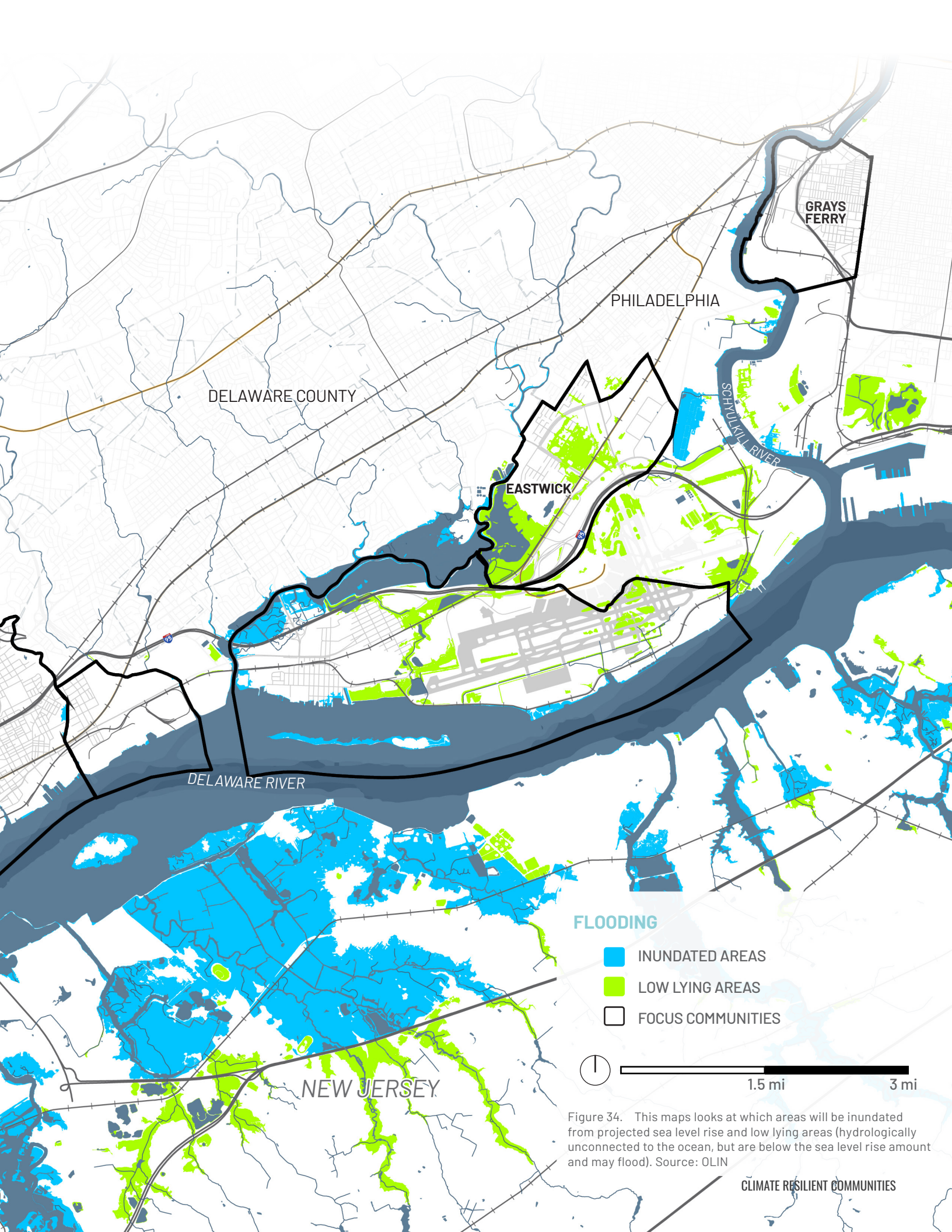


Figure 34. This maps looks at which areas will be inundated from projected sea level rise and low lying areas (hydrologically unconnected to the ocean, but are below the sea level rise amount and may flood). Source: OLIN

INCREASED RAINFALL

Extreme precipitation is expected to be more frequent, resulting in more inland and river or stream flooding. Though periods of severe drought can co-exist, the region is generally expected to see an increase in the duration and intensity of precipitation. Over the past 82 years, annual average precipitation has increased at a rate of 0.82 inches per decade. In the observed record at Philadelphia International Airport, 6 of the 10 wettest years on record have occurred since 1990.[25] While annual precipitation in the region is increasing, it is also expected that the frequency and intensity of precipitation events (such as hurricanes, nor'easters, and cloudburst events) will also increase, causing more intense pluvial, riverine, and coastal flooding.

Precipitation Projections for the Philadelphia Region (in)

DECADE	LOW ESTIMATE 10TH PERCENTILE	MIDDLE RANGE 25TH - 75TH PERCENTILE	HIGH ESTIMATE 90TH PERCENTILE
2030s	41.53 IN	42.36 - 44.85 IN	45.68 IN
2040s	41.95 IN	43.19 - 45.68 IN	46.93 IN
2050s	42.36 IN	43.61 - 46.51 IN	47.34 IN
2060s	42.36 IN	43.61 - 46.93 IN	48.59 IN
2070s	42.78 IN	44.44 - 47.34 IN	49.01 IN
2080s	42.78 IN	44.85 - 48.17 IN	50.25 IN
2100	40.70 IN	44.02 - 50.67 IN	53.99 IN

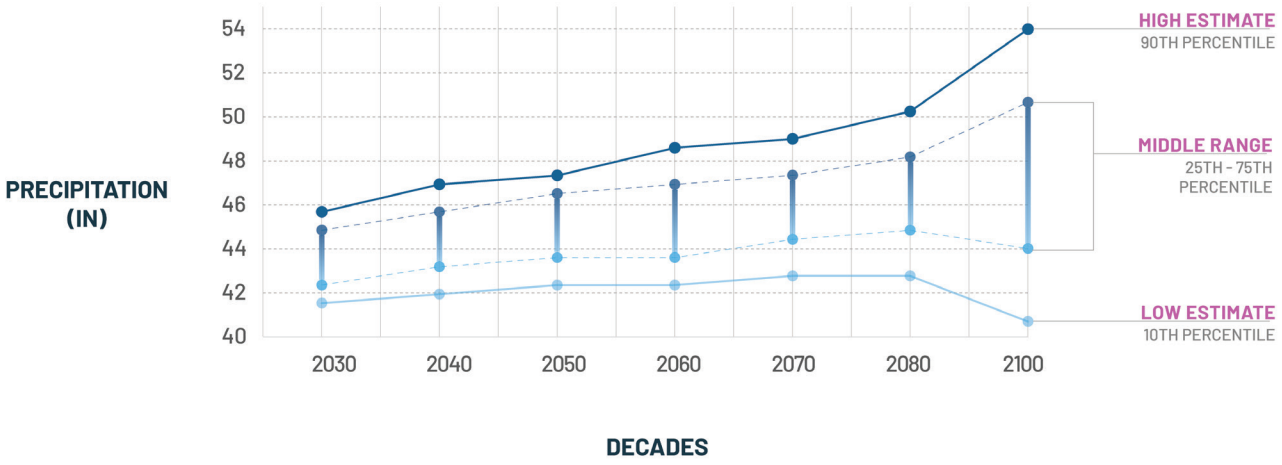


Figure 35. The line graph above shows the projected precipitation amounts over the next century. Source: OLIN, data from CCRUN, The Climate Resilience Research agenda, 2022

EXTREME HEAT

Air temperatures are expected to get hotter. From 1971 to 2000, on average, 4 days a year reached 100°F. By 2099, experts predict 55 days per year will reach 100°F.[26] Higher temperatures are likely to increase heat-related deaths and decrease air quality. Children, older adults, those with pre-existing health conditions like asthma, those living alone, those working outdoors, and/or those of lower socioeconomic status are often at higher risk of heat-related illness or death.

Air Temperature Increase Projections for the Philadelphia Region (°F)

DECADE	LOW ESTIMATE 10TH PERCENTILE	MIDDLE RANGE 25TH - 75TH PERCENTILE	HIGH ESTIMATE 90TH PERCENTILE
2030s	57.8°	58.6° - 59.8°	60.6°
2040s	58.5°	59.2° - 60.8°	61.8°
2050s	58.9°	60° - 61.7°	62.7°
2060s	59.5°	60.6° - 62.8°	64.4°
2070s	59.9°	61.2° - 63.9°	65.7°
2080s	60.6°	61.4° - 65.3°	67°
2100	60.8°	61.9° - 66.4°	68.8°

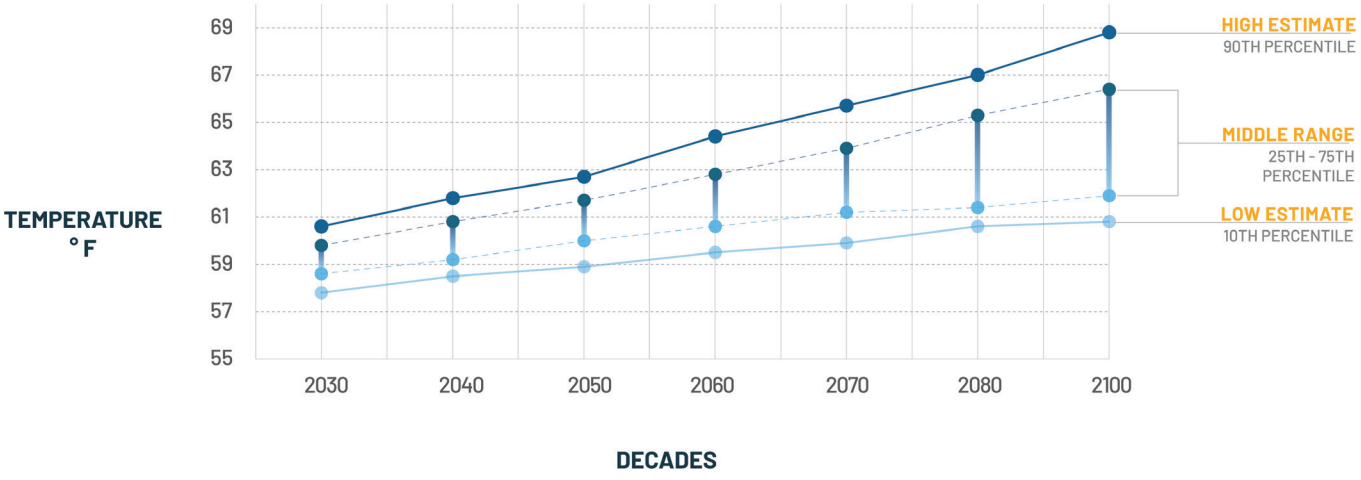


Figure 36. The chart and line graph above show the projected increase in average air temperature through the end of the century. Source: OLIN, data from CCRUN, The Climate Resilience Research agenda, 2022

MODELING THE IMPACTS OF LIKELY FUTURE STORM EVENTS WITH INCREASED SEA LEVEL RISE

As sea levels continue to rise, the Philadelphia region and Delaware River Estuary are expected to experience more frequent and intense flooding events. While rising sea levels will increase the frequency of high-tide flooding over time, the most severe impacts will occur during large storms, such as hurricanes and nor'easters, which bring intense winds, storm surges, and heavy precipitation. There is evidence that future storms may become more frequent and intense due to climate change, leading to an increased risk of severe flooding.[27]

DEVELOPING A MODEL

Rather than modeling an imaginary future storm event, we chose to model recent past storm events with sea level rise added for two reasons: 1) Because it is likely that these relatively high probability events will occur again in the future, and 2) because understanding future risk relative to previously experienced storms events is a powerful way to communicate risk to community members and local government officials.

Working with engineers Franco Montalto and PhD student Nirajan Adhikari at Drexel University's Sustainable Water Resource Engineering Lab, three recent storm events were chosen: Hurricane Sandy (2012), Hurricane Isaias (2020), and Hurricane Ida (2021). Not only are these storms all recent, but they also exhibited a variety of flooding types and impacted different areas of the region. Based on the latest climate modeling (CMIP6) downscaled from the IPCC's 6th Assessment Report, +1 foot, +2 foot, and +4 foot sea level rise scenarios were studied, with +1 foot considered the likely minimum and +4 foot considered the likely maximum. The +2 foot sea level rise scenario was chosen as the most appropriate scenario for current planning and is shown below. Maps and data associated with the +1 and +4 foot sea level rise scenarios can be found in the Appendix.
For each storm event, a Hydrologic Engineering Center River Analysis System. This model combined was used Delaware River bathymetry data; shoreline delineation; hydraulic inputs from gauges at the Ben Franklin Bridge, Fairmont Waterworks, and Marcus Hook; flow data for ungagged tributaries using a Hydrologic Engineering Center Hydrologic Modeling System rainfall-runoff watershed model; regional landcover and topographic data; and building footprints. Each model was validated by comparing observed versus simulated depth flood depth values. The result of each model is a 3 meter resolution raster for each storm and sea level rise scenario that shows modeled flood depths throughout the study area.

To analyze each storm event with future sea level rise added, flooding was defined as any area with a water depth of greater than 4 inches/100 mm (typical curb height and the value used in NYC Stormwater Resiliency maps). Flooded areas were further classified as: moderately flooded (4 inches–1 foot) or (100 mm–30 cm), extreme flooding (1 foot–2 feet) or (30–60 cm), and very extreme flooding (> 2 feet) or (> 60 cm). Comparing the amount of area flooded in the baseline storm scenario to the area flooded by the same storm with sea level rise added, the potential significant impacts of sea level rise on the region are clear.

Areas of impact

Figure 28 measures the acres of land in each focus community that were impacted by the three storms included in our model (baseline), and then measures the increase of land that would be impacted by an additional 2 feet of sea level rise is added.

The affected land is categorized by different land uses, since each use has different implications and risks associated with flooding. These categories are residential, industrial, commercial, parks and open space, and other.

Figure 37. Chart comparing the modeled impacts of storm events with +2 feet sea level rise added. Land use totals were calculated using DVRPC land use data from 2012. Source: OLIN;Drexel University

MODELED IMPACTS OF STORM EVENTS WITH +2 FEET SEA LEVEL RISE

	ALL STORMS BASELINE		ALL STORMS + 2 FEET SEA LEVEL RISE		INCREASE FROM BASELINE	
	Acres Flooded	*Proportion of Category (%)*	*Acres Flooded*	*Proportion of Category (%)*	*Acres Flooded*	*% Increase*
MARCUS HOOK	20.13	2%	74.78	7%	54.65	371%
Residential	0.01	0%	0.30	0%	0.29	2494%
Industrial	15.16	3%	61.61	11%	46.45	406%
Commercial	0.00	0%	0.27	1%	0.27	-
Parks and Open Space	3.99	7%	11.39	19%	7.40	286%
Other	0.97	0%	1.21	0%	0.24	125%
TRAINER	29.83	3%	67.25	8%	37.42	225%
Residential	0.00	0%	0.00	0%	0.00	-
Industrial	4.50	1%	33.45	11%	28.95	743%
Commercial	0.00	0%	0.00	0%	0.00	-
Parks and Open Space	17.76	11%	25.94	17%	8.19	146%
Other	7.57	3%	7.85	3%	0.28	104%
CHESTER	97.44	3%	176.92	5%	79.48	182%
Residential	0.12	0%	0.69	0%	0.58	599%
Industrial	26.18	9%	67.91	23%	41.73	259%
Commercial	9.33	1%	15.48	2%	6.15	166%
Parks and Open Space	46.30	5%	76.11	9%	29.81	164%
Other	15.52	2%	16.74	2%	1.22	108%
EASTWICK	611.52	36%	768.76	46%	157.24	126%
Residential	92.41	43%	98.43	46%	6.02	107%
Industrial	13.18	6%	39.77	17%	26.59	302%
Commercial	26.65	19%	30.19	21%	3.54	113%
Parks and Open Space	263.14	42%	339.48	54%	76.34	129%
Other	216.14	46%	260.89	56%	44.75	121%
GRAYS FERRY	108.37	11%	125.12	12%	16.75	115%
Residential	0.11	0%	0.14	0%	0.03	132%
Industrial	19.60	13%	25.45	17%	5.84	130%
Commercial	0.00	0%	0.00	0%	0.00	-
Parks and Open Space	72.70	24%	81.95	27%	9.25	113%
Other	15.96	7%	17.58	8%	1.61	110%
STUDY AREA TOTAL	**1,907.05**	**13%**	**2,991.84**	**20%**	**1,084.79**	**157%**
Residential	110.55	5%	142.51	7%	31.96	129%
Industrial	179.28	9%	388.99	19%	209.70	217%
Commercial	73.55	6%	124.09	10%	50.54	169%
Parks and Open Space	878.55	29%	1,165.47	38%	286.92	133%
Other	665.12	10%	1,170.78	18%	505.66	176%

FUTURE STORMS WITH SEA LEVEL RISE

Figure 30 shows the combined flooding impact of the three modeled storms - Hurricane Ida (2021), Hurricane Isaias (2020), and Hurricane Sandy (2012) - as well as the increased impact of similar, future storms due to the +2 feet of sea level rise likely by 2080.

Areas of the map that are shaded light blue likely flooded during these past storms, while areas shaded dark blue are those that may flood if and when similar storms occur on top of additional sea level rise in the coming decades. The impacts of sea level rise on these common storms are significant in some low-lying coastal areas and less significant in others. While this analysis focuses on flood risk over the next 50 years, in the long-term more extreme storms and sea level rise will only further increase inland areas' exposure to more moderate and extreme flooding from coastal storms (see figure 29).

The flooding impacts of sea level rise on major storm events is examined in more detail in the individual community plans in the Chapter 6 Recommendations.

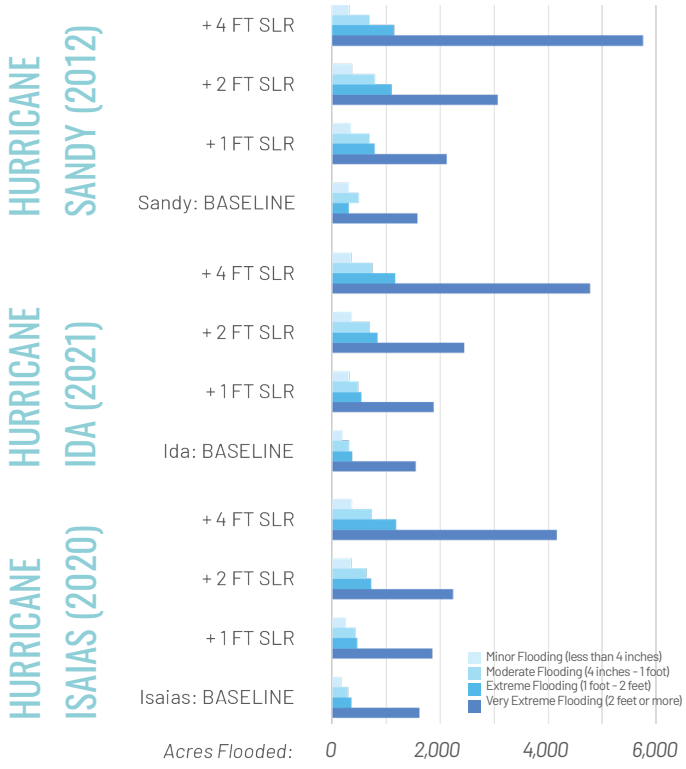
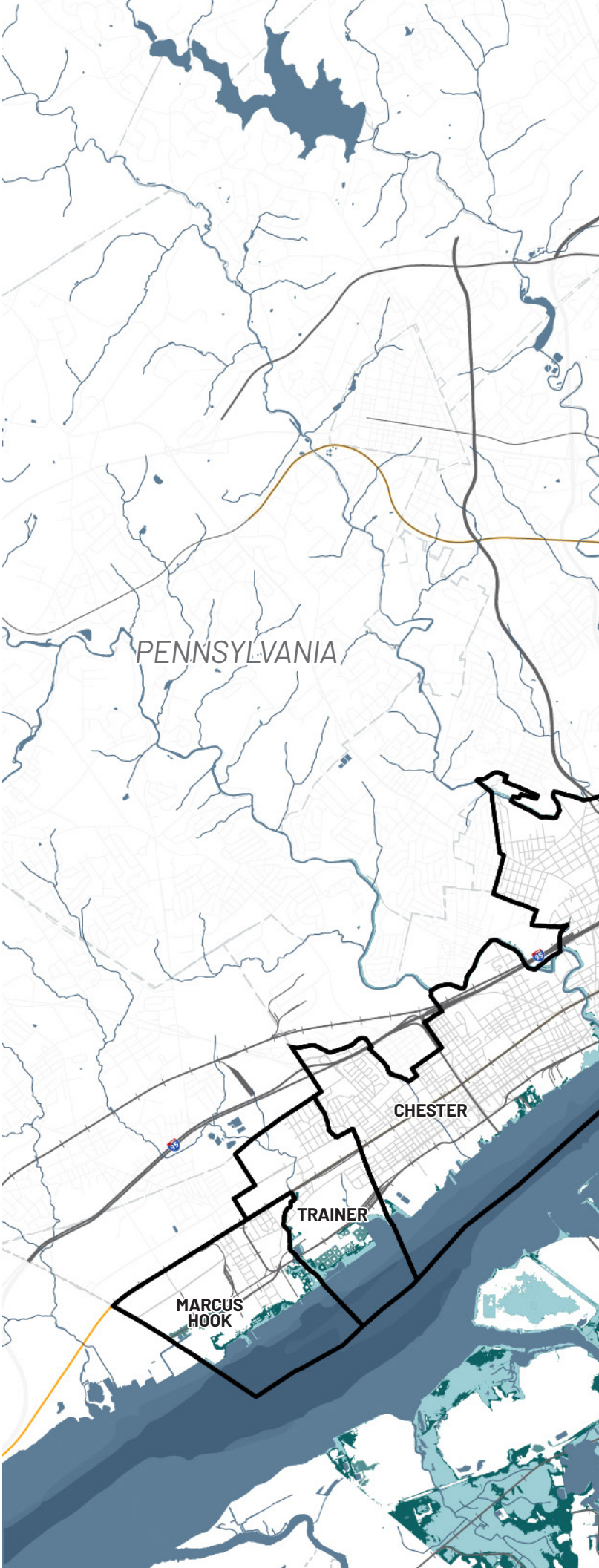


Figure 38. Chart comparing the severity of acres flooded within the project study area for each modeled storm and sea level rise scenario. Source: OLIN; Drexel University



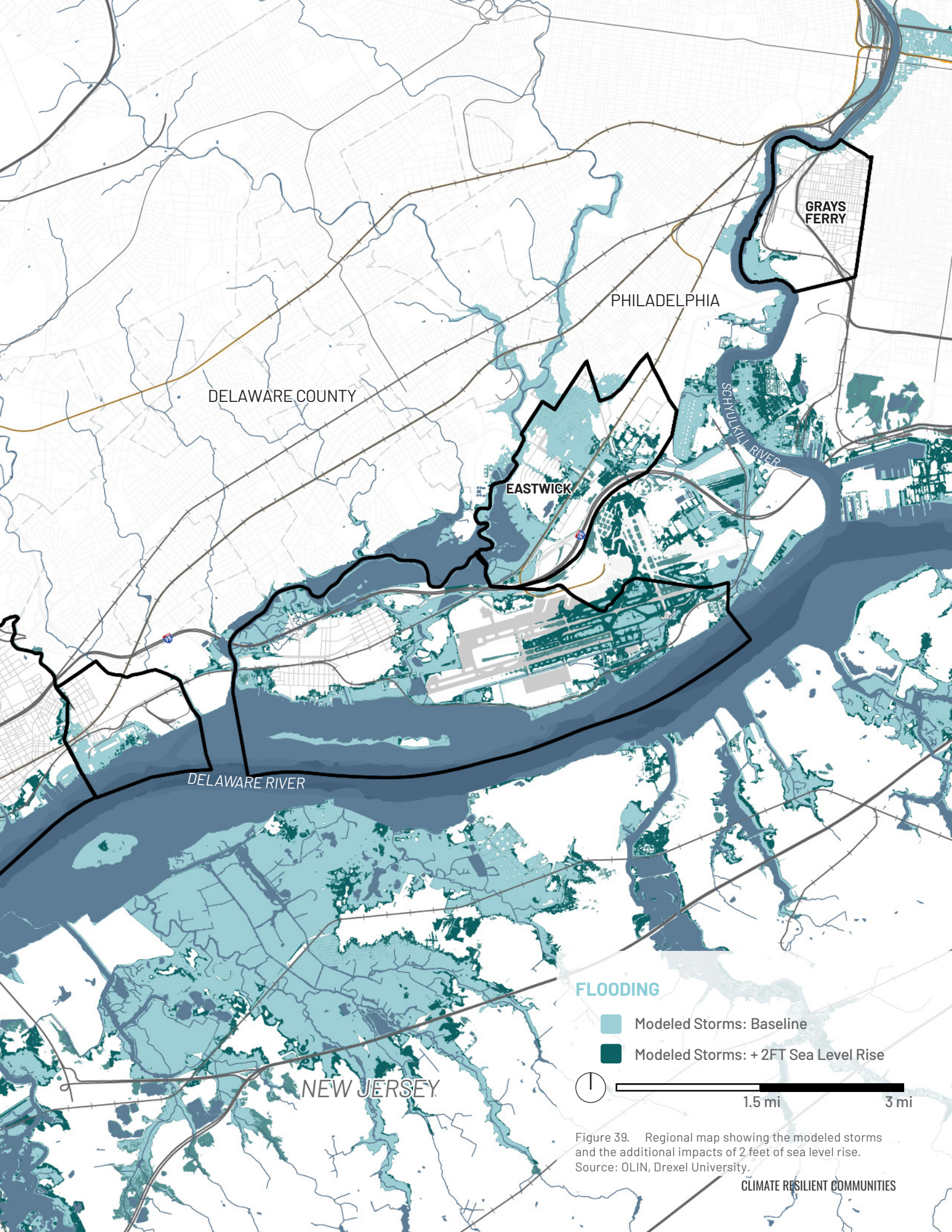


Figure 39. Regional map showing the modeled storms and the additional impacts of 2 feet of sea level rise. Source: OLIN, Drexel University.

ENDNOTES

1 "Natural Hazards | National Risk Index." Accessed November 14, 2024. https://hazards.fema.gov/nri/natural-hazards.

2 Montalto, Franco, and Nicole Pearl. "A Climate Resilience Research Agenda for the Greater Philadelphia Area," 2021.

3 ibid

4 Municipal Management of Extreme Heat." DVRPC, May 2021. https://www.dvrpc.org/Reports/MIT033.pdf.

5 ibid.

6 "Schuylkill River at Philadelphia." Accessed November 14, 2024. https://water.noaa.gov/gauges/padp1.

7 "Delaware River at Marcus Hook (IN MLLW)." Accessed November 14, 2024. https://water.noaa.gov/gauges/mrcp1.

8 "Delaware River at USCG Station Washington Street (IN MLLW)." Accessed November 14, 2024. https://water.noaa.gov/gauges/phbp1

9 "Philly H2O: Flood of 1843 in Delaware County." Accessed November 14, 2024. https://flashback.waterhistoryphl.org/backpages/Floodof1843.htm.

10 "Philadelphia District & Marine Design Center > Missions > Civil Works > Delaware River Basin Comprehensive Study > History of Delaware River Flooding." n.d. Accessed November 15, 2024. https://www.nap.usace.army.mil/Missions/Civil-Works/Delaware-River-Basin-Comprehensive-Study/History-of-Delaware-River-Flooding/.

11 Hurricane Agnes: First Storm of 1972 Packed a Punch – Daily Local." n.d. Accessed November 15, 2024. https://www.dailylocal.com/2021/06/25/hurricane-agnes-first-storm-of-1972-packed-a-punch/

12 "Philadelphia District & Marine Design Center > Missions > Civil Works > Delaware River Basin Comprehensive Study > History of Delaware River Flooding." n.d. Accessed November 15, 2024. https://www.nap.usace.army.mil/Missions/Civil-Works/Delaware-River-Basin-Comprehensive-Study/History-of-Delaware-River-Flooding

13 Delaware River at Marcus Hook (IN MLLW)." Accessed November 14, 2024. https://water.noaa.gov/gauges/mrcp1

14 Orton, Philip. Interview with Philip Orton, Steven's Institute of Technology. Virtual Meeting, Monday, May 22.

15 Montalto, Franco, and Nicole Pearl. "A Climate Resilience Research Agenda for the Greater Philadelphia Area," 2021.

16 "Extreme Heat Is Deadlier Than Hurricanes, Floods and Tornadoes Combined | Scientific American." Accessed November 14, 2024. https://www.scientificamerican.com/article/extreme-heat-is-deadlier-than-hurricanes-floods-and-tornadoes-combined/.

17 "Heat Watch vs. Warning." n.d. Accessed November 15, 2024. https://www.weather.gov/safety/heat-ww.

18 "What Happens When Extreme Heat and Air Pollution Collide | World Resources Institute." Accessed November 14, 2024. https://www.wri.org/insights/extreme-heat-air-pollution.19

19 Montalto, Franco, and Nicole Pearl. "A Climate Resilience Research Agenda for the Greater Philadelphia Area," 2021.

20 ibid.

21 "How Does Climate Change Affect Precipitation? | NASA Global Precipitation Measurement Mission." n.d. Accessed November 14, 2024. https://gpm.nasa.gov/resources/faq/how-does-climate-change-affect-precipitation.

22 "Precipitation Change in the United States - Climate Science Special Report." n.d. Accessed November 14, 2024. https://science2017.globalchange.gov/chapter/7/.

23 "Climate Impacts in the Northeast | Climate Change Impacts | US EPA." n.d. Accessed November 14, 2024. https://climatechange.chicago.gov/climate-impacts/climate-impacts-northeast.

24 Montalto, Franco, and Nicole Pearl. "A Climate Resilience Research Agenda for the Greater Philadelphia Area," 2021.

25 ibid.

26 ibid.

27 EPA Region 3 Climate Collaborative. 2024. "Climate Adaptation Implementation Plan." 903K24001. U. S. Environmental Protection Agency Mid-Atlantic Region.



04 COMMUNITY OVERVIEW



CLIMATE RESILIENT COMMUNITIES

REGIONAL DEMOGRAPHICS

Burdens to Philadelphia and Delaware County residents who suffer from environmental injustices will be exacerbated with climate change as higher temperatures and flooding increase.

Evaluating the combination of climate risk, vulnerability, and exposure that each focus community faces is key to understanding how to move towards a more resilient region, people, and environment.

Environmental Justice

The core principle of environmental justice advocates for protected environmental rights and benefits for everyone across all backgrounds. The Environmental Protection Agency (EPA) has defined environmental justice as "the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the environment." In doing so, environmental justice seeks to ensure people are fully protected from adverse human health and environmental effects and hazards, including those related to climate change and the legacy of racism or other structural barriers. Equitable access to a healthy and resilient environment is also a key component to environmental justice. However, this is often not the reality for all, especially communities of color and low-income communities.

During the New Deal era, federal policies like redlining—a discriminatory housing practice that denied mortgages and financial services to people of color and diverse ethnicities—were widely implemented across the country, including in Philadelphia and Delaware County.[1] These practices led to widespread segregation, forcing marginalized residents to seek housing and form communities in areas associated with higher levels of pollution and environmental hazards and, in the case of the focus communities, that are prone to flooding. The legacy of redlining continues to affect these communities today, as many previously redlined neighborhoods remain close to active industrial sites and face elevated levels of pollution and environmental risks.[2]

Other discriminatory land-use practices compound environmental injustices, such as the siting of major highways, power plants, refineries, and other major polluting infrastructure in low-income communities and communities of color. At the same time, access to clean water, green spaces, and other environmental amenities is often severely lacking in these neighborhoods.

The overall uneven distribution of environmental benefits and burdens has and continues to have profound impacts on public health and quality of life in the communities of Marcus Hook, Trainer, Chester, Eastwick, and Grays Ferry.

Vulnerability and Exposure

Exposure refers to the presence of people, assets, infrastructure, and ecosystems in hazard-prone areas.[3] It is important to note that exposure and risk are not the same; risk assesses the potential for negative consequences from a hazard.[4] For example, two houses in a low-lying area are exposed to the same threat (flooding), but if one house is elevated, it has a lower risk of being flooded while the other is at a higher risk of damage.

Vulnerability describes the degree to which people, assets, and ecosystems are adversely affected by a hazard.[5] Within that definition, climate and social vulnerability are understood to be intertwined and often synonymous. In communities burdened by environmental injustice, one cannot address one vulnerability without addressing

the other. Communities that have faced historical discrimination and disinvestment often have less adaptive capacity and fewer resources to respond to climate impacts, while simultaneously bearing greater exposure to climate risks.

One working definition of climate vulnerability is "the degree to which natural, built, and human systems are at risk of exposure to climate change impacts."[6] Federal Emergency Management Agency defines social vulnerability as the susceptibility of social groups to the adverse impacts of natural hazards, which includes disproportionate death, injury, loss, or disruption of livelihood.[7] It also includes the challenges these groups face in anticipating, withstanding, and recovering from adverse impacts from the stressors to which they are exposed. For example, older adults, low-income communities, or people with chronic illnesses may be less equipped to prepare for or recover from a natural disaster. It may mean that low-income households lack air conditioning during heat waves or that elderly individuals struggle to evacuate during an emergency.

These vulnerabilities often intersect and compound one another. Resiliency requires confronting both the physical and social dimensions of climate risk, from upgrading infrastructure and expanding green stormwater infrastructure to addressing underlying social inequities to help increase a community's capacity to adapt and respond. Barbara Brown Wilson, a professor of Urban and Environmental Planning at the University of Virginia, proposes a redefinition of resiliency with equity in mind – what does it mean to go beyond bouncing back after a crisis or simply absorbing shock? A resilient community or neighborhood brings social and ecological systems together, and understands that adaptive capacity and inclusivity is critical to any resilience planning.[8]

Indicators of Social and Environmental Burdens

This project looked at three national datasets to evaluate social vulnerability across the focus communities and region: the Social Vulnerability Index from the Center for Disease Control and Prevention and Agency for Toxic Substances and Disease Registry, EJScreen from the EPA, and the Climate Economic Justice Screening Tool from the Justice40 Initiative.

Each dataset measures and aggregates various socioeconomic and environmental data such as age, race, ethnicity, and exposure to environmental stressors to evaluate community burdens and vulnerability (either by census tract or block group). Further detail about each dataset and index follows.

EPA EJSCREEN

EJScreen is the EPA's environmental justice mapping and screening tool at the national level, highlighting areas that have higher environmental burdens and/or vulnerable populations. EJScreen provides demographic and environmental information and includes a method for combining them into environmental justice (EJ) indexes.

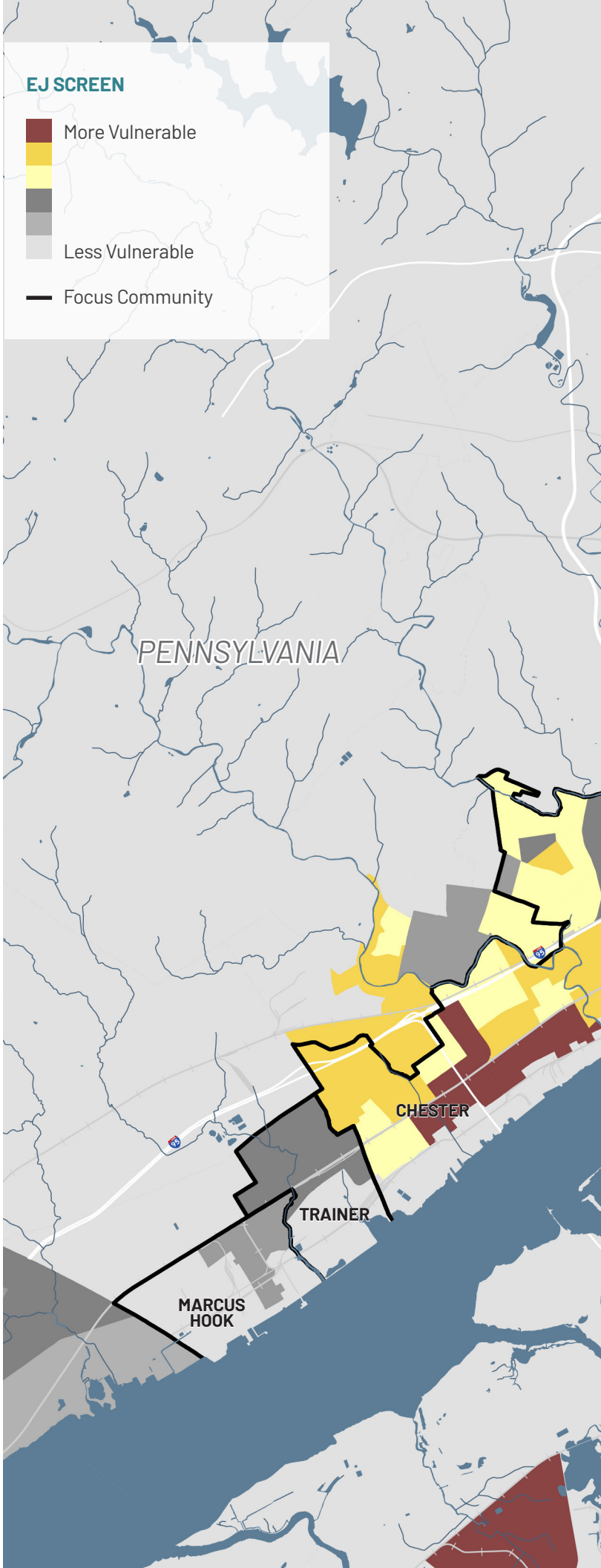
Areas emerge when they exceed the 80th national percentile for an EJ Index, which combines an environmental indicator with the demographic index (percent people of color x percent low-income).[9]

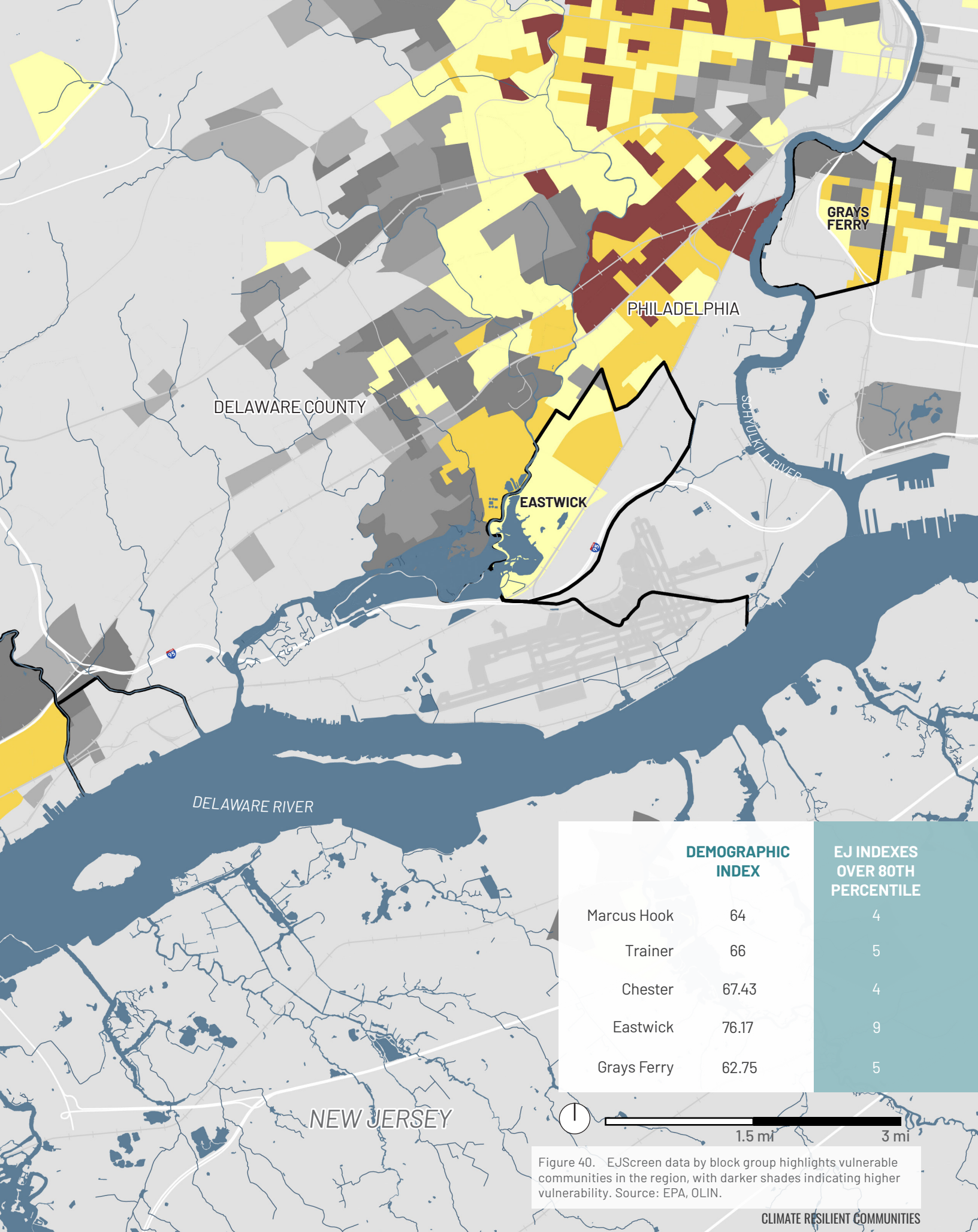
Socioeconomic indicators:

- People of color
- Low-income
- Unemployment rate
- Limited English speaking household
- Less than high school education
- Under age 5
- Over age 64

Environmental indicators:

- Particulate Matter 2.5
- Ozone
- Diesel Particulate Matter
- Air Toxics Respiratory HI
- Toxic Releases to Air
- Traffic Proximity
- Lead Paint
- Superfund Proximity
- RMP Facility Proximity
- Hazardous Waste Proximity
- Underground Storage Tanks
- Wastewater Discharge





	DEMOGRAPHIC INDEX	EJ INDEXES OVER 80TH PERCENTILE
Marcus Hook	64	4
Trainer	66	5
Chester	67.43	4
Eastwick	76.17	9
Grays Ferry	62.75	5

Figure 40. EJScreen data by block group highlights vulnerable communities in the region, with darker shades indicating higher vulnerability. Source: EPA, OLIN.

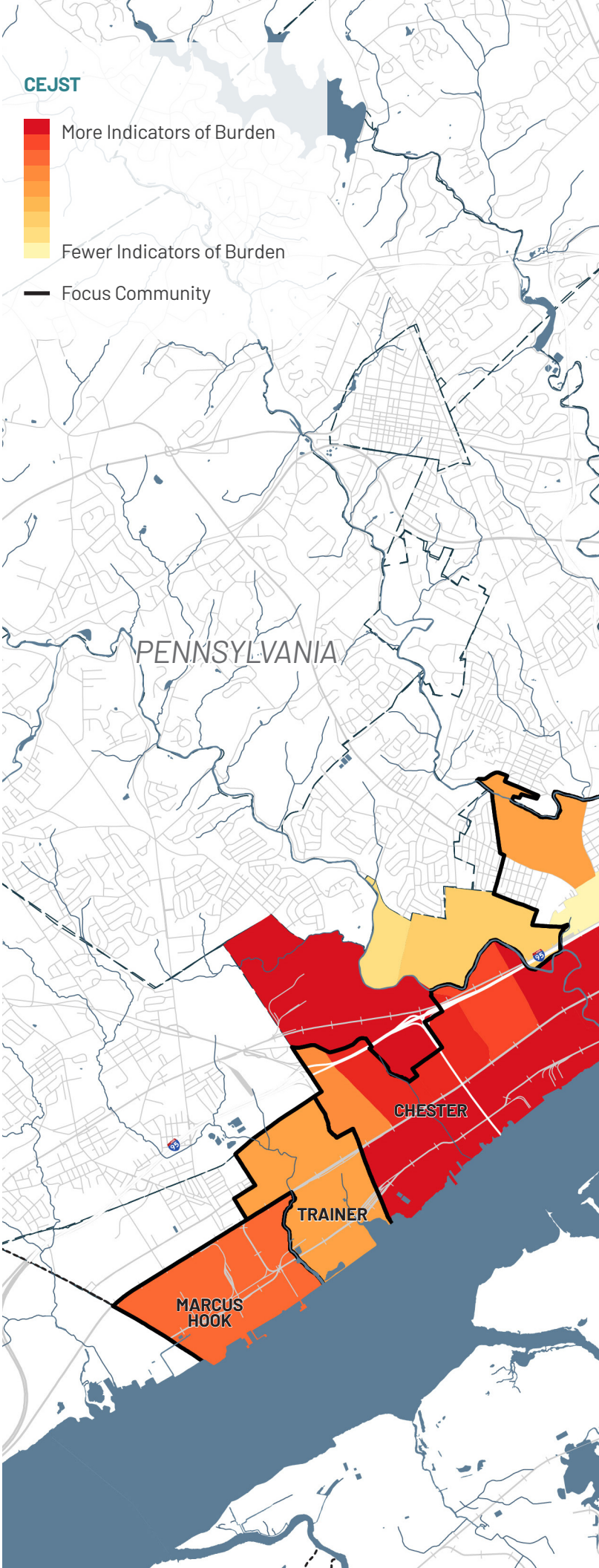
CLIMATE AND ECONOMIC JUSTICE SCREENING TOOL (CEJST)

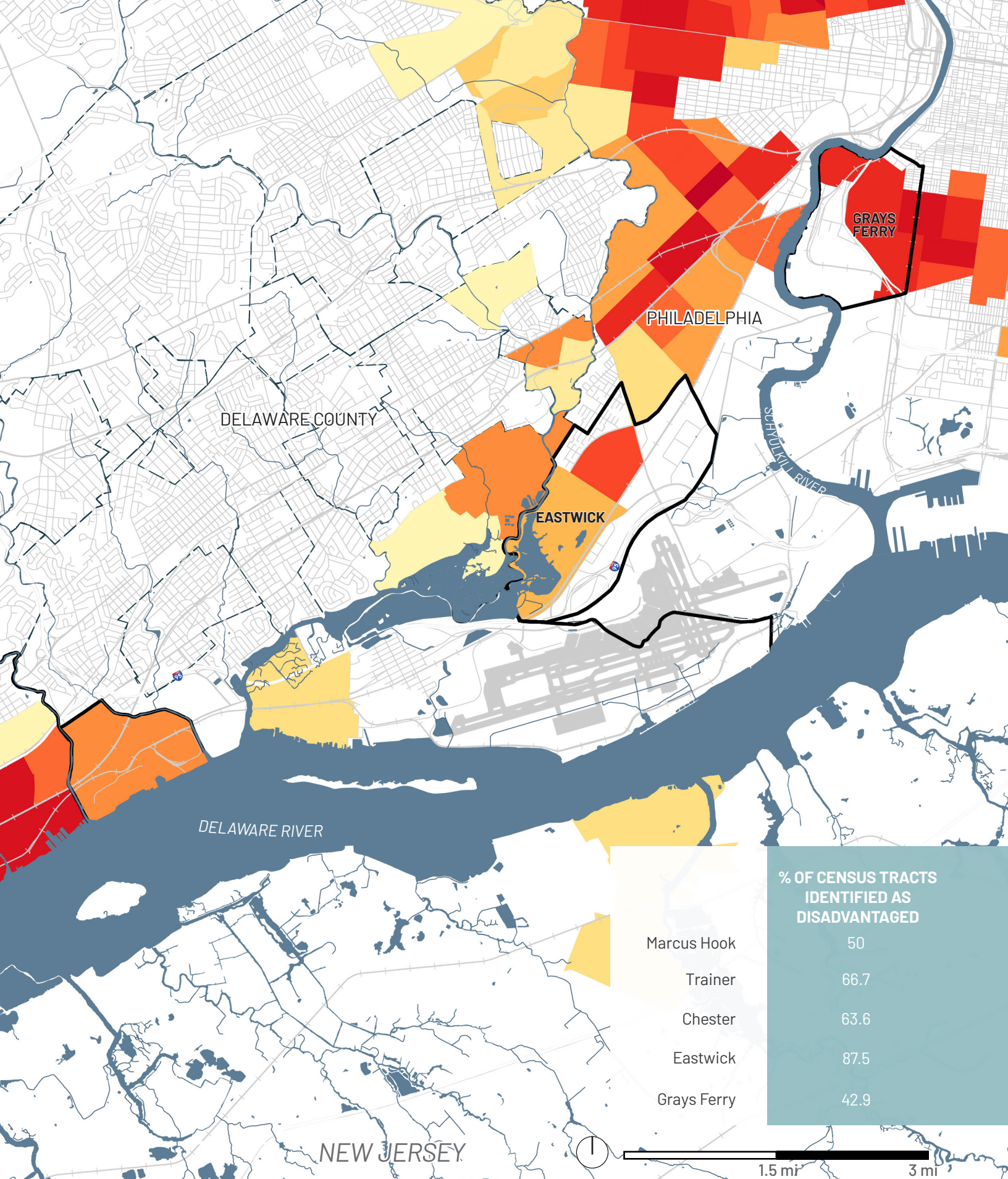
The Climate and Economic Justice Screening Tool (CEJST) was developed by the federal government and used to identify communities that are overburdened and underserved. Within the tool, various datasets indicate burdens across eight categories: climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development. Communities are considered disadvantaged if they are located in census tracts that meet the thresholds for at least one category of burden while at or above the threshold for an associated socioeconomic burden (e.g. low-income, less than high school education). A census tract completely surrounded by disadvantaged communities and also at or above the 50% percentile for low income is also considered disadvantaged.[10]

Federal agencies can use the CEJST to identify communities that will benefit from various federal programs, including the Justice40 Initiative, which seeks to deliver 40% of overall benefits of investments in climate, clean energy, and related areas to disadvantaged communities.

Burdens:

- Climate Change
- Energy
- Health
- Housing
- Legacy Pollution
- Transportation
- Waste and Wastewater
- Workforce Development





	% OF CENSUS TRACTS IDENTIFIED AS DISADVANTAGED
Marcus Hook	50
Trainer	66.7
Chester	63.6
Eastwick	87.5
Grays Ferry	42.9

Figure 41. CEJST data by census tracts highlights vulnerable communities in the region, with darker shades indicating higher vulnerability. Source: CEJST, OLIN.

CDC/ASTR SOCIAL VULNERABILITY INDEX

The Agency for Centers for Disease Control and Prevention and the Toxic Substances and Disease Registry (CDC/ASTR) created the Social Vulnerability Index (SVI) with the goal of aiding public health officials and emergency response planners to identify and map communities that will need the most support before, during, and after a hazardous event.

SVI indicates the relative vulnerability at the census tract level; the tool evaluates 16 social factors sorted into four ranked themes[11]:

1) Socioeconomic Status

- income
- poverty
- employment
- education

2) Household Characteristics

- age
- single parenting
- disability

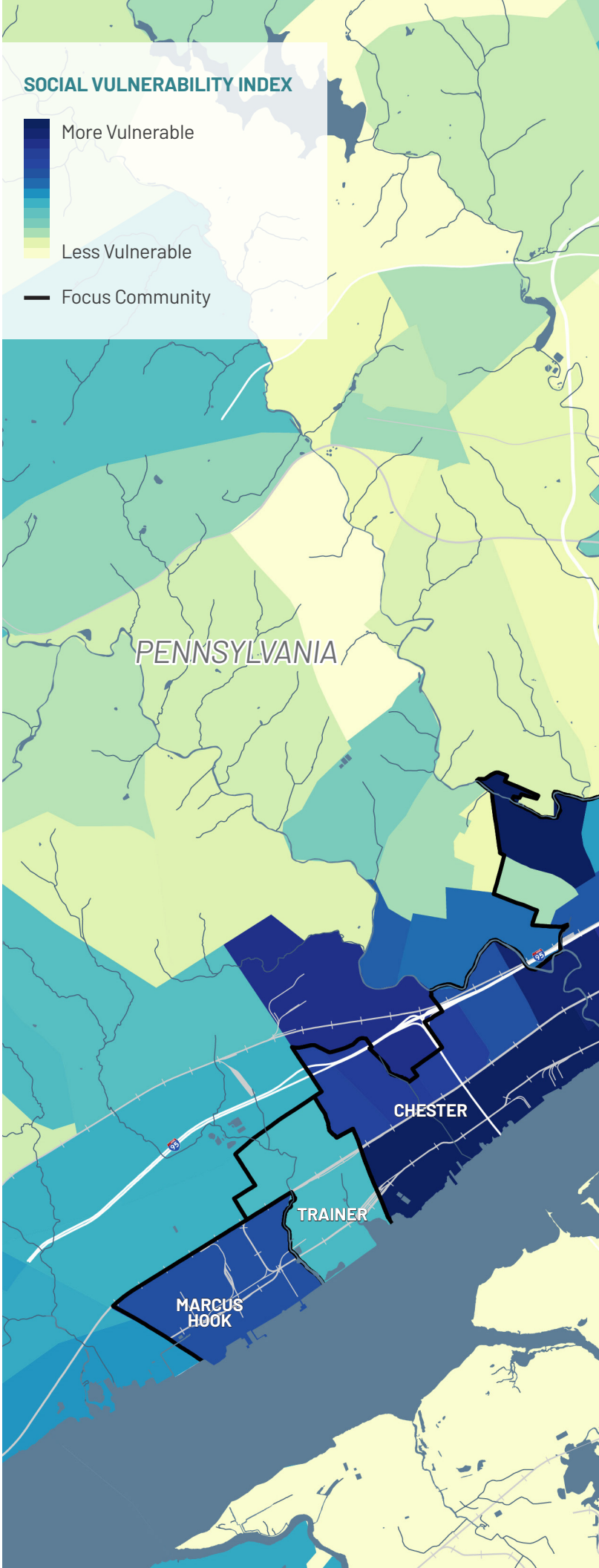
3) Racial & Ethnic Minority Status

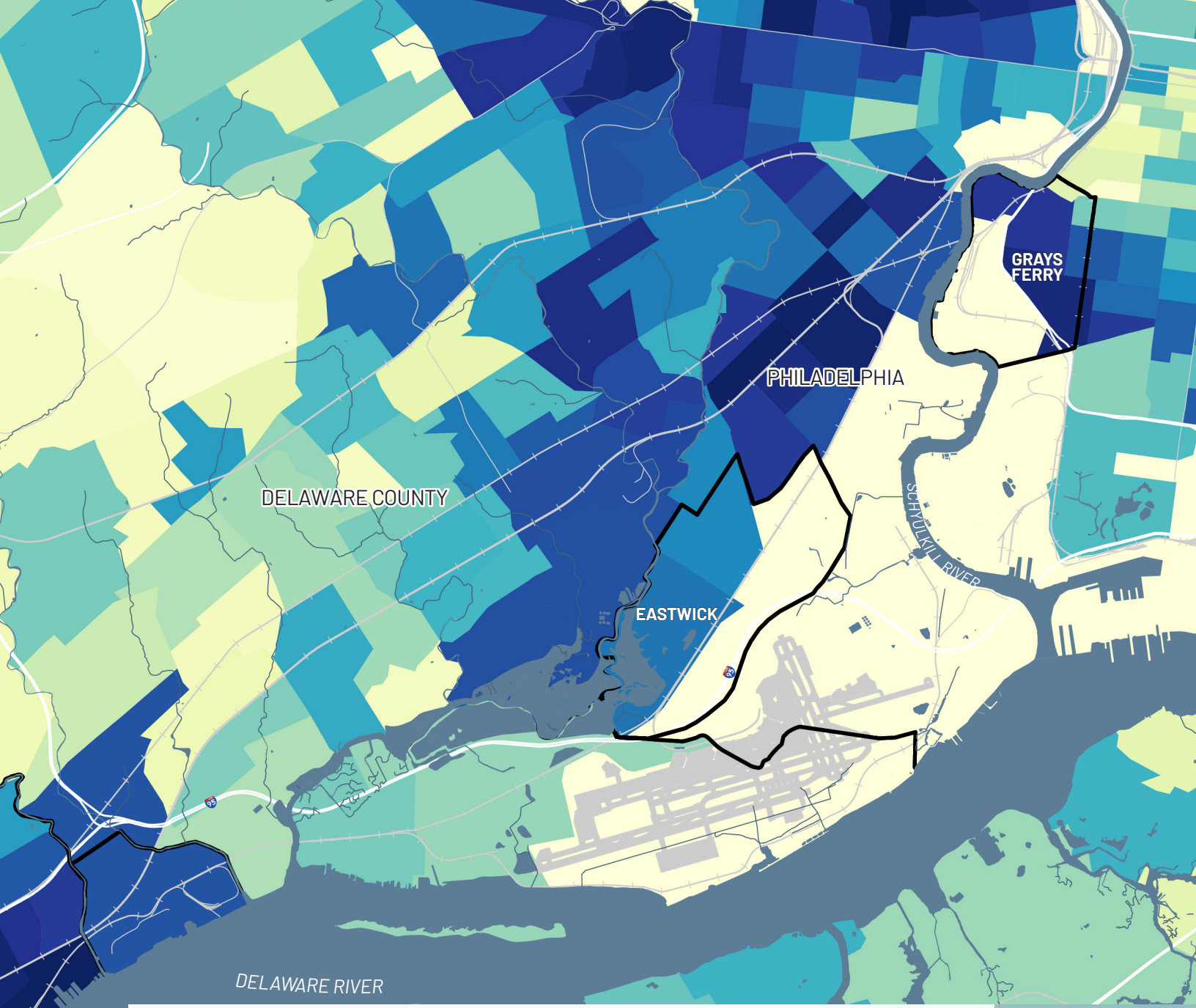
- race
- ethnicity
- English-language proficiency

4) Housing Type and Transportation

- housing structure
- crowding
- vehicle access

The average of all four themes is an indicator of overall vulnerability for each census tract and in this case, each focus community. The chart to the right highlights each community's score per theme and their overall vulnerability score, while the map shows the relative overall vulnerability of each census tract.





	RPL THEME 1 Socioeconomic Status	RPL THEME 2 Household Status	RPL THEME 3 Racial and Ethnic Minority Status	RPL THEME 4 Housing Type/ Transportation	RPL THEMES OVERALL
Marcus Hook	0.73	0.78	0.72	0.36	0.71
Trainer	0.77	0.83	0.77	0.51	0.78
Chester	0.73	0.72	0.84	0.53	0.73
Eastwick	0.84	0.57	0.86	0.49	0.77
Grays Ferry	0.66	0.39	0.83	0.48	0.6

Figure 42. SVI data by census tract highlights vulnerable communities in the region, with darker shades indicating higher vulnerability. Source: CDC/ASTR,OLIN.

COMMUNITY ENGAGEMENT

IN COORDINATION WITH CLEAN AIR COUNCIL, THE PROCESS OF DEVELOPING RECOMMENDATIONS FOR THE PROJECT WAS DEEPLY EMBEDDED IN THE FIVE COMMUNITY FOCUS AREAS AND BUILDS OFF OF THE DECADES OF COMMUNITY ORGANIZING, PLANNING, AND ONGOING ADVOCACY OF THE PEOPLE LIVING AND WORKING THERE.

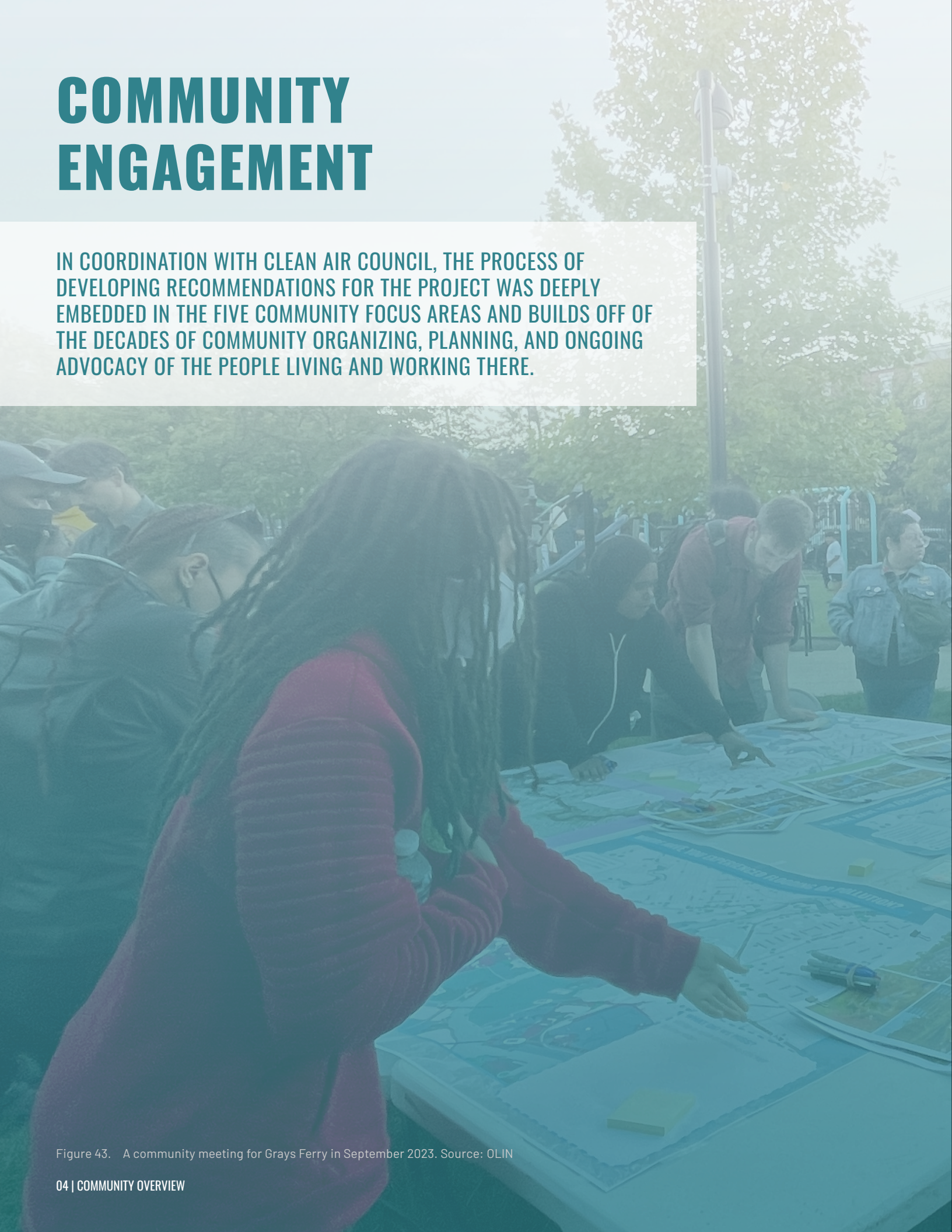
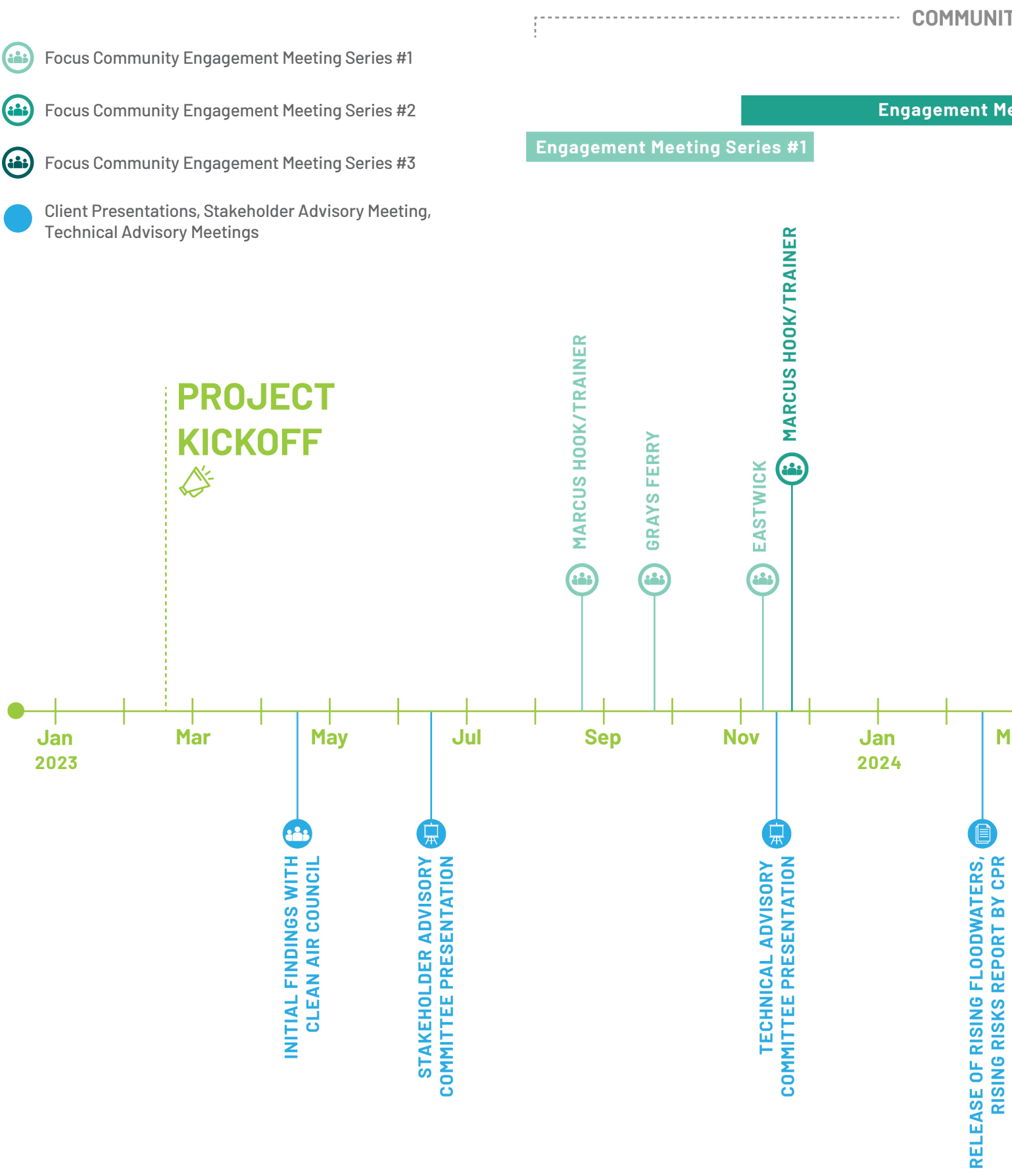


Figure 43. A community meeting for Grays Ferry in September 2023. Source: OLIN



ENGAGEMENT TIMELINE



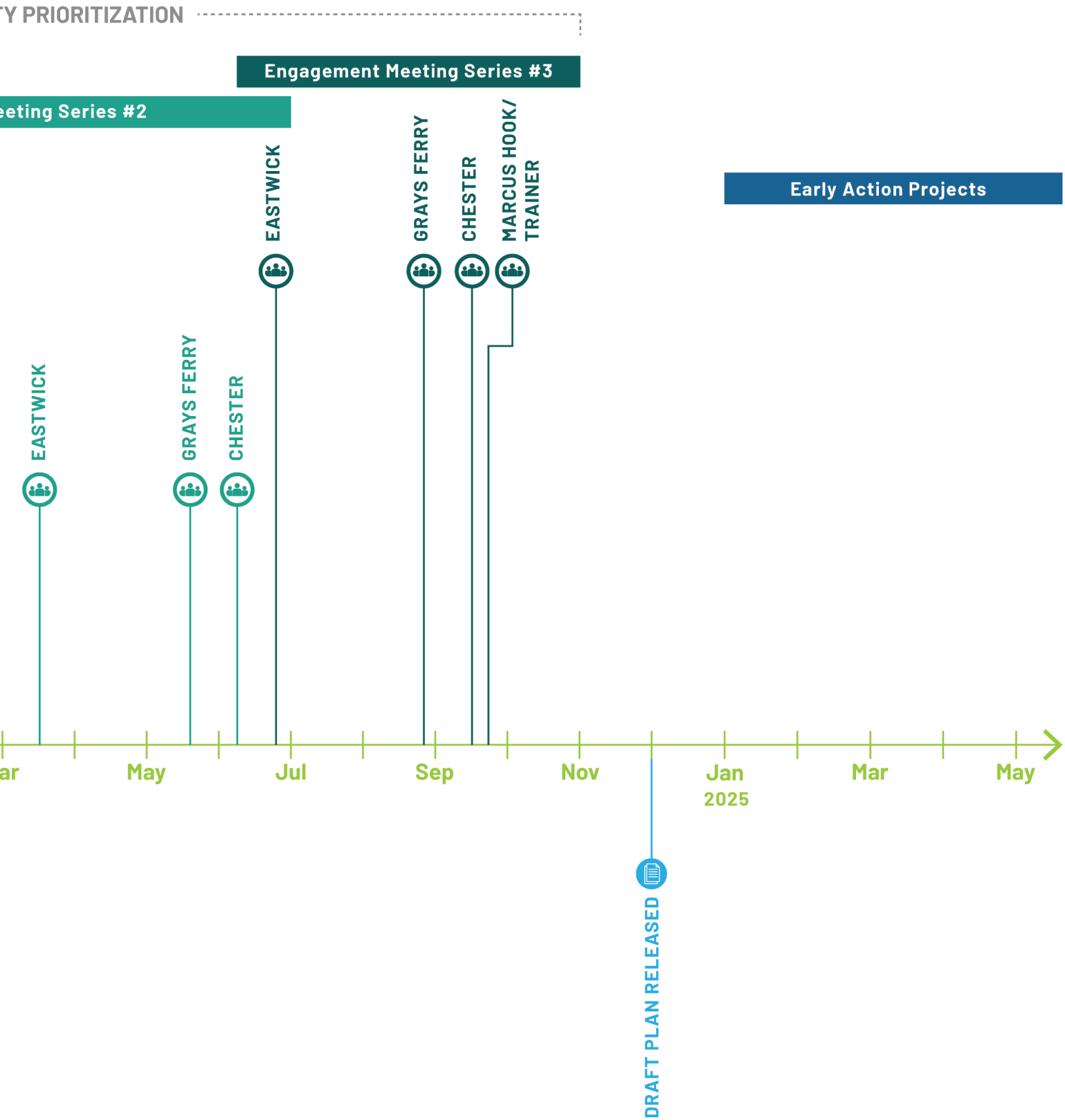

TY PRIORITIZATION
Engagement Meeting Series #3
eeting Series #2
Early Action Projects
EASTWICK
GRAYS FERRY
CHESTER
EASTWICK
GRAYS FERRY
CHESTER
MARCUS HOOK/
TRAINER
ar
May
Jul
Sep
Nov
Jan
2025
Mar
May
DRAFT PLAN RELEASED



Figure 45. Community meeting at Eastwick Library. Source: OLIN.



Figure 46. Community meeting at Stinger Square focused on identifying toolkit elem

FOCUS COMMUNITY ENGAGEMENT MEETINGS

Engagement began early in the process, with some preliminary data gathering to understand community profiles and assess risk. This foundational work helped ensure that engagement was sensitive to each of the five community contexts. For instance, Grays Ferry and Eastwick are neighborhoods within the larger municipality of Philadelphia, whereas Chester, Trainer, and Marcus Hook operate as smaller local governments with varying capacities. We also observed differences in community organization: Eastwick, for example, has a strong tradition of community organizing and meets frequently. Developing an engagement process that could be holistically applied across all communities while respecting these unique organizational histories and capacities was essential.

A three-part engagement strategy was created to maximize support, build momentum, and ensure each community could progress at its own pace without redundancy or pressure.

Listening, Data Sharing, and Vision Gathering (Fall 2023)

» The first meeting series focused on introducing the project and meeting individually with each community. Each session provided an open forum for residents to share their concerns and priorities while reviewing preliminary data on local risks. These conversations allowed the project team to understand unique challenges and strengths, setting a solid foundation for the next steps.

Tools, Methods and Project Ideas (Winter 2023 / Spring 2024)

» In the second meeting series, residents were presented with tools and methods specifically tailored to address their community's challenges. Project ideas were reviewed and discussed in-depth, with a focus on approaches to flood management, preservation of community assets, and green infrastructure opportunities. This stage allowed residents to guide and refine proposed solutions to align with their needs.



ents that resonated with community members. Source: OLIN.



Figure 47. Community meeting at Chester Eastside, Inc focused on small-scale, local projects. Source: OLIN.

Early Action Project Planning (Summer 2024)

» The final meeting series centered on early action planning. Residents identified specific sites and selected priority projects, with options such as green infrastructure and social spaces. The community-driven toolkit offered a range of scalable solutions, and residents contributed directly to the design of spaces that reflect their priorities and resilience goals. This structured engagement process laid the groundwork for a community-centered approach, encouraging local ownership and ensuring that project planning remained responsive and effective across each unique community (see Chapter 6: Community Resilience Toolkit on page 120 for more detail on site-specific approaches).

» In Marcus Hook, Trainer and Chester, a small nature storybook walk, which are short curated walks that display the pages from a story book, integrated with plans for tree planting and green infrastructure was proposed. In Grays Ferry a rain garden and gathering space was constructed. In Eastwick and Grays Ferry, investments were made in creating small community hubs for local resilience information and book and seed sharing.

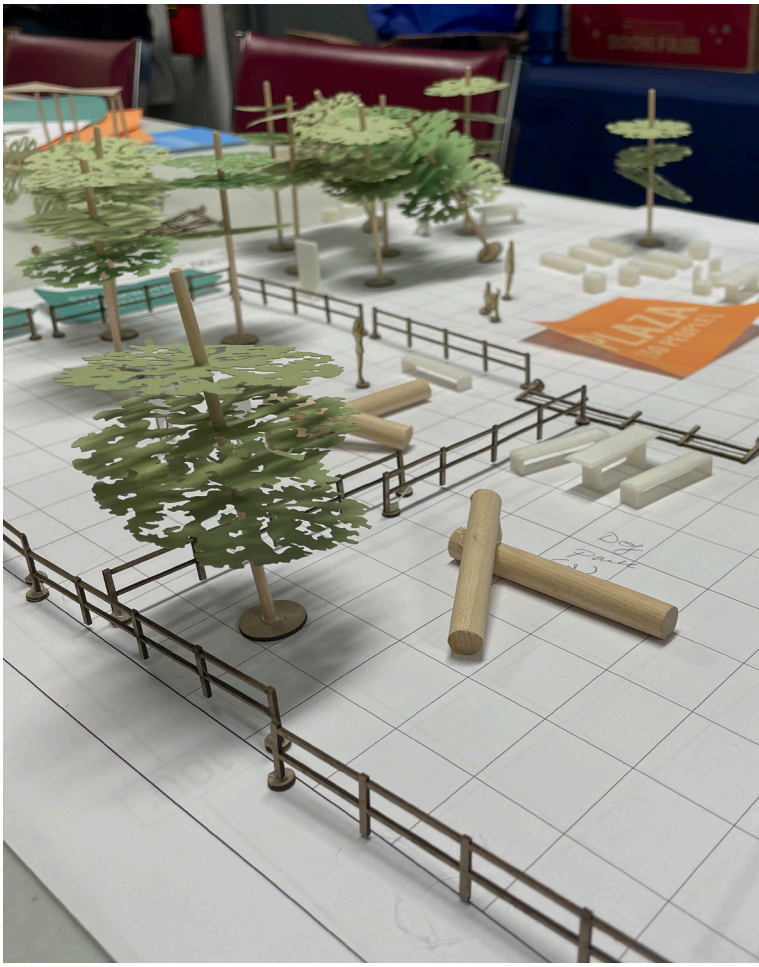


Figure 48. Residents used scaled model pieces to test different designs of spaces in their community. Source: OLIN.

COMMUNITY CANVASSING

As part of the community outreach, Clean Air Council did canvassing in each of the focus communities to help spread awareness about the project, upcoming meetings, and of initiatives they are working on. As part of the canvassing, pamphlets were developed to give to residents as a brief but comprehensive overview of the project, including flooding and pollution issues as well as ways of building resiliency.

COMMUNITY SURVEY

In the summer of 2024, Clean Air Council developed a community survey for each focus community to help gather feedback on the early action greening projects. The survey asked participants to rank the type of project they'd like most, where they'd like to see the project in their neighborhood, and additional recreational and environmental elements they would like to be included in future projects.

TECHNICAL ADVISORY BOARD

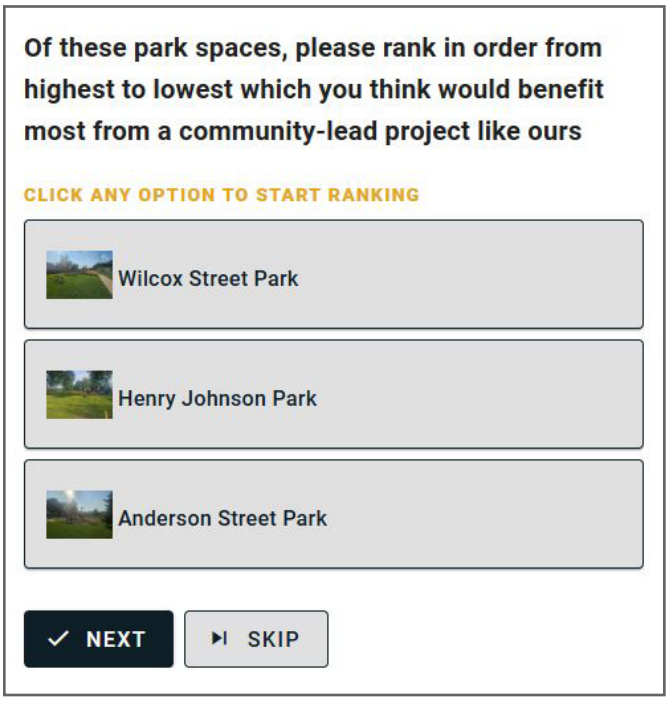
As part of the engagement process, it was critical that agencies, staff, and partners were regularly updated on the project. Interested parties were invited to join the Technical Advisory Board and provide technical feedback on the project.

ADVISORY BOARD & KEY GROUP CONVERSATIONS

The project team organized a series of conversations with a Community Advisory Board and key groups. The conversations served as a platform to introduce the project, gather input, and identify any areas of issue or concern. Each conversation began with a concise presentation led by the Consultant Team and Clean Air Council, providing participants with an overview of the process, including project progress, purpose, and goals. Following the introduction, participants were encouraged to share their ideas and perspectives. These conversations played an essential role in the project, providing the team with invaluable insights and areas of identified opportunities and constraints.

EARLY ACTION PROJECTS

A significant outcome of the community engagement process has been the development of early action projects in each community. These pilot interventions are based on feedback from residents and focus on infrastructure, recreation, and environmental education. Chapter 7 outlines these projects at the end of each community profile.



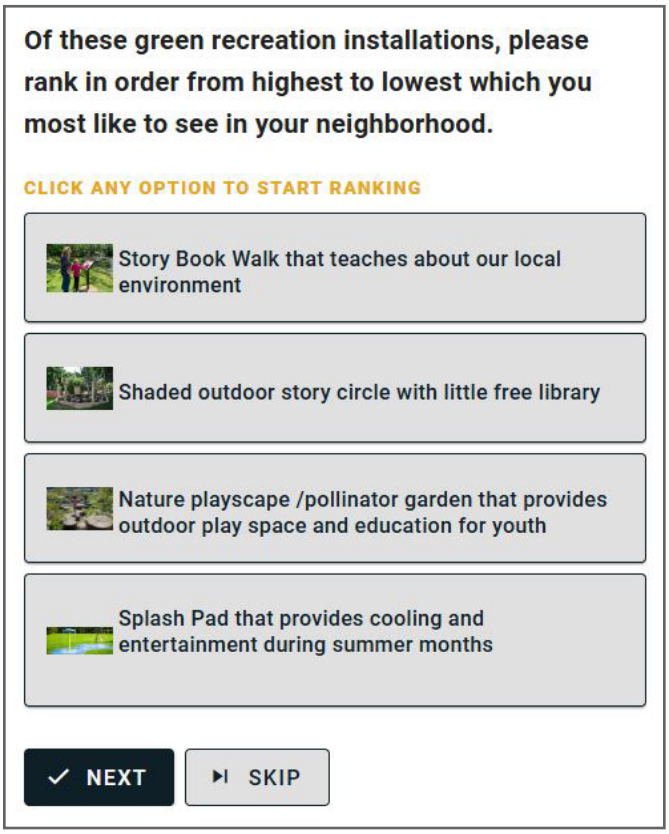


Figure 49. Questions from the Trainer Community Survey asked residents to provide their thoughts about project locations, types, and their environmental concerns. Source: Clean Air Council

Climate Resiliency Toolkit

A toolkit of actions ranging in scale was developed and brought to engagement meetings to understand which projects and actions resonated most with community members. See Chapter 6 on page 108 for further information on each toolkit item.

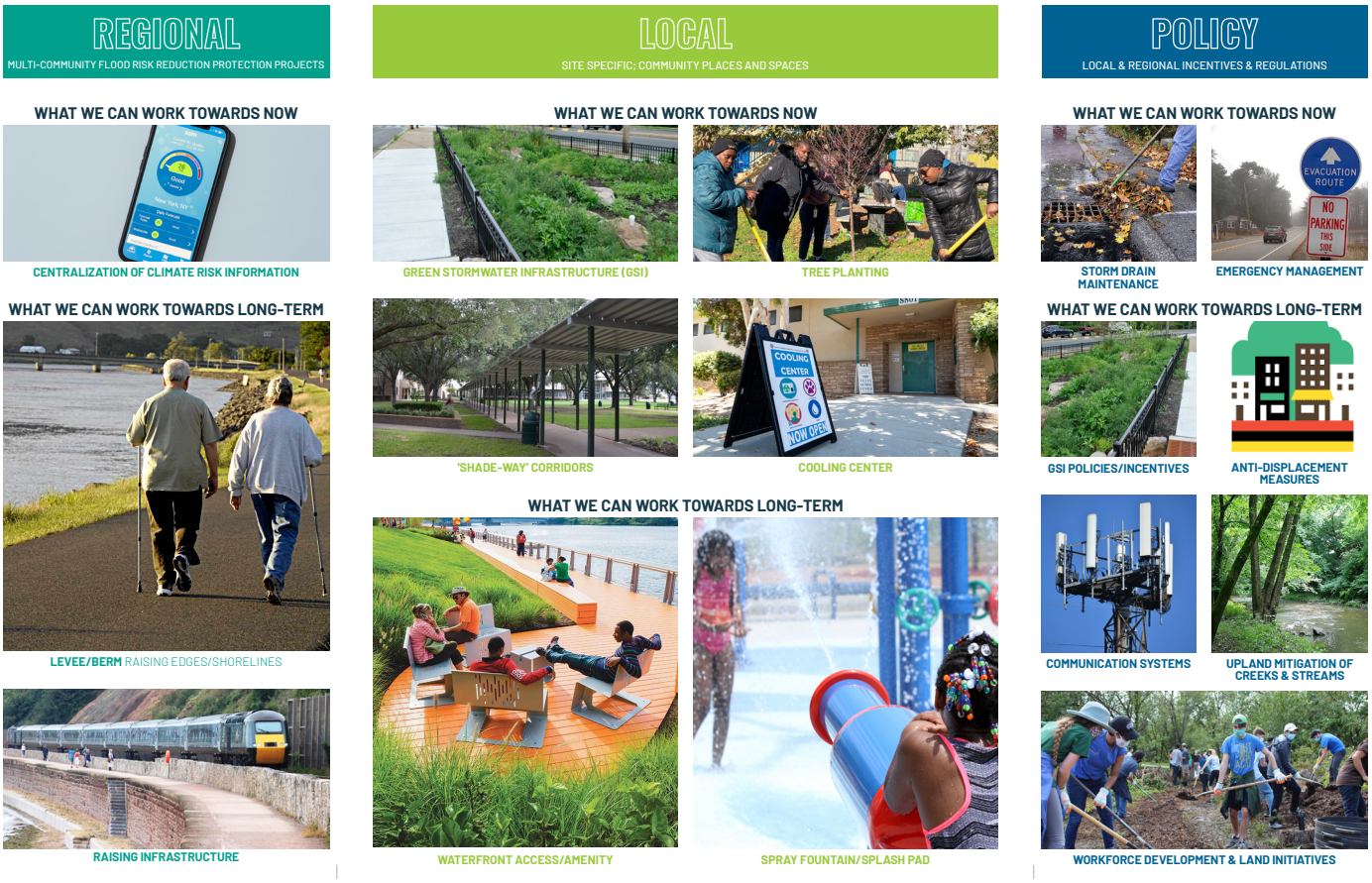
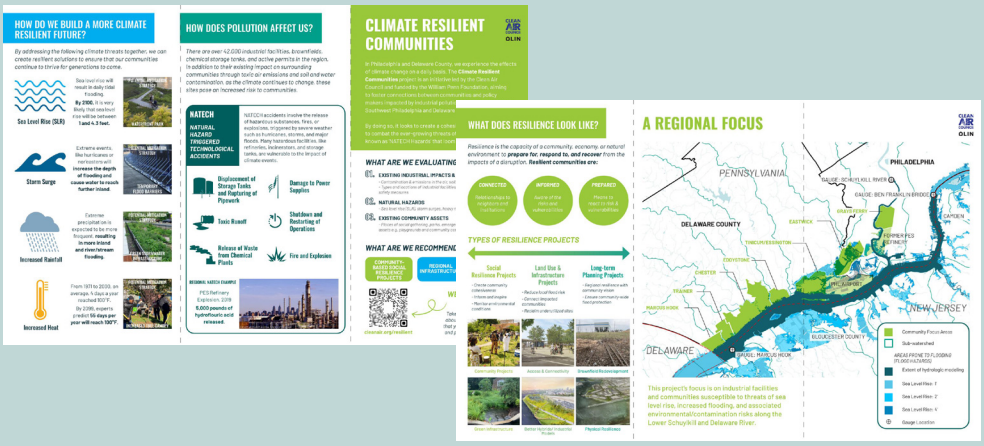


Figure 50. Toolkit of interventions for community meetings. Source: OLIN



Outreach

Pamphlets were developed to give to residents as a brief but comprehensive overview of the project, including flooding and pollution issues as well as ways of building resiliency.

Figure 51. 11x17" pamphlets to provide information on the study and learn about environmental and industrial risks. Source: OLIN



Figure 52. Residents sharing experiences at Eastwick Library. Source: OLIN.



Figure 53. Community members identifying toolkit elements that resonated with the

KEY TAKEAWAYS

- Four of the five communities experience recurrent flooding.
- Several participating residents have experienced flooding in their homes.
- The most common types of flooding of note were related to structures and streets.
- Several communities described the need for resources to address heat island effects.
- All communities had needs associated with a lack of access to open space and recreational needs, particularly for tweens and teens.
- Some communities experience isolation and are cutoff by highways and rail lines, raising concerns related to access to community space as well as ensuring the integrity of evacuation routes.
- Residents were interested in an early warning system and emergency preparedness.
- Some communities are experiencing flooding because of failing and aging infrastructure.
- Residents described the importance of community open spaces that enriched the quality of life and organization in communities such as gardens, community pools, athletic courts, and community centers.



m at Stinger Square. Source: OLIN.



Figure 54. Discussing small-scale, local projects with community members at Chester Eastside. Source: OLIN.

Trying to get water access back from junk yard.

– Marcus Hook-Trainer meeting participant

Is it possible to model the flooding impacts of HRP Group (formerly Hilco) raising their land?

– Grays Ferry meeting participant

No access zones during flood.

– Eastwick meeting participant

Must be public access to the river. That's important for human well-being.

– Eastwick meeting participant

Increase tree canopy.

– Grays Ferry meeting participant

Joint clean-up of creek.

– Marcus Hook-Trainer meeting participant

Figure 55. Example responses to the question: "what would you like to see in your community?" Source: OLIN.

Endnotes

1 Legal Information Institute. "Redlining." Accessed November 13, 2024. https://www.law.cornell.edu/wex/redlining.

2 Lane, Haley M., Rachel Morello-Frosch, Julian D. Marshall, and Joshua S. Apte. "Historical Redlining Is Associated with Present-Day Air Pollution Disparities in U.S. Cities." Environmental Science & Technology Letters 9, no. 4 (April 12, 2022): 345–50. https://doi.org/10.1021/acs.estlett.1c01012.

3 UNDRR. "Exposure," January 23, 2009. https://www.undrr.org/terminology/exposure.

4 UNDRR. "Disaster Risk," January 23, 2009. https://www.undrr.org/terminology/disaster-risk.

5 UNDRR. "Vulnerability," August 30, 2007. https://www.undrr.org/terminology/vulnerability.

6 "Defining Vulnerable Communities in the Context of Climate Adaptation." Integrated Climate Adaptation and Resiliency Program (ICARP), July 2018. https://lci.ca.gov/docs/20180723-vulnerable_communities.pdf.

7 FEMA. "Social Vulnerability | National Risk Index." Accessed November 13, 2024. https://hazards.fema.gov/nri/social-vulnerability.

8 Wilson, Barbara Brown. Resilience for All: Striving for Equity through Community-Driven Design. Island Press, 2018.

9 US EPA, OEJECR. "EJScreen: Environmental Justice Screening and Mapping Tool." September 3, 2014. https://www.epa.gov/ejscreen.

10 Climate and Economic Justice Screening Tool. "Climate and Economic Justice Screening Tool." Accessed November 13, 2024. https://screeningtool.geoplatform.gov.

11 Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry. "CDC/ATSDR Social Vulnerability Index 2020 Database." Accessed Nov 13, 2024. https://www.atsdr.cdc.gov/placeandhealth/svi/index.html



05 INCREASED COMMUNITY RISK


RESIDENTIAL
PERMIT
PARKING
ONLY
STOP

INCREASED RISK

In addition to the industrial facilities' existing impact on surrounding communities through toxic air emissions and soil and water contamination, these sites pose an increased risk to communities as the climate continues to change and natural disasters become more frequent and/or severe.

A review of past Natural Hazard-Triggered Technological Accident disasters signals a critical need for responding to these compounding challenges as they reveal new and destructive types of risks for residents, municipalities, and government agencies.

Natural Hazard-Triggered Technological Accident

Many hazardous facilities present in the Lower Schuylkill and Delaware River area, like refineries, incinerators, and storage tanks, are susceptible to the risks associated with climate events. These facilities present a risk of Natural Hazard-Triggered Technological Accident events, which involves the release of hazardous substances, fires, or explosions that have been triggered by a natural hazard event such as a hurricane, storm, or a major flood.[1] Examples of natural hazards that pose significant risks include lightning, earthquakes, and flooding.[2]

Natural Hazard-Triggered Technological Accident accidents pose various, serious problems and involve careful coordination between risk management, emergency response planning, and disaster response. The following page highlights several key case studies of past natural hazard events and the varied impacts they have had on industrial facilities.

FLOOD RISKS AND HAZARDOUS SITES

Flooding of industrial facilities poses several risks to facility equipment, entire facilities, and communities. Within the study area, multiple industrial facilities lie within the 1% (100-year) and 0.2% (500-year) FEMA floodplains, projected sea level rise zones (up to 2 feet), as well as within the areas of projected storm surges as modeled by Drexel University.

Floodwaters can cause the flotation of equipment which can inflict damage to the equipment itself, while floating parts and debris carried by floodwaters may collide and damage other sensitive equipment or structures downstream.[3] Tanks may also collapse or implode under strong pressure, releasing chemicals stored inside into waterways as well as toxic vapors that may form from chemical reactions with water.[4] Any electrical equipment that comes into contact with water incurs the risk of short circuits, power failure, and fires.[5]

Damage to facility equipment or facilities is an automatic risk to environments and communities both near and far: large amounts of toxic chemicals in water bodies can be hard to contain and may take years to clean up. Vaporization of chemicals and subsequent air pollution can travel far distances.

Flooding can impact industrial facilities in different ways. A hurricane and the resulting storm surge can trigger a sudden and catastrophic Natural Hazard-Triggered Technological Accident accident. The immediate flooding can compromise existing infrastructure and create widespread environmental contamination with the instantaneous dispersal of substances. In contrast, rising sea levels represent a chronic stress for industrial facilities through projected, repeated inundation and increased operational risk. As industrial site viability and economic viability decreases with sea level rise, industrial facilities may choose to relocate their operations if they do not

invest heavily in extensive protective infrastructure like sea walls.

EMERGENCY RESPONSE

Not only do floodwaters pose a significant risk to these facilities, they increase the potential of triggering or aggravating further accidents by impacting critical utilities. For example, the flooding of key roads prevents both evacuation of local residents and emergency response coming in, while power outages can impact residences and potential loss of services from various infrastructure systems, including communication systems that provide evacuation warnings for local residents.[6]

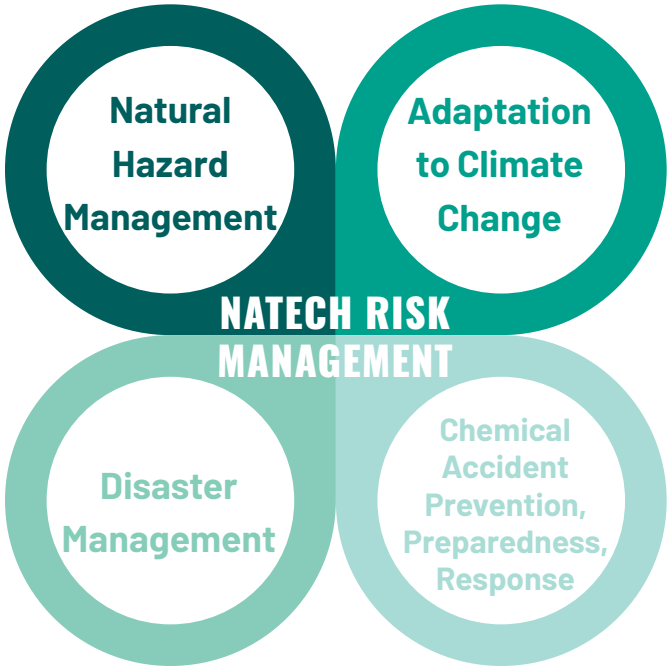


Figure 56. Natural Hazard-Triggered Technological Accident (Natech) Risk Management diagram. Source: OLIN

As the effects of climate change intensify, so does the risk of extreme weather events impacting the industrial facilities within the project region. Not only will the facilities' operations be impacted, but so will the surrounding environment - waterways, soils, groundwater, air - as will the communities living adjacent to these facilities.



Figure 57. Marcus Hook Terminal. Source: OLIN



Figure 58. Marcus Hook Terminal. Source: OLIN

NATURAL HAZARD-TRIGGERED TECHNOLOGICAL ACCIDENT (NATECH) CASE STUDIES

Hurricane Katrina, 2005
Category 5 storm

Hurricane Katrina led to the onshore release of more than **200 hazardous chemicals**, petroleum, and gas from various industrial facilities, like storage tanks, and from equipment failures, like pipeline ruptures. Of those releases, at least 10 were greater than 10,000 gallons of chemicals and **cumulatively they totaled about 8 million gallons of chemical releases**. Within the areas impacted by Katrina, nine refineries shut down completely while four refineries reduced operations.[7] [8]

Hurricane Ike, 2008
Category 4 storm

There were a total of **448 releases of oil, gasoline, and other toxic substances** from the impact of Hurricane Ike in the Louisiana, Texas, and Mississippi region. The worst spilled totaled nearly **266,000 gallons of oil** from storage tank displacement. Fourteen oil refineries and two petroleum reserve sites shut down operations as a result of the hurricane. [9]





Figure 59. Grays Ferry neighborhood. Source: OLIN

Hurricane Harvey, 2017
Category 4 storm

In Louisiana and Texas, Hurricane Harvey led to the release of more than **100 toxic chemicals** which amounted to **millions of pounds of hazardous substances released into the environment**. At least 14 current and former toxic waste sites were impacted by the flooding, with little known about the extent of damage. The flaring of fuels and chemicals during multiple shut-down and restart operations caused excess emissions; it was reported that one plastic plant released 1.3 million pounds of airborne emissions. Floodwaters at the Arkema chemical plant, which lies inside the 1% (100-year) FEMA floodplain, caused **multiple fires and explosions**, causing evacuations lasting over a week and hospitalizations across various communities.[10,11]

VULNERABLE INDUSTRIAL AREAS

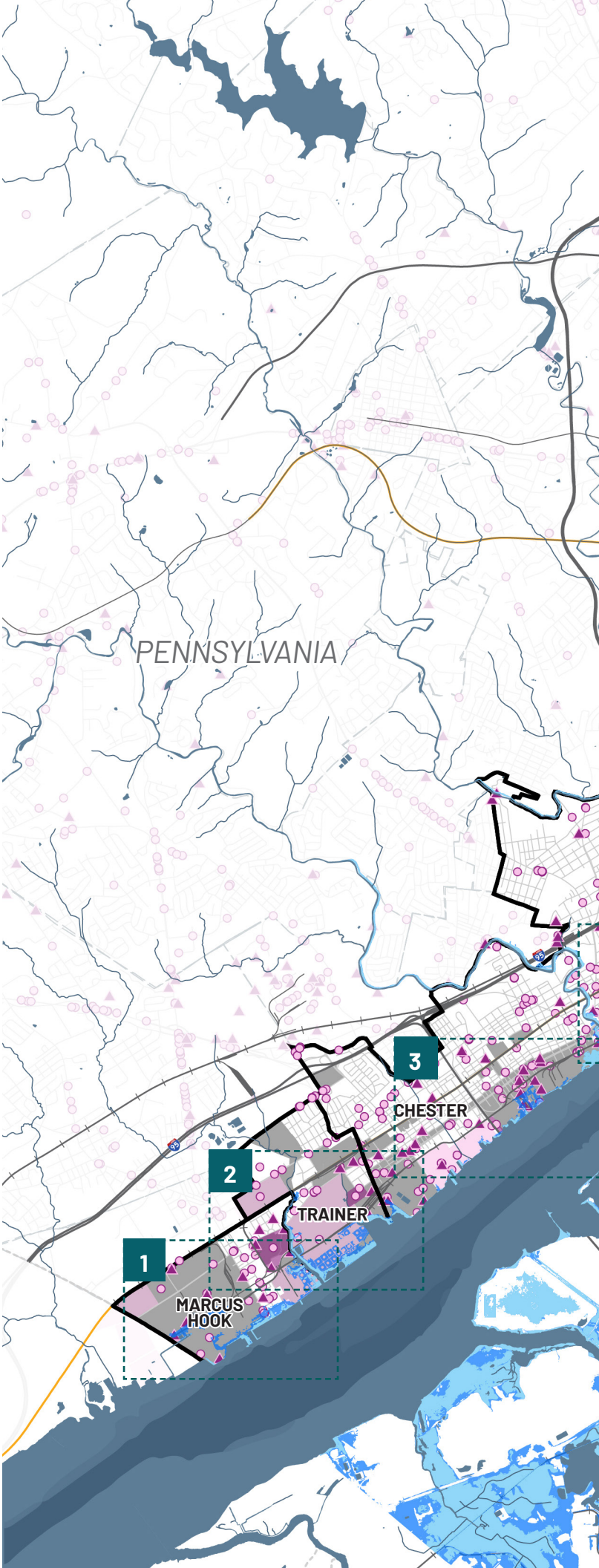
Of the 556 industrial sites and brownfields in the project area, 160 are located in the most socially vulnerable census tracts. Almost 49 of these toxic sites are considered "flood-exposed" to potential river flooding, hurricane storm surge, and/or projected sea-level rise.

Major industrial sites of concern within the study area flood zones:

- Marcus Hook Terminal
- Monroe Energy LLC (Oil Refinery)
- Marcus Hook Energy Center
- Reworld (formerly Covanta) (Waste)
- DELCORA Western Regional Treatment Plant
- PQ Corporation (Chester, chemical plant)
- Entegris Inc (Chester)
- Kimberly Clark
- Penn Terminals (Eddystone)
- Former PES Refinery and tank farm

Areas of Focus (see pages 100-103):

1. Marcus Hook Terminal
2. Monroe Energy LLC (Oil Refinery)
3. Chester Waterfront - Evonik
4. Chester Waterfront - Kimberly Clark/Penn Terminals
5. Chester Sun Village Park
6. Philadelphia Airport
7. Eastwick
8. Former PES Refinery & Tank Farm



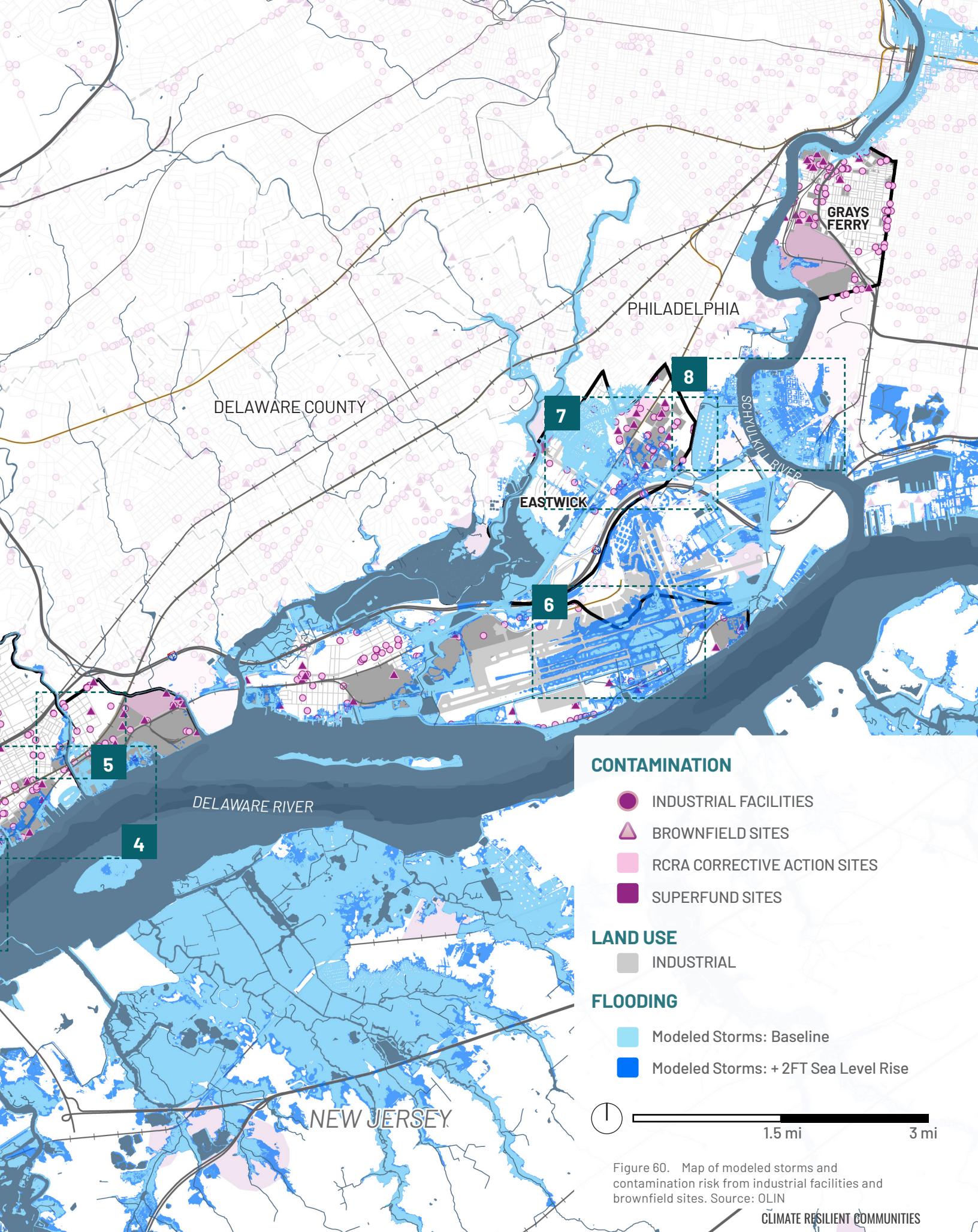


Figure 60. Map of modeled storms and contamination risk from industrial facilities and brownfield sites. Source: OLIN

POTENTIAL COMMUNITY IMPACTS

Modeled Storms: Baseline Modeled Storms: + 2FT Sea Level Rise Base Images Source: Google Earth, Image Landsat, Copernicus



Figure 61. Modeled sea level rise in Marcus Hook. Source: OLIN, Drexel

MARCUS HOOK TERMINAL

Formerly the Marcus Hook Refinery, this area now focuses on gas liquids infrastructure, which faces increased flood risk from rising sea levels. Inland, a low point along the freight rail line is also susceptible to floodwater accumulation, threatening transport and nearby facilities.



Figure 62. Modeled sea level rise in Trainer. Source: OLIN, Drexel

MONROE ENERGY LLC (TRAINER REFINERY)

Coastal and riverine flooding combines at the refinery site where Marcus Hook Creek joins the Delaware River. Sea level rise significantly increases the likelihood that existing tanks and related infrastructure could be exposed or damaged by flooding. Contaminated flood waters from the site could move up or down the Delaware River or push inland up Marcus Hook Creek, potentially exposing residential communities.



Figure 63. Modeled sea level rise in Chester. Source: OLIN, Drexel

CHESTER WATERFRONT - EVONIK

The Evonik chemical plant is highly vulnerable to projected sea level rise and inundation of their storage and processing facilities. Many storage tanks are located right at the water's edge; displacement or rupturing of the tanks can potentially cause a release of chemicals into the environment. Areas of the Chester Riverfront trail near the stadium will also face flooding threats.

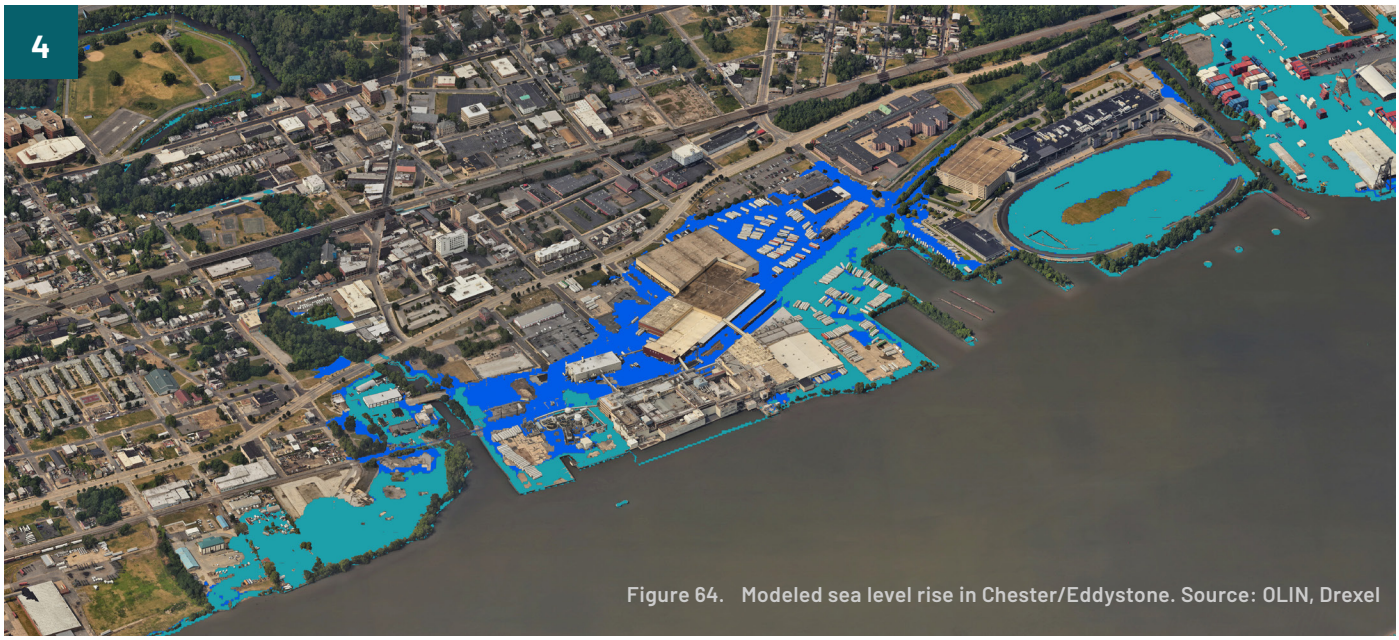


Figure 64. Modeled sea level rise in Chester/Eddystone. Source: OLIN, Drexel

CHESTER WATERFRONT - KIMBERLY CLARK/PENN TERMINALS

Flooding at the Chester/Eddystone border occurs where Chester Creek meets the Delaware River. Kimberly Clark, the Chester Water Authority Distribution Center, and the adjacent casino and racetrack are threatened by sea level rise. East 4th Street is the northern boundary of sea level rise threats in the area, protecting several community assets from the immediate threats of flooding, including the Chester Transportation Center and Chester Community Charter School.

POTENTIAL COMMUNITY IMPACTS

Modeled Storms: Baseline Modeled Storms: + 2FT Sea Level Rise Base Images Source: Google Earth, Image Landsat, Copernicus

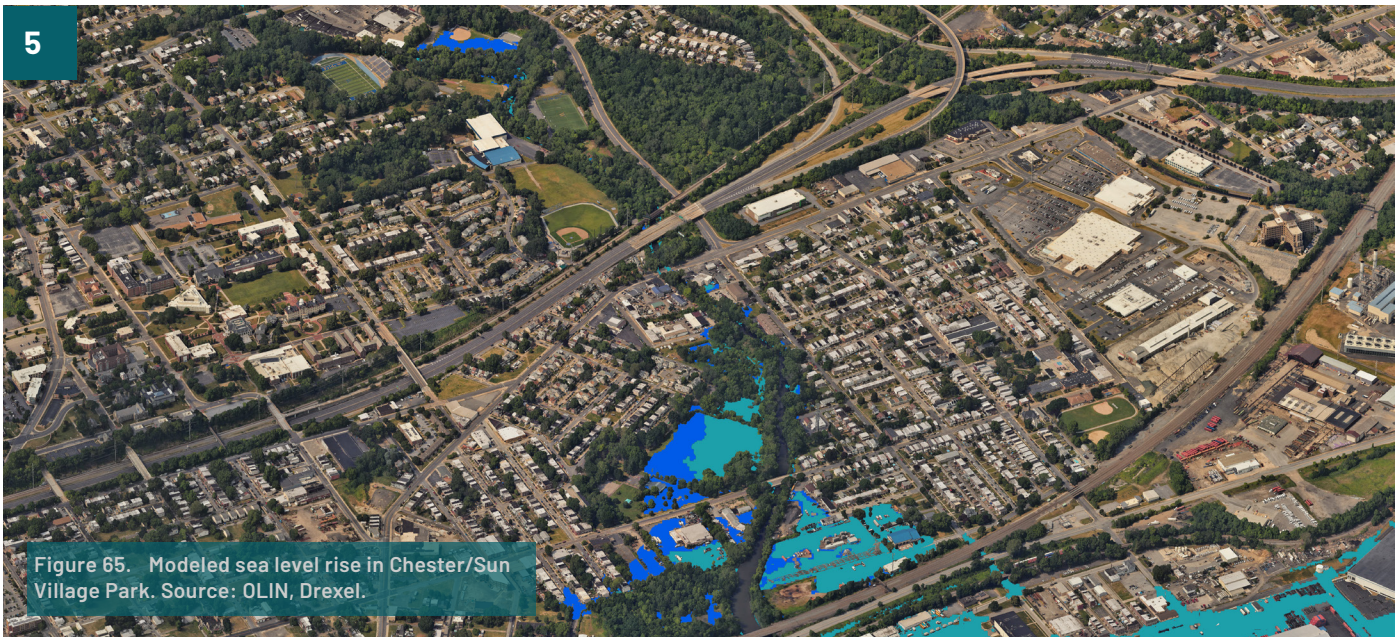


Figure 65. Modeled sea level rise in Chester/Sun Village Park. Source: OLIN, Drexel.

CHESTER - SUN VILLAGE PARK

Further inland, sea level rise and storm surge threatens Sun Village Park. The Eddystone Fire Station and pockets of residential areas are also under flooding threat, which are located between the eastern side of the creek and the Amtrak/ SEPTA rail line.



Figure 66. Modeled sea level rise at the Philadelphia Airport. Source: OLIN, Drexel.

PHILADELPHIA AIRPORT

Pluvial, fluvial, and coastal flooding combine in and around Philadelphia International Airport with direct impacts to the airport runways as well as numerous support facilities and adjacent infrastructure. Given the large amount of jet fuel and other chemicals used and stored at the airport, flooding could carry contaminants into adjacent communities and natural areas.

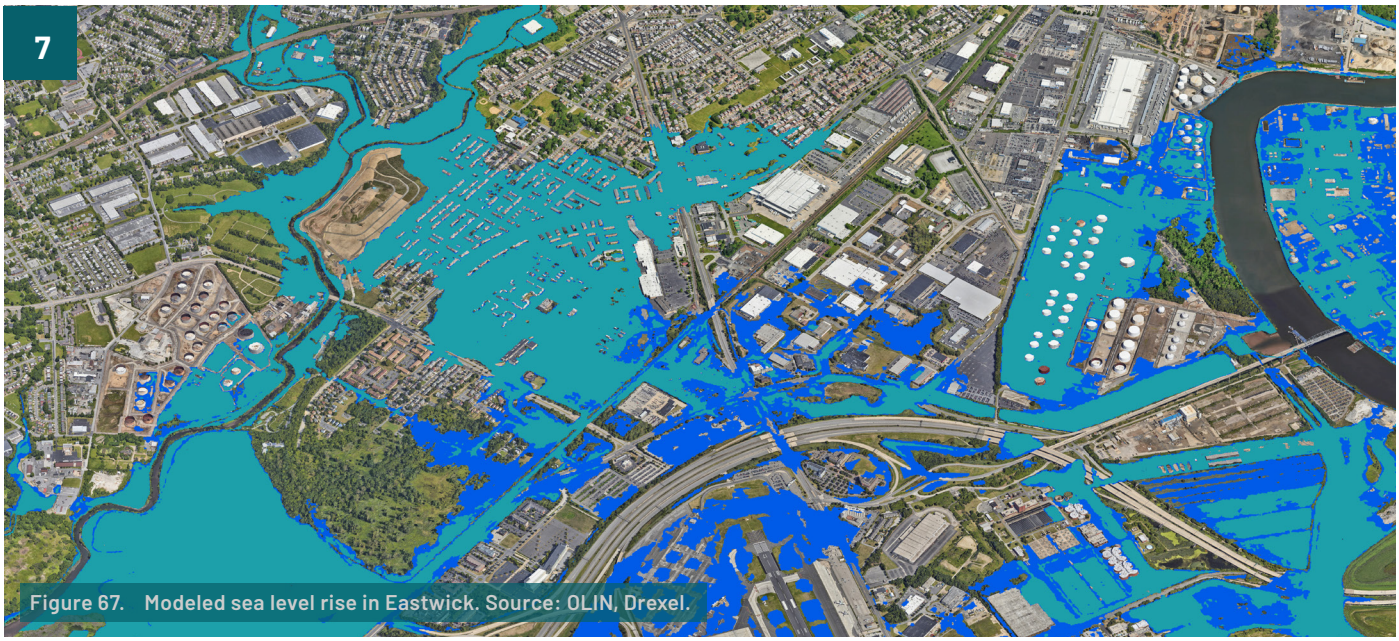


Figure 67. Modeled sea level rise in Eastwick. Source: OLIN, Drexel.

EASTWICK

Eastwick has a long history of flooding from Darby and Cobbs Creek along its western edge, with floodwaters commonly flowing across the community to the southeast. With sea level rise, flooding increasingly becomes a threat in southwest Eastwick and the industrial areas that are just north of Philadelphia International Airport.



Figure 68. Modeled sea level rise in the lower Schuylkill. Source: OLIN, Drexel.

FORMER PES REFINERY & TANK FARM

Much of the low-lying, former PES Refinery and Tank Farm will be inundated under projected flood models. It is unclear how much HRP Group's (formerly Hilco) plan to raise the site by 4 feet will alleviate flooding; however, the tank farm on the western banks of the Schuylkill River will be impacted and suffer from potential damage and consequent environmental hazards.

ENDNOTES

1 OECD. "The Impact of Natural Hazards on Hazardous Installations," February 2022. https://www.oecd.org/content/dam/oecd/en/topics/policy-sub-issues/chemical-accident-prevention-preparedness-and-response/impact-of-natural-hazards-on-hazardous-installations.pdf.

2 World Health Organization. "Chemical Releases Caused By Natural Hazard Events and Disasters," n.d. https://www.who.int/publications/i/item/9789241513395

3 Necci, Amos, and Elisabeth Krausmann. "JRC Technical Report: Natech Risk Management." JRC Publications Repository, June 20, 2022. https://doi.org/10.2760/666413.

4 Ibid.

5 OECD. "The Impact of Natural Hazards on Hazardous Installations," February 2022. https://www.oecd.org/content/dam/oecd/en/topics/policy-sub-issues/chemical-accident-prevention-preparedness-and-response/impact-of-natural-hazards-on-hazardous-installations.pdf.

6 Necci, Amos, and Elisabeth Krausmann. "JRC Technical Report: Natech Risk Management." JRC Publications Repository, June 20, 2022. https://doi.org/10.2760/666413.

7 Ibid.

8 Picou, Steven. "Katrina as a Natech Disaster: Toxic Contamination and Long-Term Risks for Residents of New Orleans." Journal of Applied Social Science, September 2009.

9 Necci, Amos, and Elisabeth Krausmann. "JRC Technical Report: Natech Risk Management." JRC Publications Repository, June 20, 2022. https://doi.org/10.2760/666413.

10 Ibid.

11 U.S. Chemical Safety and Hazard Investigation Board. "Organic Peroxide Decomposition, Release, and Fire at Arkema Crosby Following Hurricane Harvey Flooding," May 2018. https://www.csb.gov/arkema-inc-chemical-plant-fire-/.



06 RECOMMENDATIONS



Figure 69. New stormwater basin under construction in Chester's Veterans Memorial Park. Source: OLIN.

RECOMMENDATIONS OVERVIEW

Recommendations are organized at three scales of implementation: community/local, regional, and policy. Under each scale of approach, there are various complementary actions and tools that target different aspects of climate resiliency, from emergency preparedness to creating social spaces for fostering connections. No single approach can address the full scope of these challenges; instead, effective climate resilience requires layered solutions across all scales to build a comprehensive, adaptable strategy.

1. COMMUNITY RESILIENCE TOOLKIT

Clean Air Council and OLIN have developed a toolkit of local actions to help address larger climate issues of rising sea levels and temperatures as well as more local issues like a lack of tree cover or localized flooding. These can be implementable in the near-to mid-term horizon, with lower levels of funding needed than some larger scale, regional interventions. Some toolkit elements intersect with social resiliency, an important aspect in enabling communities to withstand shock and challenges by drawing upon collective strength, established support networks, and shared resources. By including both physical and social infrastructure, the toolkit identifies ways for communities to develop resiliently while fostering connection within and between communities.

2. REGIONAL INTERVENTIONS

Regional interventions are more complex and larger in scale, requiring coordination and planning across multiple jurisdictions and sectors. The interventions range from "hard" infrastructure projects like levee systems to nature-based solutions such as watershed restoration. Centralization of climate and hazard information is also key in a region susceptible to both natural events like storms and vulnerable to the hazardous impacts of these events. These interventions often take multiple years to implement and necessitate secure funding; however, they can be instrumental in the effort to mitigate local and regional climate impacts.

3. POLICY RECOMMENDATIONS

Climate resilience policy has to operate across multiple scales of governance in order to be effective, from federal funding programs to state-level environmental mandates to local zoning reforms. Key policy recommendations are geared towards ensuring resilient neighborhoods: emergency management in the event of a disaster, staying-in-place measures for current residents, physical interventions to address flooding, and industrial facility-specific measures.

Communities are all at different starting points in their journey towards becoming more environmentally just and better adapted to climate change.

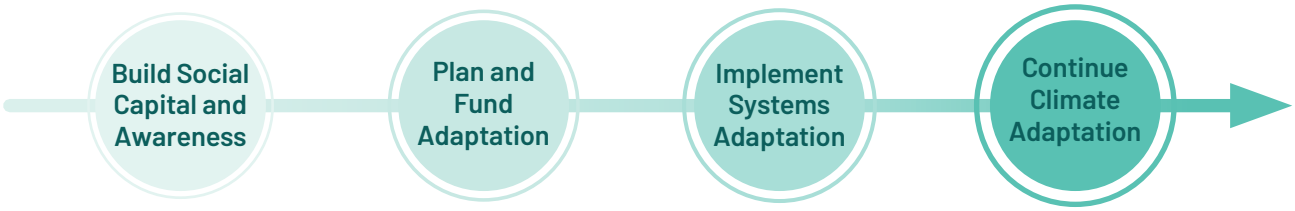


Figure 70. Diagram illustrating steps towards climate adaptation. Source: OLIN

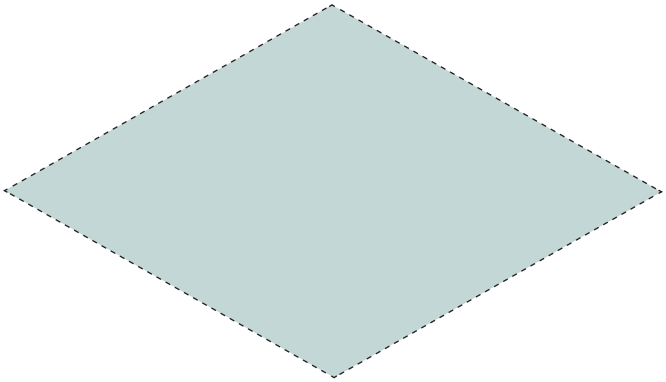


This project provides a multi-scalar overview of resiliency tools and recommendations, recognizing that climate adaptation measures must reach communities on the ground, build resilient networks, and develop holistic policy frameworks.

Figure 71. Diagram illustrating scale of recommendations. Source: OLIN

LANDSCAPE TYPES

These next few pages illustrate the typical characteristics of various landscape types found in the study area and where they are found in each community. An overview of exposures, risks, and vulnerabilities to flooding as well as opportunities for enhancing resiliency are outlined. See Chapter 4 for definitions of exposure, risk, and vulnerability based on the UN Office for Disaster Risk Reduction definitions.[2]



The recommendations laid out in this chapter are also based on the types of landscapes found in the study area. For example, an industrial shoreline may warrant a levee in certain areas to minimize the risk of a Natural Hazard-Triggered Technological Accident disaster, while a residential neighborhood can explore local green stormwater infrastructure opportunities for stormwater management. The landscape types also inform policy recommendations, such as upland mitigation of creeks to protect and restore the creek systems.

Context

- A brief overview of the characteristics of each landscape type in each community and any key locations.

Landscape Types

- Industrial Shoreline
- Residential Neighborhoods
- Cultural Clusters
- Commercial Corridors
- Linear Infrastructure
- Creek Corridors

Exposure

The presence of people, assets, infrastructure, and ecosystems located in hazard-prone areas

- Each landscape type is exposed to flooding and located in a flood-prone area; however, the degree of exposure varies and corresponds highly to the degree of risk involved.

Risk

The potential for negative consequences from a hazard

- The degree of risk varies and is characterized by low, moderate, or high risk. High risk is associated with multiple levels and timelines of harm to human and environmental health as well as long-term economic implications.

Vulnerability

The degree to which people, assets, and ecosystems are adversely affected by a hazard

- While no vulnerability assessments were conducted for this study, vulnerability was generally assessed based on existing conditions and past research into historic developments.

Opportunity

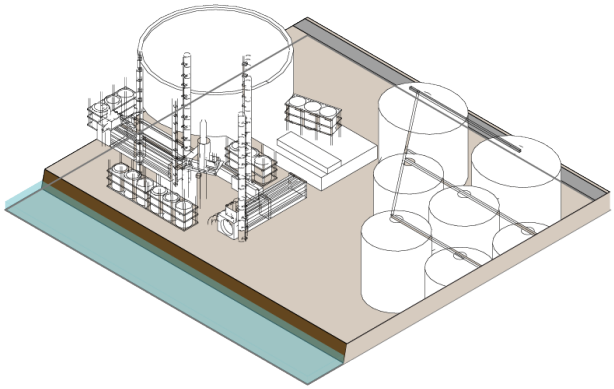
Potential areas of intervention to mitigate risk

- Landscape types were evaluated for their opportunities to enhance resiliency and/or opportunities to manage risk in the event of flooding.



Figure 72. Chester Creek with industrial facilities in the background. Source: OLIN

LANDSCAPE TYPES



INDUSTRIAL SHORELINE

Industrial areas occupy most of the Delaware River waterfront in many of the focus communities, with hardened shorelines and bulkheads and little room for a naturalized edge. The shoreline is reinforced with concrete and riprap, and along with industrial piers, works to support industrial operations. These industrial facilities consist primarily of oil storage tanks, loading facilities, pipelines, and petroleum refineries and storage units. Access is heavily restricted and monitored.

Figure 73. Industrial shoreline axon. Source: OLIN

Exposure

» Industrial facilities are typically situated near the waterfront and in areas susceptible to flooding and sea level rise.

Risk

» High.

» Flooding of industrial areas (or other natural disasters) can cause Natural Hazard-Triggered Technological Accident events, which have high impacts on human health and environmental health.

Vulnerability

» Storage tanks have individual berms/levees to prevent overflow; however, there is little other (known) protection from flooding. There is also little vegetation or natural features.

» Hard to retrofit large facilities that were built decades ago without much planning for future flooding

» Local economies may be dependent on industrial facilities and the shutdown of a facility may impact livelihoods

Opportunity

» Requires coordination with industry to retrofit facilities and prepare for flooding.

» Decommissioning of facilities opens up opportunities for alternative land uses that have broader community benefits, like waterfront parks.



Figure 74. Examples of industrial shorelines throughout the project study area. Source: OLIN

RESIDENTIAL NEIGHBORHOODS

The residential fabric across the focus communities varies with their different histories. The Delaware County industrial neighborhoods of Marcus Hook, Trainer, and Chester feature more suburban patterns of modest detached homes and twin row houses from the 20th century, with small yards and driveways, and areas that are immediately adjacent to industrial facilities. Marcus Hook and Trainer have relatively stable housing stock while Chester's housing stock reflects decades of economic distress. In Philadelphia, Eastwick's housing fabric is reflective of its urban renewal history: larger lots and planned subdivision housing. Grays Ferry is more representative of a late 19th century Philadelphia neighborhood, with dense blocks of two to three-story row houses following the street grid.

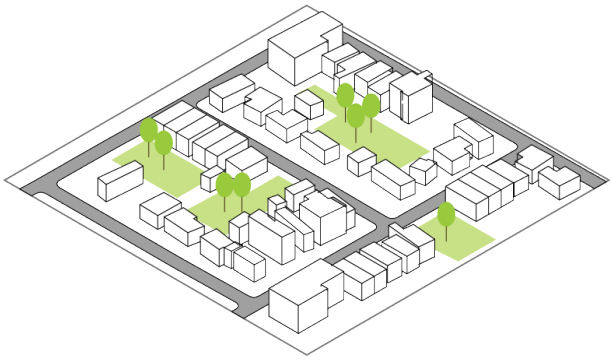


Figure 75. Residential neighborhood axon. Source: OLIN

Exposure

» Exposure to flooding varies. Some communities are located in higher elevations, such as Grays Ferry, and do not see the same level of flooding that other low-lying neighborhoods do, such as Eastwick.

Risk

» Moderate to high.

» A common thread among all the neighborhoods is a general lack of building retrofits that anticipates flooding, thereby increasing risk.

Vulnerability

» All of the focus communities are vulnerable to the risks of flooding stemming from historic and structural inequality that have led to present-day land-use decisions: the siting of these neighborhoods near industrial facilities, in areas unsuitable for development, and in low-lying, flood-prone areas.

Opportunity

» Neighborhoods and housing on higher ground can benefit from the redevelopment of adjacent low lying and flood-prone areas. Multi-level row housing can have lower floors retrofitted while other single stand alone housing can be elevated to reduce flood impacts.



Figure 76. Examples of residential neighborhoods throughout the project study area. Source: OLIN

LANDSCAPE TYPES

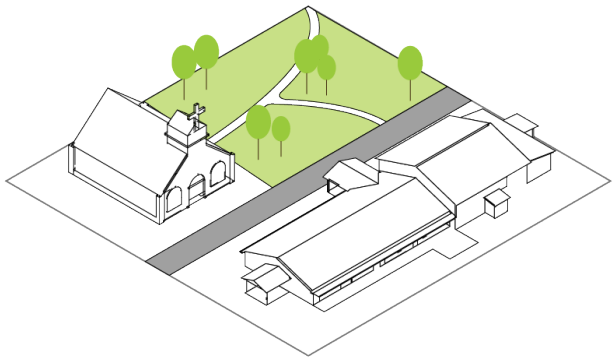


Figure 77. Cultural cluster axon. Source: OLIN

CULTURAL CLUSTERS

Each neighborhood has pockets of cultural assets, including schools, recreation centers, and neighborhood libraries. Market Street is the main cultural corridor of Marcus Hook and Trainer, anchored by Market Square Memorial Park and Marcus Hook Community Center. In Chester, Edgemont Avenue near the train station and the Chester Riverfront area features local businesses and small shops while other assets are located throughout the neighborhood. Eastwick's library and community garden serve as community anchors and John Heinz National Wildlife Refuge is both a neighborhood and city-wide asset. Grays Ferry's cultural assets are evenly distributed throughout the neighborhood with a variety of park spaces, waterfront access, and recreation/community centers.

Exposure

» Exposure to flooding varies by community. Some are in low-lying areas while others are on high ground and safe from floods.

Risk

» Low to moderate.

» Flooding of parks and open spaces do not pose the same threat to human life and environmental health that an industrial facility does; however, damage to important social and cultural spaces may impact a community's social capacity.

Vulnerability

» Funding, maintenance, and capacity differs by neighborhood. The lack of funding or maintenance impacts the ability of an asset, like a community center, to serve its residents during a disaster event.

Opportunity

» There are opportunities to transform existing cultural spaces into more resilient assets, like expanding stormwater capacities in a waterfront park or turning an existing recreation center into a cooling and resilience hub.



Figure 78. Examples of community cultural assets throughout the project study area. Source: OLIN

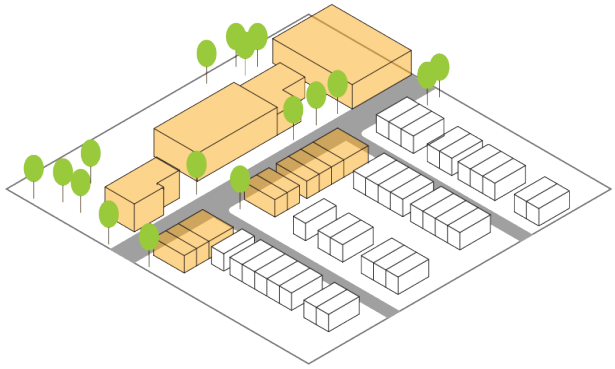


Figure 79. Commercial corridor axon. Source: OLIN

COMMERCIAL CORRIDOR

Except for Grays Ferry, there is no strong commercial corridor present in the focus communities, which is itself indicative of vulnerability and disinvestment. Small shops, local businesses, and some warehouse facilities are located in each community; however, they are fairly disparate and not tied to any street. Several main thoroughfares and pedestrian-trafficked areas present opportunities for more commercial development, including Chester's Market Street and waterfront area.

In contrast to the row house residences of the neighborhood, Grays Ferry Avenue is more representative of strip mall development and is defined by larger commercial buildings with little human-scale, pedestrian-oriented businesses.

Exposure

» Most commercial businesses are located away from the waterfront and away from most flood risks.

Risk

» Low.

» Commercial businesses are essential for providing critical community services and sustaining jobs and economic livelihoods.

Vulnerability

» Commercial businesses can be vulnerable to disasters even if they are not directly impacted due to disturbances to supply chains and the loss of business.

Opportunity

» Since most commercial areas are on higher ground, the transformation of these areas into higher density, mixed-use residential-commercial corridors can begin to knit neighborhoods together, particularly in areas where other development areas have higher flood risk.



Figure 80. Examples of commercial corridors throughout the project study area. Source: OLIN

LANDSCAPE TYPES

LINEAR INFRASTRUCTURE

In Delaware County, major transportation infrastructure runs parallel to the waterfront and through all the focus communities, including: I-95, I-76, PA Route 291, and the commercial Amtrak/Southeastern Pennsylvania Transit Authority (SEPTA) rail line. I-95 hugs the boundary of Marcus Hook, Trainer, and Chester to the north and Eastwick to the south, while I-76 forms the western border of most of Grays Ferry.

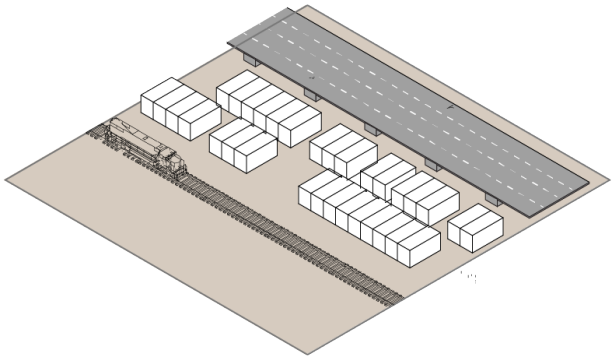


Figure 81. Linear infrastructure axon. Source: OLIN

Exposure

» Freight lines, industrial rail lines, and pipelines are situated close to the waterfront and in areas susceptible to flooding. Commercial rail lines and major highways are set back further from the waterfront, but create other concerns of air pollution and noise pollution.

Risk

» High.

» Flooding of freight lines and/or impact to trains, trucks, and ships carrying hazardous materials can cause a Natural Hazard-Triggered Technological Accident event. Transportation infrastructure is often located by populated areas, posing even more of a risk.

Vulnerability

» Aging infrastructure and lack of maintenance can lead to the disruption of rail lines and cause unanticipated risk.

» High traffic on highways and other major roads may increase the likelihood of a crash and a resulting Natural Hazard-Triggered Technological Accident event.

Opportunity

» Major roads can serve as emergency routes during a disaster event.

» Portions of rail lines or highways can be elevated to protect areas against flooding; however, this requires a lot of planning, funding, and time.



Figure 82. Examples of linear infrastructure throughout the project study area Source: OLIN

CREEK CORRIDOR

The main creeks running through the project area are Marcus Hook Creek, Chester Creek, Ridley Creek, and Darby Creek, connecting upland watersheds to the Delaware River. They all feature some engineered and hardened conditions in their industrial and urban context, and contribute to the flooding issues each community faces.

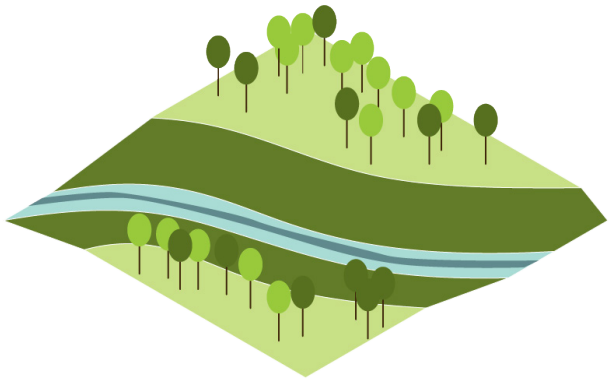


Figure 83. Creek corridor axon. Source: OLIN

Exposure

» Creeks and adjacent land within the broader watershed system are impacted by tidal influences as well as natural events upstream and downstream.

Risk

» Moderate to high

» Flood risk from creeks varies by community; flooding impacts residential areas in some communities (like Eastwick, where the creek regularly floods the streets and residents' basements) whereas in others, flooding is mainly limited to existing open spaces.

Vulnerability

» Centuries of industrial development have transformed most of the creeks into an engineered and hardened system. The channelization of the creeks has made it difficult to handle major storm flows and the creeks are susceptible to overtopping their banks during periods of high precipitation.

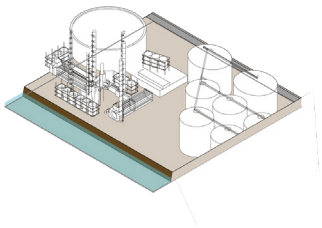
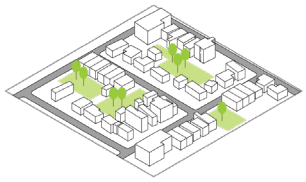
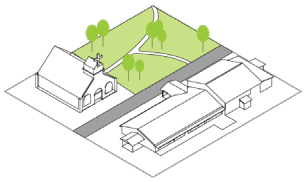
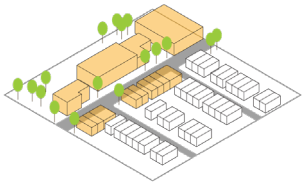
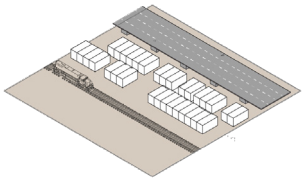
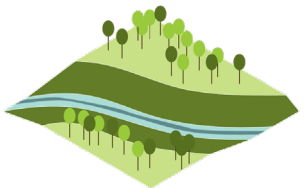
Opportunity

» Creek edges can be softened and riparian buffers widened in key places to accommodate flooding. The creek system can also be strengthened by creating recreational trail systems along the corridors.



Figure 84. Examples of creek corridors throughout the project study area. Source: OLIN

LANDSCAPE TYPES

			MARCUS HOOK	TR
INDUSTRIAL SHORELINE		Typical along all communities and along both the Delaware River and Schuylkill River. The shoreline is hardened and leaves little room for a naturalized edge.	**Delaware River**	**Del R**
RESIDENTIAL NEIGHBORHOOD		Residential fabric is typically representative of each community's history, from suburban patterns of single-family homes to subdivision housing to late 19th century row houses.		
CULTURAL CLUSTER		Community and cultural assets tend to be scattered throughout each community with no defined hub. Some neighborhoods are lacking smaller scale assets like neighborhood parks.	**Market Street**	
COMMERCIAL CORRIDOR		No defined pedestrian-oriented commercial corridors in most communities; most businesses are scattered throughout each neighborhood or more representative of strip mall development.	**Market Street 10th Street**	**9t**
LIENAR INFRASTRUCTURE		Major transit corridors run parallel to the waterfront but freight and industrial rail lines tend to be closer to the water, posing flooding concerns.	**US 13 Amtrak/SEPTA Norfolk Southern Rail CASO Local Haul PECO**	**Amtr Norfolk CASO**
CREEK CORRIDOR		Various conditions along the different creeks, ranging from more naturalized edges (typically upstream and near the John Heinz Wildlife Refuge) to the more engineered and hardened edge as the creeks meet the Delaware River.	**Marcus Hook Creek**	**Marcus Sto**

RAINER	CHESTER	EDDYSTONE	TINICUM	EASTWICK	GRAYS FERRY
laware River	Delaware River	Delaware River	Delaware River		Schuylkill River
	Edgement Ave. Chester Waterfront			Pepper School	John Heinz National Wildlife Refuge
h Street	Edgemont Ave.	Chester Pike	N. Governer Printz Blvd.		Grays Ferry Ave.
US 13 rak/SEPTA Southern Rail Local Haul PECO	I-95 US 13 US 322 Pennsylvania 291 Amtrak/SEPTA Norfolk Southern Rail CASO Local Haul CSX Rail	I-95 US 13 Pennsylvania 291 Amtrak/SEPTA Norfolk Southern Rail CASO Local Haul	I-95 Pennsylvania 291 Pennsylvania 420 CASO Local Haul	I-95 Pennsylvania 291 Amtrak/SEPTA Norfolk Southern Island Ave. Trolley	I-76 12th St. Viaduct CSX Rail Schuylkill River Trail
s Hook Creek ney Creek	Chester Creek Ridley Creek	Ridley Creek Crum Creek	Darby Creek	Darby Creek Cobbs Creek	

COMMUNITY RESILIENCE TOOLKIT

GREEN STORMWATER INFRASTRUCTURE

Green stormwater infrastructure includes systems and practices that use or mimic natural processes to manage stormwater. Examples include rain gardens, green roofs, permeable pavements, and bioswales. These systems help reduce runoff, improve water quality, and provide additional benefits such as urban cooling and habitat creation. Green stormwater infrastructure can be integrated into urban landscapes to enhance resilience against flooding and reduce the burden on traditional stormwater systems. By promoting infiltration and evapotranspiration, Green stormwater infrastructure helps mitigate the impacts of heavy rainfall and urban heat islands.



Figure 85. Northwest Resiliency Park. Source: OLIN

COOLING CENTERS

Cooling centers are designated public spaces that provide air-conditioned environments for people to escape extreme heat. These centers are crucial during heatwaves, especially for vulnerable populations such as the elderly, children, and those with health conditions. They are often located in community centers, libraries, or other public buildings. Cooling centers not only offer relief from heat but also provide opportunities for social interaction and access to other community services. Effective communication and accessibility are key to ensuring that those in need can utilize these facilities.



Figure 86. Free Library Cooling Center. Source: Wikipedia User A. Suresh

WATERFRONT ACCESS & AMENITIES

Waterfront access and amenities enhance the connection between communities and their water bodies. This can include parks, promenades, piers, and recreational facilities that encourage public use and enjoyment of waterfront areas. Such amenities promote physical activity, mental health benefits, social interaction, and economic development. They also play a role in environmental education and stewardship by fostering a sense of ownership and responsibility towards local water resources. Properly designed waterfront spaces can also serve as buffers against flooding and sea level rise.



Figure 87. East Park Canoe House. Source: OLIN

TREE PLANTING

Tree planting initiatives involve the strategic placement of trees to provide multiple environmental, social, and economic benefits. Trees improve air quality, reduce urban heat islands, and enhance biodiversity. They also contribute to stormwater management by intercepting rainfall and reducing runoff. In addition to their ecological benefits, trees provide aesthetic value, increase property values, and improve mental health and well-being. Community involvement in tree planting can strengthen social cohesion and environmental awareness.



Figure 88. Source: A. Yee, City of Philadelphia

SHADE-WAY CORRIDORS

Shade-way corridors are pathways or streets lined with trees or other shading structures to provide relief from the sun. These corridors make walking and cycling more comfortable, encouraging active transportation and reducing reliance on cars. They also help lower ambient temperatures, mitigate urban heat islands, and improve air quality. Shade-way corridors can be integrated into urban planning to create cooler, more livable cities. They also enhance the aesthetic appeal of streetscapes and contribute to the overall green infrastructure network.



Figure 90. Mill River Park and Greenway. Source: OLIN

SPRAY FOUNTAINS & SPLASH PADS

Spray fountains and splash pads are recreational water features designed for public use, particularly by children. These amenities provide a fun and interactive way to cool off during hot weather. They are often located in parks, playgrounds, and community centers. In addition to their recreational value, spray fountains and splash pads can serve as community gathering spaces and promote social interaction. They are typically designed with water conservation in mind, using recirculated water and automated controls to minimize waste.



Figure 89. Dilworth Park. Source: M. Fischetti

BUILDING RETROFITS

Building retrofits involve upgrading existing structures to improve energy efficiency, resilience, and overall performance. This can include installing insulation, energy-efficient windows, and HVAC systems, as well as implementing renewable energy sources like solar panels. Retrofits can also address climate resilience by enhancing a building's ability to withstand extreme weather events, such as flooding and heatwaves. These improvements reduce energy consumption, lower greenhouse gas emissions, and increase occupant comfort. Retrofitting buildings is a key strategy in achieving sustainability and resilience goals.



Figure 91. Build It Back NYC: Attached, two-family elevated homes. Source: New York City Mayor's Office of Housing Recovery Operations

DEPLOYABLE/TEMPORARY BARRIERS

Deployable or temporary barriers are structures that can be quickly installed to protect against flooding and other hazards. Examples include sandbags, inflatable dams, and modular flood barriers. These barriers provide flexible and cost-effective solutions for emergency situations, offering protection to critical infrastructure and vulnerable areas. They can be deployed in response to weather forecasts and removed once the threat has passed. Deployable barriers are an important component of emergency management and disaster response plans.



Figure 92. Sandbags that act as temporary barriers against flooding. Source: Flickr User Jnzl

PAVEMENT REDUCTION

Pavement reduction refers to the removal or replacement of impervious surfaces, such as concrete and asphalt, with permeable materials or green spaces. This practice helps reduce stormwater runoff, mitigate urban heat islands, and improve groundwater recharge. Pavement reduction can be implemented in various settings, including streets, parking lots, and plazas. By increasing the amount of permeable surface area, this strategy enhances the resilience of urban environments and contributes to the overall aesthetic and ecological health of cities.



Figure 93. Permeable paving. Source: OLIN

ENVIRONMENTAL MONITORING & MODELING

Environmental monitoring and modeling involves the systematic collection of data on various environmental parameters, such as air and water quality, temperature, and precipitation. This information is crucial for understanding and managing the impacts of climate change and other environmental stressors. Monitoring programs can inform policy decisions, support regulatory compliance, and guide adaptive management strategies. Advances in technology, such as remote sensing and Internet of Things (IoT) sensors, have enhanced the ability to collect, analyze, and transmit environmental data in real-time, such as air pollution metrics. Effective monitoring requires collaboration among government agencies, research institutions, and community organizations.



Figure 94. I See Smoke PA Program.
Source: Clean Air Council

REGIONAL INTERVENTIONS

RAISING EDGES/SHORELINES: LEVEEES & FLOOD BARRIERS

Levees are embankments constructed to provide flood protection by raising the edges of shorelines and riverbanks. These structures help prevent floodwaters from inundating adjacent land areas, protecting communities and infrastructure. Levees and berms can be designed to accommodate varying levels of water flow and can be integrated with other flood management strategies. Regular maintenance and monitoring are essential to ensure their effectiveness. In addition to flood protection, levees and berms can support habitat restoration and recreational opportunities.



Figure 96. Tidal levee with trail in New Castle, Delaware. Source: OLIN

RAISING INFRASTRUCTURE

Raising infrastructure involves elevating critical infrastructure, such as roads, bridges, and buildings, to protect them from flooding and sea level rise. This strategy is important in coastal and flood-prone areas where rising water levels pose a significant threat. By elevating infrastructure, communities can reduce the risk of damage and ensure the continued functionality of essential services during extreme weather events. This approach requires significant investment and planning to integrate with existing urban landscapes. Raising infrastructure also includes the use of elevated platforms, stilts, and other engineering solutions.



Figure 97. Miami Beach Road Raising, 2015. Source: Creative Commons 1.0 User B137

CENTRALIZATION OF CLIMATE RISK INFORMATION

Centralizing climate risk information involves consolidating data on climate hazards, vulnerabilities, and impacts into a single, accessible platform. This approach enables better coordination and decision-making among government agencies, businesses, and communities. Centralized information can support the development of resilience plans, inform emergency response efforts, and guide investment in adaptation measures. Effective communication and dissemination of climate risk information are essential to ensure that all stakeholders are informed and prepared. This strategy also promotes transparency and accountability in climate resilience efforts.



Figure 95. The Watershed: Flood Resilience Hub that opened in Germantown in 2024. Source: City of Philadelphia Water Department.

NATURE-BASED SOLUTIONS

Nature-based solutions (NBS) leverage natural processes and ecosystems to address climate challenges and enhance resilience. Examples include wetland restoration, reforestation, and the creation of green infrastructure. These solutions provide multiple benefits, such as flood protection, carbon sequestration, and biodiversity conservation. NBS are often more sustainable and cost-effective than traditional engineering approaches. They also enhance the aesthetic and recreational value of landscapes, contributing to the well-being of communities. Integrating nature-based solutions into urban and regional planning is essential for building resilient and sustainable environments.



Figure 99. Eastwick. Source: OLIN

IMPROVED CONNECTIVITY

Improved connectivity refers to enhancing the physical and social links between communities, infrastructure, and natural systems. This can include developing transportation networks, green corridors, and communication systems that facilitate movement and interaction. Improved connectivity supports resilience by enabling efficient evacuation, resource distribution, and emergency response. It also promotes social cohesion and economic development by connecting people to jobs, services, and recreational opportunities. Planning for connectivity should also consider the needs of vulnerable populations.



Figure 98. Lower Appomattox River Connector. Source: OLIN



Figure 101. Rendering of a boardwalk permitting community access around industrial araes . Source: OLIN

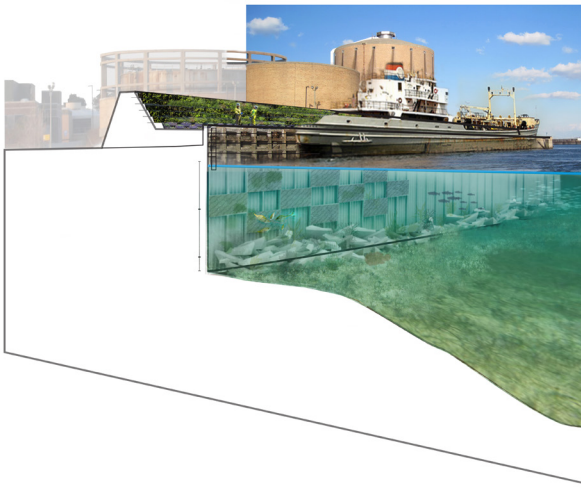


Figure 102. Axon graphic of a levee system in an industrial area.

PROJECT EXAMPLE: HUNTS POINT LIFELINES

Part of the U.S. Department of Housing and Urban Development's Rebuild by Design competition, Hunts Point Lifelines is a plan to safeguard the hub of New York's Food Supply through a protective and resilient landscape infrastructure.

The project demonstrates innovative, scalable solutions that increase long term resilience along the Eastern Seaboard and enables cities, towns, and neighborhoods to reduce risks from flooding and industrial hazards through a combination of natural and structural adaptations. Lifelines was built upon an integrated design process with deep community engagement, research, and analysis. These efforts resulted in a landscape-based flood protection system that encouraged the use of local industries, the creation of green jobs and the identification of funding strategies that would result in buildable projects.

The project consisted of four initiatives, known as "Lifelines:" The Levee Lab, a protection system that serves a dual purpose as a shoreline greenway; Cleanways, a multi-step plan for clean infrastructure; an Emergency Maritime Supply Chain; and Livelihoods, a policy proposal to promote the local economy and create green jobs.[3]



Source: OLIN



Figure 103. Rendering of a restored shoreline and trail system. Source: OLIN

Team:
PennDesign/OLIN with HR&A Advisors, eDesign Dynamics, Level Infrastructure, Barretto Bay Strategies, McLaren Engineering Group, Philip Habib & Associates, Buro Happold

Location:
The Bronx, NY

Outcome:
Resiliency Plan, released 2014

Funding:
$85.68 million ($20M Community Development Block Grant Disaster Recovery (CDBG-DR) grant through Rebuild by Design, $51M City Capital and additional CDBG-DR, $14.68M FEMA Building Resilient Infrastructure and Communities (BRIC) Grant)

POLICY RECOMMENDATIONS

EMERGENCY MANAGEMENT

Emergency management involves planning, coordinating, and implementing measures to prepare for, respond to, and recover from emergencies and disasters. This includes developing emergency response plans, conducting drills and training, and establishing communication systems. Effective emergency management requires collaboration among government agencies, first responders, and community organizations. It also involves engaging the public in preparedness efforts and ensuring that vulnerable populations are protected. Building resilient communities depends on robust emergency management systems that can adapt to evolving threats and challenges.

1. EFFECTIVE COMMUNICATION SYSTEMS

Effective communication systems are essential for disseminating information and coordinating actions before, during, and after emergencies and disasters. County or municipal officials in charge of emergency management need to ensure that communication protocols are established and widely understood by the public in advance of an event by using public alert systems, social media or a dedicated website, and existing community networks. These tools should distribute timely and accurate information in the event of a natural disaster or hazardous event, focusing on those that are most at risk and most vulnerable to impacts. The City of Philadelphia's recently introduced place-based message system in Eastwick is particularly effective in that it texts and emails individuals based on a targeted geography.[4]

2. ENVIRONMENTAL MONITORING POLICIES & INCENTIVES

Environmental monitoring policies and incentives are designed to encourage the systematic collection and analysis of environmental data. These policies can include regulations that require industries to monitor emissions, water quality, and other environmental parameters. Incentives, such as tax credits or grants, can be provided to support the adoption of advanced monitoring technologies. Additionally, local governments can support community monitoring efforts. The data collected through these programs is crucial for assessing environmental health, informing policy decisions, and guiding adaptive management strategies.

CASE STUDY:
Philadelphia Water Department Contamination Dashboard

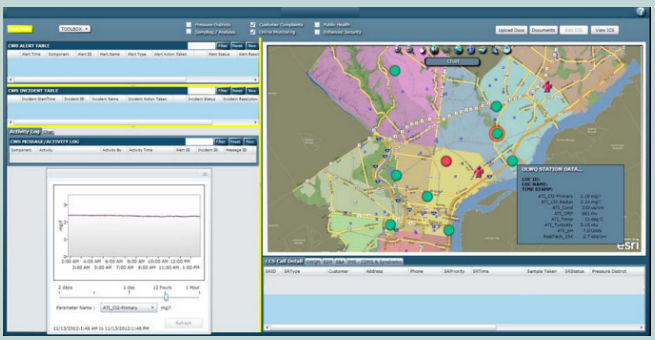


Figure 104. PWD's CWS dashboard shows potential contamination issues across the city. Source: epa.gov

The Philadelphia Water Department developed a comprehensive contamination warning system (CWS) for its drinking water system with an EPA grant.[5]

- Facilitated integration of multiple information streams from different offices
- Database helps determine whether a water contamination event has occurred and facilitates appropriate responses and consequent management actions

STAYING IN PLACE

Supporting communities to stay intact and in place is the foundation to creating and sustaining the social ties that underpin resilient communities. Community investments and policies should prioritize the needs of the most underserved communities and those that are most vulnerable to climate change as well as social and economic challenges. Measures that protect existing residents against displacement and policies and programs that support fair and safe housing and workforce development should be put in place. Land use planning and initiatives that opportunistically anticipate and plan for the future can help support these initiatives.

1. ANTI-DISPLACEMENT MEASURES

Anti-displacement measures are strategies designed to prevent the displacement of residents, particularly in areas that are or may undergo significant development or gentrification. These measures can include policies such as rent control, affordable housing requirements, tenant protection laws, and land banks. They aim to stabilize communities by ensuring that long-term residents and businesses can remain in their communities despite rising property values and living costs. Effective implementation requires collaboration between government agencies, community organizations, and developers.

2. WORKFORCE DEVELOPMENT & LAND INITIATIVES

Workforce development and land initiatives focus on building the skills and capacity of individuals and communities to address climate resilience challenges. This can include training programs, job creation, preserving industrial zoning in some areas, and support for local businesses and entrepreneurs. Land initiatives may involve proactive land use planning, conservation, and the development of sustainable maintenance programs for building and infrastructure retrofits, urban farming, and forestry initiatives. These efforts help create resilient local economies and communities by providing opportunities for employment and sustaining a local workforce that can help communities prepare and respond to natural disasters and the challenges of climate change.

3. FAIR AND SAFE HOUSING PROGRAMS

Fair and safe housing programs aim to ensure that all individuals have access to decent, affordable, and safe housing. These programs address issues such as housing and renter discrimination, substandard living conditions, and housing affordability. They include initiatives like housing vouchers, public housing developments, and enforcement of fair housing laws, and fair and safe housing ordinances. The goal of these is to sustain inclusive communities where everyone, regardless of race, income, or disability, can live in safe and healthy environments.



Figure 105. Signs for single-family housing development in Marcus Hook. Source: OLIN

URBAN INFRASTRUCTURE

Policies and incentives are necessary to help promote the planning, construction, and upkeep of the existing and new infrastructure needed to manage and reduce the risks of climate change. Policies and incentives for green stormwater infrastructure within and upland of communities are essential for reducing stormwater flooding. Improvements in floodplain construction standards and storm drain infrastructure and maintenance can reduce the likelihood that extreme rain and storm events damage infrastructure and buildings.

1. GREEN STORMWATER INFRASTRUCTURE INCENTIVES

Promoting green stormwater infrastructure with policies and incentives encourages the adoption of sustainable and more nature-based practices for managing stormwater. These can include grants, tax credits, zoning bonuses, and other regulatory requirements that support the implementation of green stormwater infrastructure projects that reduce stormwater. By providing financial and regulatory guidelines and support, these policies help overcome cost and other technical barriers. Green stormwater infrastructure policies and incentives contribute to improved water quality, reduced flooding, and enhanced urban resilience, while also supporting the creation of construction and maintenance jobs that support local workforce development and the economy.

2. IMPROVED FLOODPLAIN CONSTRUCTION STANDARDS

Improved floodplain construction standards are regulations that ensure buildings and infrastructure in flood-prone areas are designed to better withstand flooding. These standards typically require elevating structures and/or utilities a certain height above the base flood level, strengthening foundations, using flood-resistant materials, and implementing proper stormwater management systems. The goal is to reduce the impacts of flooding and the risk of flooding damaging buildings and infrastructure. It is important that changes to the floodplain on one site do not displace floodwater onto other sites or communities.

3. UPLAND MITIGATION OF CREEKS AND STREAMS

Upland mitigation involves policies, incentives, and regional coordination to promote measures that protect and restore creeks and streams in upland areas to slow the release of water downstream. Additionally, watershed-wide initiatives to build wetland basins, restore floodplain storage, and increase green infrastructure help stormwater more gradually seep into the ground, improving water quality and mitigating creek and river flooding for downstream communities. These measures can also include reforestation, erosion control, and the creation of larger riparian buffer zones. Upland mitigation also helps reduce sedimentation, improve water quality, and enhance and conserve valuable wetland habitat areas. Effective upland mitigation requires collaboration among a variety of landowners, government agencies, and conservation organizations. These collaborations should support shared assets and connectivity to ensure that improvements are accessible to communities up-and down-stream

4. STORM DRAIN INFRASTRUCTURE & MAINTENANCE

Adequately sized storm drain infrastructure is essential for managing rainwater and preventing flooding in urban areas. These systems include a network of pipes, drains, and channels designed to collect and transport stormwater to creeks and rivers. Regular maintenance is crucial to ensure the system functions effectively and is not clogged by leaves, sticks, and other debris. This involves investing and training public works, streets, and other municipal or county departments as well as private landowners to clear debris, inspect for blockages, and report and repair any damage. As climate change increases extreme rainfall events, older stormwater infrastructure needs to be evaluated and potentially resized to continue to be effective.

INDUSTRIAL FACILITIES

Disruption of operations at industrial facilities from flooding can pose great risks. Given the hazardous nature of industrial facilities, their current regional economic relevance, and their vulnerability to flooding, proactive measures should be taken to protect facilities from current and future flood risks while planning for a future of transition and decommissioning. Policies need to target facility-specific protection and require companies to adopt and uphold stringent measures.

1. ARMOR, RAISE, PROTECT

Facilities should first evaluate the gaps between available FEMA floodplain data or other modeled flood predictions from when the facility was constructed and when FEMA maps were first developed for their areas. Older facilities may not have the most up-to-date information embedded in their safety and hazard assessments, further exacerbating the risks of a flood-related Natural Hazard-Triggered Technological Accident disaster. Facilities should take stock of existing equipment and storage units and evaluate which equipment needs to be retrofitted, secured, or elevated.

- **Elevate** above flood water levels: Critical infrastructure, key utilities, backup power supplies
- **Retrofit**: Install flexible connections, anchor equipment, elevate supports, waterproof shelters for electrical equipment
- **Secure**: Anchor any objects that can float (e.g. tanks) with bolts or other restraining systems

2. SITE SPECIFIC DECOMMISSION PLANNING

When new industrial facilities are built, community benefit agreements should be required to ensure industrial impacts are offset. These agreements can include constructing or financing off-site facilities such as parks, community centers, cooling and resilience hubs, and other public benefit projects. The large refining and waste management activities in the area produce a disproportionate amount of pollution and greenhouse gas emissions. Adoption of clean energy policies and/or a relocation of industrial operations is highly dependent on long-term economic prospects. Municipalities and cities need to proactively plan for a future where fossil-fuel based industry is not the dominant economic driver. This involves evaluating facility lifespans as well as assessing and providing for future decommissioning costs. Decommissioning an active facility requires a thorough evaluation and sequencing of cleanup activities, depending on the site's future use as a light industrial hub, recreational space, nature-based solutions, or residential area.

» *See: the former PES Refinery's transformation into a commercial and light industrial hub (pages 34, 131)*

3. EVACUATION ROUTES AND LOCAL RECOVERY PLANS

In the event of an industrial accident, such as a fire, evacuation routes may sometimes overlap with designated evacuation zones, potentially compromising safety. To mitigate this risk, assess all evacuation routes in relation to facility evacuation zones and develop alternative routes that maintain a safe distance from high-risk facilities in the event of a Natural Hazard-Triggered Technological Accident disaster.

Coordination among boroughs and neighboring jurisdictions is essential to align evacuation protocols with industrial facilities' emergency management plans. Additionally, facilities should collaborate with local jurisdictions and other nearby facilities to establish a cohesive recovery plan. Post-disaster startup operations are particularly high-risk, especially if facilities have incurred storm damage. By coordinating these startup activities, facilities can reduce the risk of additional emissions and public exposure to hazards. Effective planning must consider the safety needs of both the plant and the community, ensuring evacuation strategies cover both workers and community residents in emergency scenarios.



Figure 106. Ongoing decommissioning work at the Bellwether District/former PES Refinery site. Source: OLIN

ENDNOTES

1 U.S. Chemical Safety and Hazard Investigation Board. "Organic Peroxide Decomposition, Release, and Fire at Arkema Crosby Following Hurricane Harvey Flooding," May 2018. https://www.csb.gov/arkema-inc-chemical-plant-fire-/.

2 UNDRR. "Sendai Framework Terminology on Disaster Risk Reduction," March 9, 2023. https://www.undrr.org/drr-glossary/terminology.

3 Rebuild by Design. "Hunts Point Lifelines." Rebuild by Design, October 12, 2021. https://rebuildbydesign.org/work/funded-projects/hunts-point-lifelines/.

4 Office of Emergency Management. "Emergency Messaging Expands in Eastwick. Pilot Program Looks to Inform Before, During, and After Severe Weather." City of Philadelphia, October 31, 2024. https://www.phila.gov/2024-10-31-emergency-messaging-expands-in-eastwick-pilot-program-looks-to-inform-before-during-and-after-severe-weather/.

5 Philadelphia Water Department, and CH2M Mill. "Philadelphia Water Department Contamination Warning System Demonstration Pilot Project: Contamination Warning System Dashboard Development.," May 2013. https://www.epa.gov/sites/default/files/2017-10/documents/pwd_report_contamination_warning_system_dashboard_development.pdf



07 COMMUNITY PROFILES



Figure 107. Example of community cultural assets throughout the project study area. Source: OLIN

MARCUS HOOK & TRAINER

Marcus Hook and Trainer share a deep history intertwined with industrial development. The industrial landscape continues to dominate both neighborhoods today, with active facilities lining the waterfront and industrial development right on residential borders.

HISTORY

The adjacent boroughs of Marcus Hook and Trainer are located in the southernmost portion of the project boundary along the Delaware River.

Originally the ancestral territory of the Lenni Lenape, the area encompassing Marcus Hook and Trainer saw an influx of Dutch, Swedish, and English settlers throughout the 17th century. As the boroughs became more established, the ship-building industry in the 18th century set the stage for its industrial development today.

Economic development, historically and in the present day, relates to the boroughs' position on the Delaware River and connections to rail, road, and deep water ship facilities. Marcus Hook's strategic location attracted industries in the 20th century like oil refineries; in 1901, 82 acres were purchased by J.N. Pew for the Sunoco Refinery, which is still operational today under the name of Marcus Hook Terminal.

Other companies leased land for similar operations across Marcus Hook and Trainer, like the Sinclair Refining Company and American Viscose Corporation, anchoring their industrial bases and transforming these two boroughs into industrial and petroleum hubs.[1,2]

As Marcus Hook and Trainer grew, their populations similarly peaked in the early 20th century as industry demands sustained population growth. With a decline in manufacturing, both boroughs have seen a decline in population and investment. Marcus Hook and Trainer remain small communities, with populations of 2,445 and 1,828, respectively.[3,4] Despite an overall decline in manufacturing jobs, industry has remained constant; active industrial facilities line the waterfront and residential development is largely set back from the water's edge.

Present day challenges heavily center industry: ongoing environmental contamination and health risks posed to fence line communities from both active and inactive industrial sites, threats of Natural Hazard-Triggered Technological Accident disasters in the event of flooding, and a need for economic diversification.

Despite being smaller communities, Marcus Hook and Trainer are well into the process of building social capital and awareness around their environmental challenges.

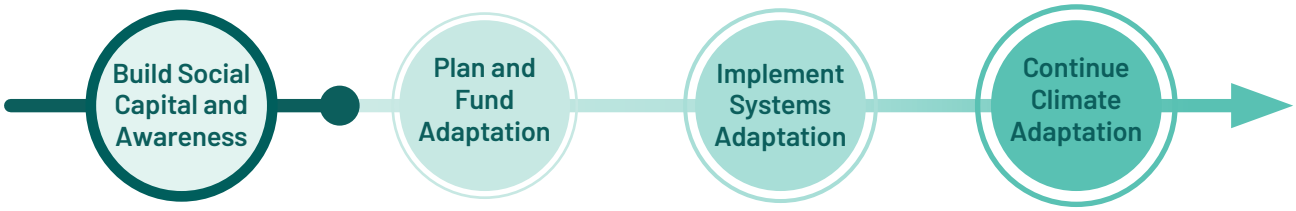


Figure 108. Diagram illustrating the steps towards climate adaptation. Source: OLIN

MARCUS HOOK / TRAINER

BY THE NUMBERS



DATA: ACS COMMUNITY SURVEY, 2022

MARCUS HOOK / TRAINER

MEDIAN AGE
38.6 / 36.2

RACE & ETHNICITY
16% / 30.5%
NON-HISPANIC BLACK

7% / 7.2%
HISPANIC / LATINO

POPULATION
2,445 / 1,828
TOTAL

3,962 / 4,053
DENSITY per sq mile

INCOME
16.7% / 18.3%
BELOW POVERTY LINE

HOUSING
61% / 69%
OWNER-OCCUPIED UNITS

39% / 31%
RENTER-OCCUPIED UNITS

LANDUSE
5.9% / 17.4%
OPEN SPACE

51.6% / 33.9%
INDUSTRIAL



Figure 109. Marcus Hook Borough Hall. Source: OLIN



Figure 110. Housing and vacant land near the Trainer Refinery. Source: OLIN

COMMUNITY PROFILE

TRAINER

The majority of Trainer Borough is defined by its industrial waterfront and the various industries that occupy wide swaths of land, including Monroe Energy, an active oil refinery. Most residential land is set back from the water but abuts either the Amtrak/SEPTA regional rail line or active industrial land. There is no waterfront access in Trainer.

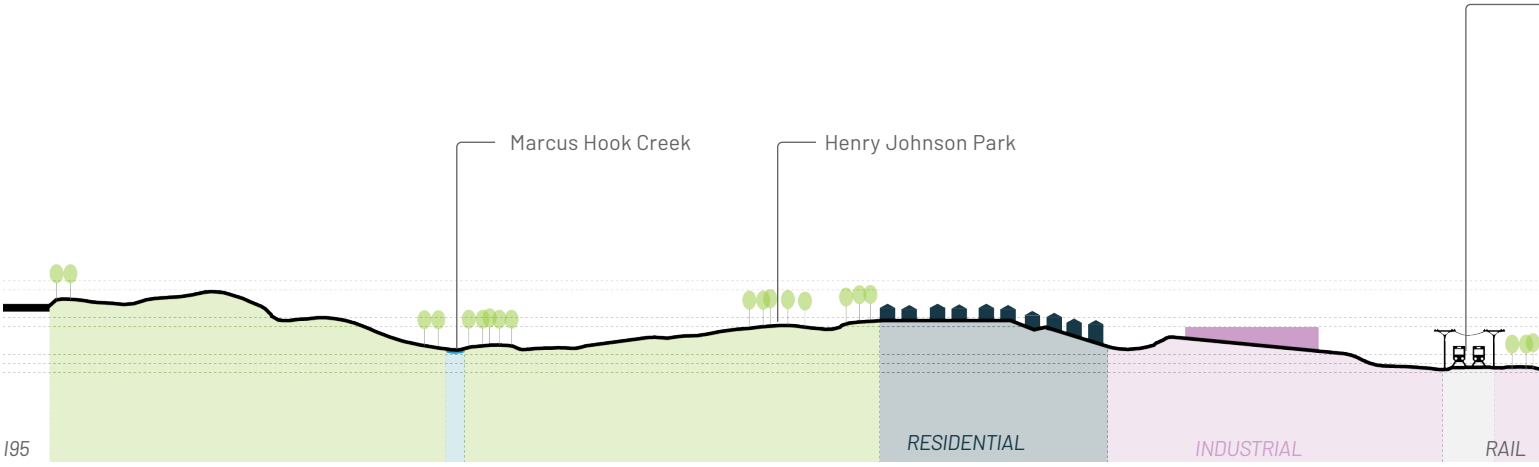


Figure 111. Illustrative section through Trainer depicting typical land use. Source: OLIN

MARCUS HOOK

Like Trainer, Marcus Hook is characterized by active industry and large industrial facilities along its waterfront and inland. There is a pocket of residential land that runs from the rail down to the waterfront along Market Street, ending in a public park (Market Square Memorial Park). Residential and industrial land co-exist directly next to each other.

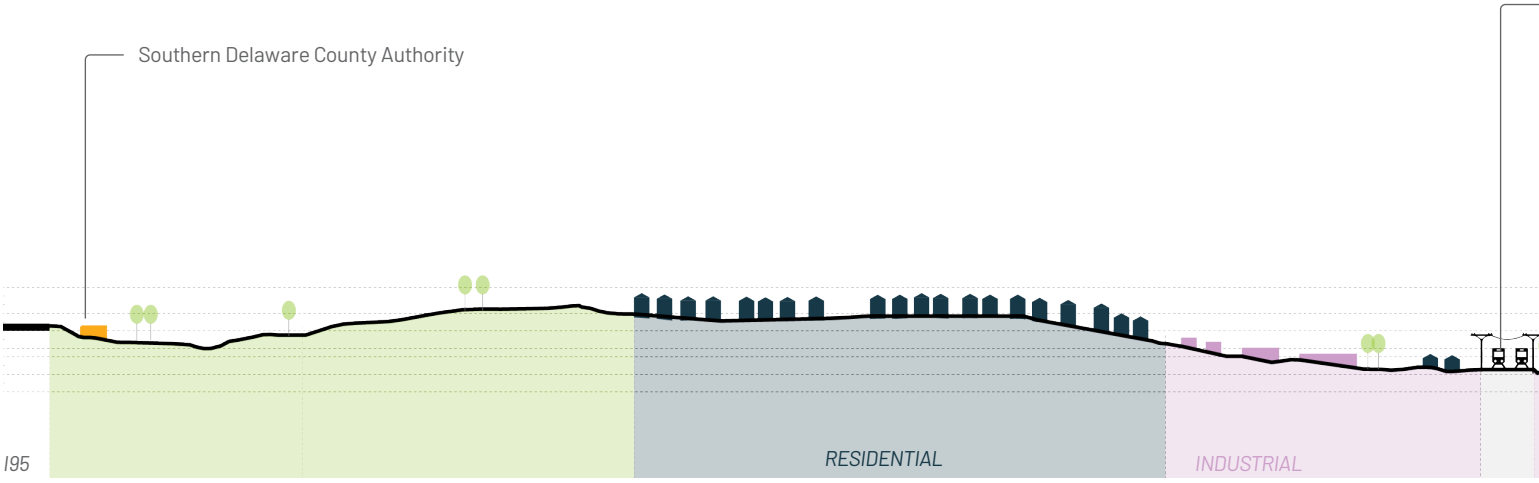
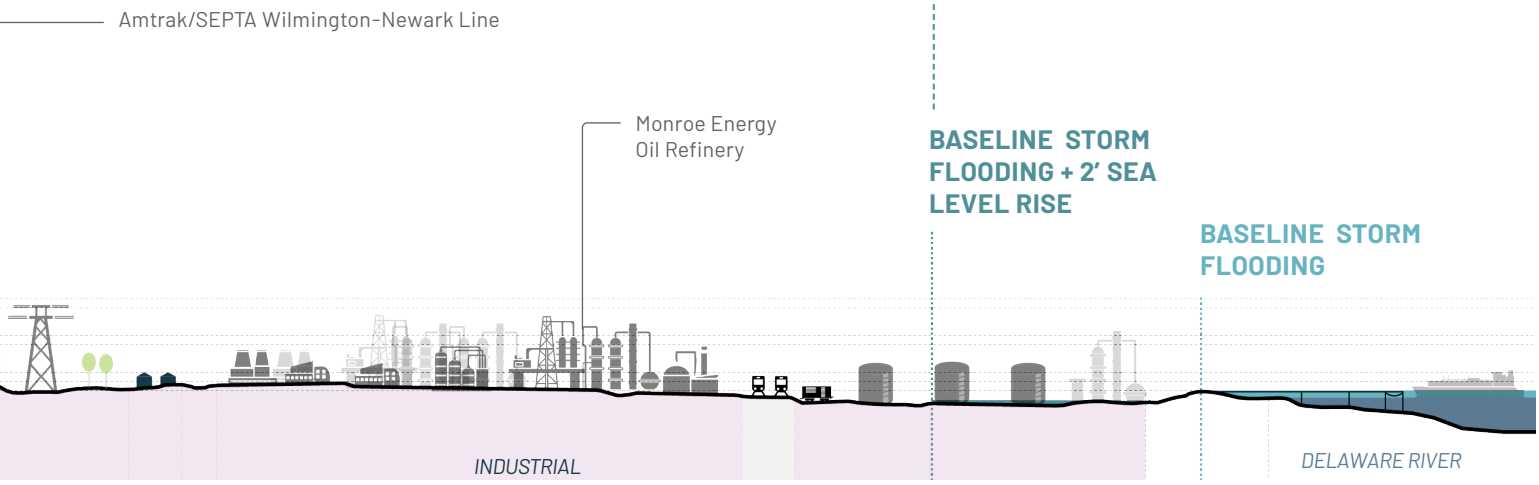


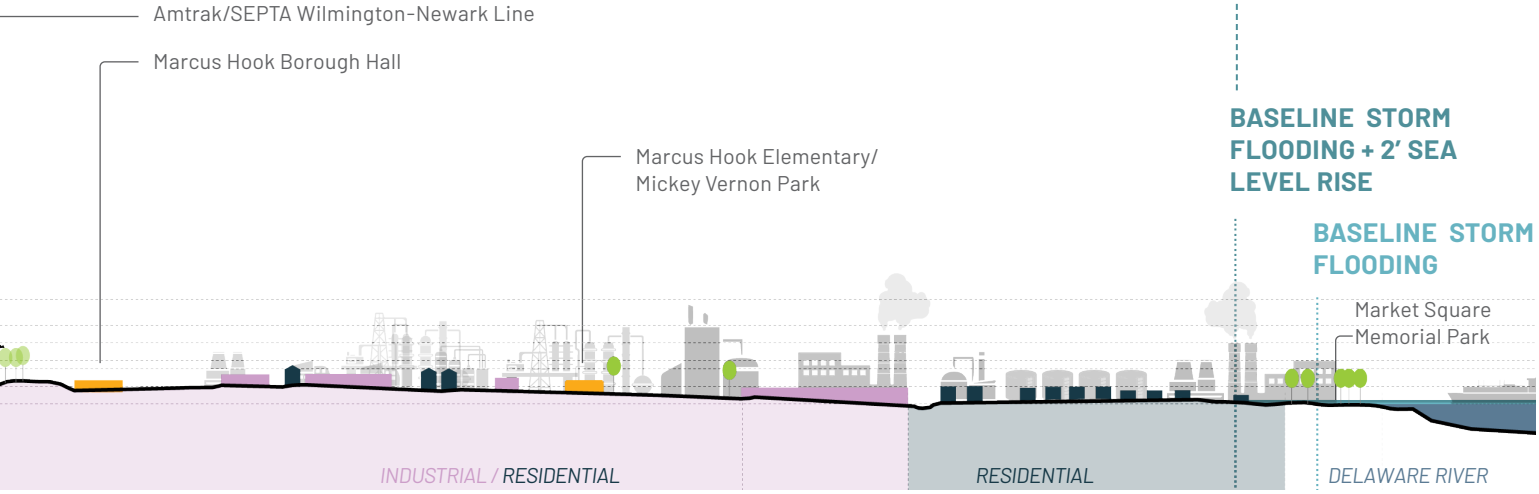
Figure 112. Illustrative section through Marcus Hook depicting typical land use. Source: OLIN

**VERTICALLY SCALED 500%*

IN A MODELED STORM SURGE + 2 FEET SEA LEVEL RISE SCENARIO, FLOODWATERS IMPACT MOST OF MONROE ENERGY'S TANK FARM



IN A MODELED STORM SURGE + 2 FEET SEA LEVEL RISE SCENARIO, FLOODWATERS REACH WATERFRONT HOMES AND PARTS OF INDUSTRIAL FACILITIES



COMMUNITY ASSETS



Figure 113. Map locating community assets in Marcus Hook/Trainer. Source: OLIN

For Marcus Hook and Trainer, open spaces (as well as residential areas) are often located near or right next to industrial sites. Currently active and used public spaces are limited to a few sites and remain disconnected from one another. One of the more used sites is Market Square Memorial Park, a site abutting the Marcus Hook Terminal and one of few sites that offers waterfront access and fishing opportunities in the area. Other active sites include Mickey Vernon Park, a baseball field adjacent to Marcus Hook Elementary School.

While there are fewer public parks in the area, borough residents have expressed interest in further activating existing parks and open spaces within the neighborhood like Henry Johnson Park, which is adjacent to Marcus Hook Creek, and creating a more cohesive network of green spaces. There is potential land that can be reclaimed for public use or for flood mitigation; however, these sites face significant challenges such as a lack of access routes, possible contamination and remediation needs, and ownership.

Other community assets include both Marcus Hook and Trainer Emergency Medical Services (EMS) facilities, fire stations, and police stations. The Marcus Hook Terminal has its own fire department which serves the industrial facilities within the complex.



Figure 114. Community Day at Trainer's Henry Johnson Park. Source: OLIN



Figure 115. Waterfront Pier at Market Square Memorial Park. Source: OLIN



Figure 116. Mickey Vernon Park in Marcus Hook. Source: OLIN

CONTAMINATION IN THE AREA

INDUSTRIAL SITES

- EPA Risk Management Program Site
- PADEP Water Pollution Control Site
- PADEP Air Emission Plant

BROWNFIELD SITES

- EPA Underground Storage Tank
- RCRA - Active Site
- NPL Superfund Site
- PADEP Aboveground Storage Tank
- Superfund Site Boundary
- RCRA Facility

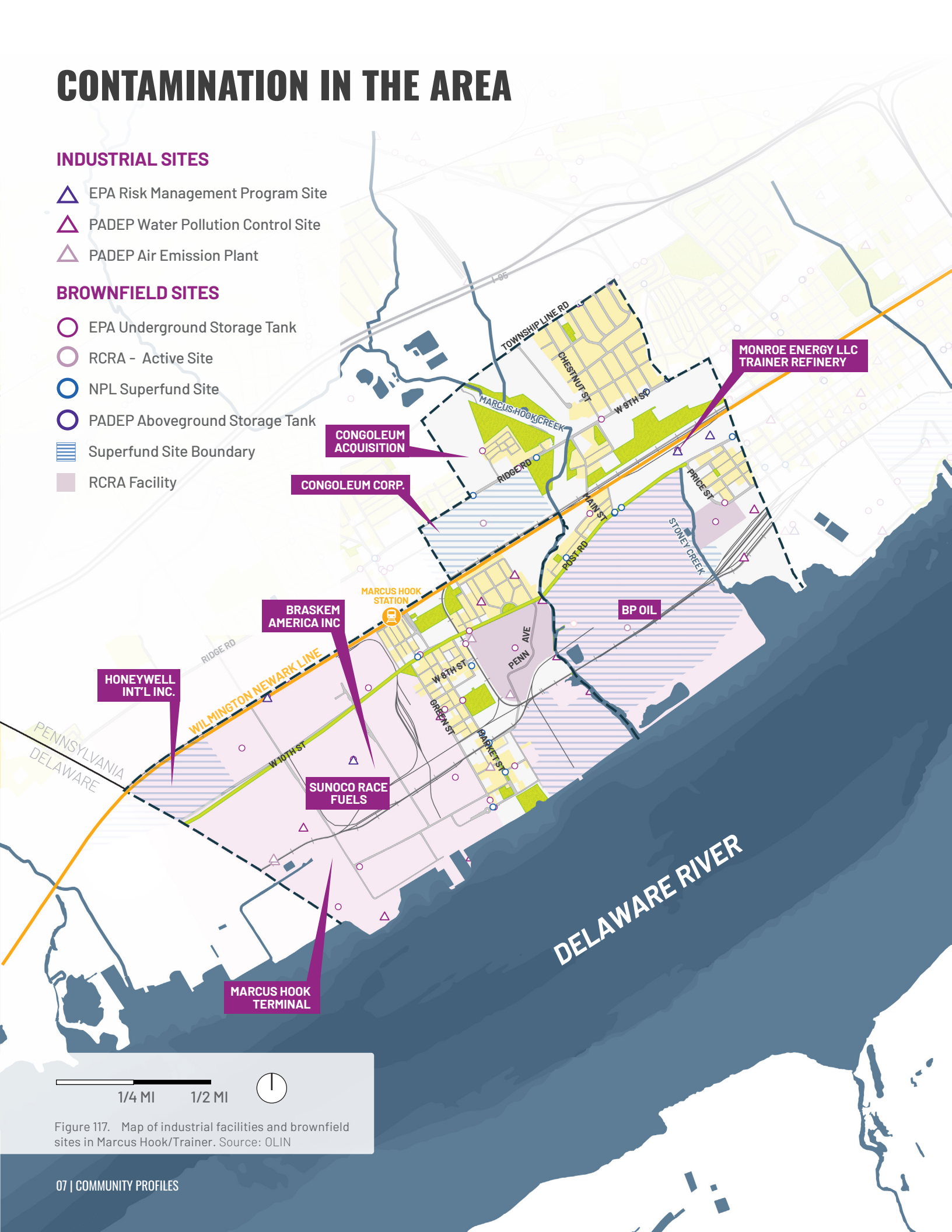


Figure 117. Map of industrial facilities and brownfield sites in Marcus Hook/Trainer. Source: OLIN

Industry dominates much of the land use and has a significant presence in Marcus Hook and Trainer. Many facilities are located next to waterways and/or residential land uses, posing significant concerns of Natural Hazard-Triggered Technological Accident disasters with potential flood risks from storm surge and/or sea level rise.

Prominent facilities include:

Marcus Hook Terminal

Formerly the Sunoco oil refinery site, this industrial complex is located on approximately 788 acres along the Delaware River and has about 4,800 feet of waterfront frontage. Bordered by industrial land use and commercial/residential properties, this facility is now primarily a natural gas liquids hub with pipeline connections to the Mariner East pipeline network. The facility currently has a Resource Conservation and Recovery Act (RCRA) operating permit for a hazardous waste storage area. Contaminants of concern include petroleum hydrocarbons, including concentrations of benzene, toluene, ethylbenzene, and xylene in groundwater.[5]



Figure 118. Energy Transfer Facility at the Marcus Hook Terminal. Source: OLIN

Braskem America

Braskem is a thermoplastic resins producer and one of the country's main producers of polypropylene, a type of commodity plastic found in packaging materials, automotives, consumer goods, and other uses. In Marcus Hook, the company's facility is used primarily to manufacture and process polypropylene.[6] The facility is inland from the waterfront and immediately adjacent to Marcus Hook Terminal.



Figure 119. Braskem Facility. Source: OLIN

Monroe Energy Trainer Refinery

The 350-acre Trainer Refinery produces 185,000 barrels per day, primarily for jet fuel production but also for other petroleum products like gasoline, diesel, and home heating oil. The facility is located adjacent to Interstate 95 and Route 291, with Stoney Creek along its western and northern perimeters. In the late 20th century, the U.S. Environmental Protection Agency (EPA) initiated an investigation and subsequent cleanup activities at this site; the latest updates are from 2013 and indicate that RCRA cleanup actions are underway, if not completed by the publication of this report. Main contaminants found are typical hazardous petroleum products like benzene, ethyl benzene, total xylene, semi-volatile organic compounds, arsenic, chromium, and lead. [7]



Figure 120. Trainer Refinery. Source: OLIN

CLIMATE RISKS: CURRENT MAPPED FLOOD RISK

WHAT ASSETS & INDUSTRY ARE AT RISK OF FLOODING?

FEMA FLOOD HAZARD ZONES

- FEMA 1% Annual Chance of Flooding (100-Yr Flood)
- FEMA 0.2% Annual Chance of Flooding (500-Yr Flood)
- FEMA Floodway
- NOAA: Modeled Category 3 Hurricane Storm Surge (SLOSH)

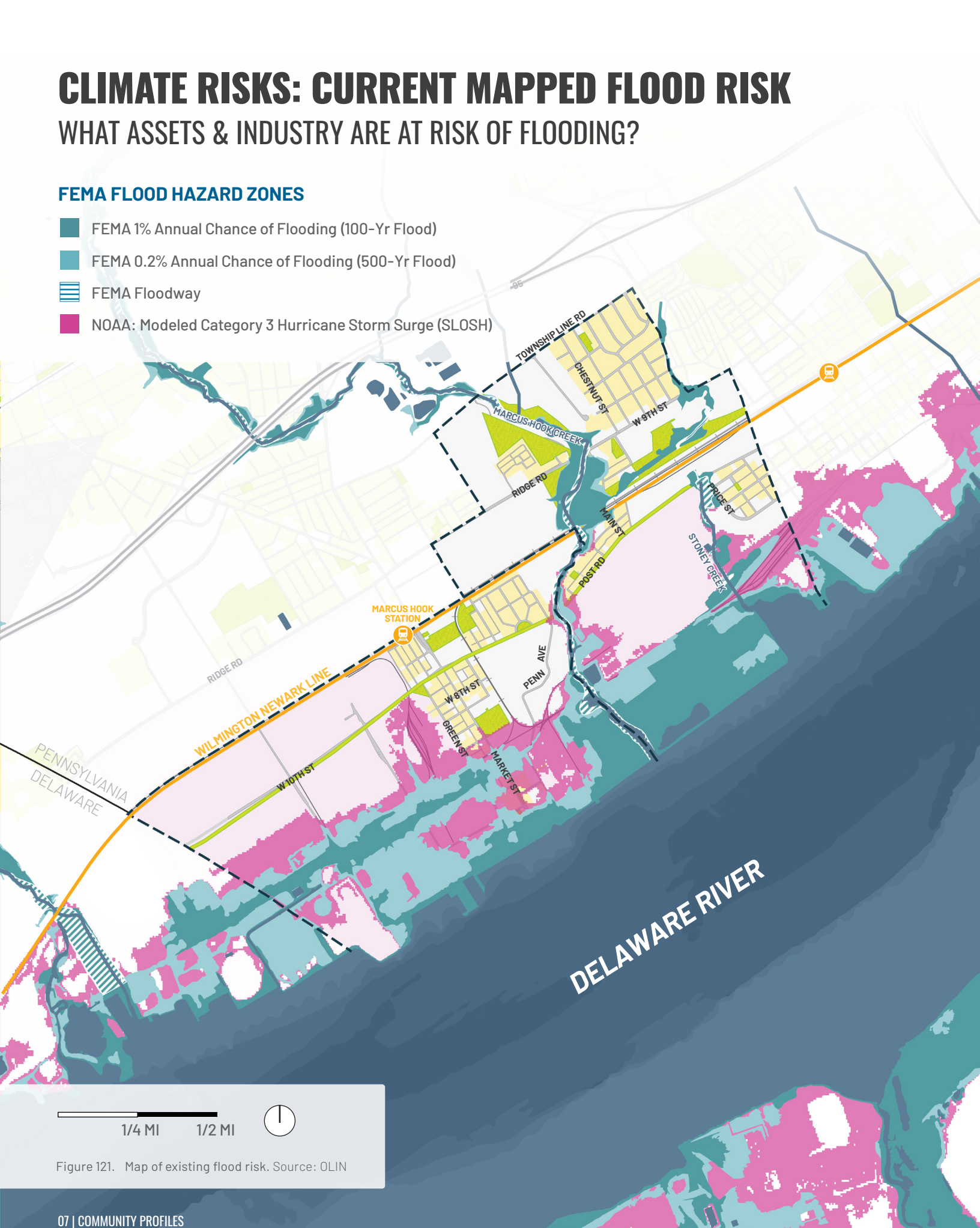


Figure 121. Map of existing flood risk. Source: OLIN

Flood Risk

Marcus Hook and Trainer are vulnerable to a variety of flooding types including fluvial flooding from the Delaware River, Marcus Hook Creek, and Stoney Creek, coastal flooding from the Tidal Delaware River, and groundwater and pluvial (stormwater) flooding on inland, flat, and low-lying sites. Long-term, Sea level rise along the Delaware River Waterfront and increased rainfall events in upland areas are expected to increase the area and impacts of flood hazards. Of recent storms, Hurricane Ida (2021) and Hurricane Isaias (2020) produced minor coastal flooding and moderate fluvial flooding along Marcus Hook Creek. Hurricane Sandy (2012) produced a more significant and record storm surge of 10.14 feet at the Marcus Hook gauge on the Delaware River, suggesting that such extreme coastal flooding events may be more likely with future storms and SLR.[8]

Current Mapped Flood Risk

Important community facilities that overlap with existing Federal Emergency Management Agency (FEMA) flood hazard areas include Market Square Memorial Park and the adjacent Curt Weldon Community Center in Marcus Hook. Many shoreline areas of the Marcus Hook Terminal and the Monroe Energy (Trainer) Refinery are mapped in FEMA flood hazard areas. In addition to increasing flooding in the facilities already mentioned, a more extreme storm event such as a National Oceanic and Atmospheric Administration modeled Cat 3 storm surge may also impact facilities further inland such as the Marcus Hook/Trainer Fire Department and Mickey Vernon Park in Marcus Hook.

Extreme Heat

Due to lack of tree canopy in urban areas, large areas of impervious surfaces, and numerous air pollution sources, communities in Marcus Hook and Trainer are exposed to urban heat island effects and air temperatures higher than the regional average. Similar to other communities throughout the region, heat waves are expected to last longer and occur more frequently due to climate change.



Figure 122. A mature tree canopy provides ample shade and relief from heat in Marcus Hook's Market Square Memorial Park. As sea level rises, these trees are threatened by more routine flooding. Source: OLIN

CLIMATE RISK: MODELED STORMS WITH SEA LEVEL RISE

WHAT ASSETS & INDUSTRY ARE AT ADDITIONAL RISK OF FLOODING DUE TO SEA LEVEL RISE?

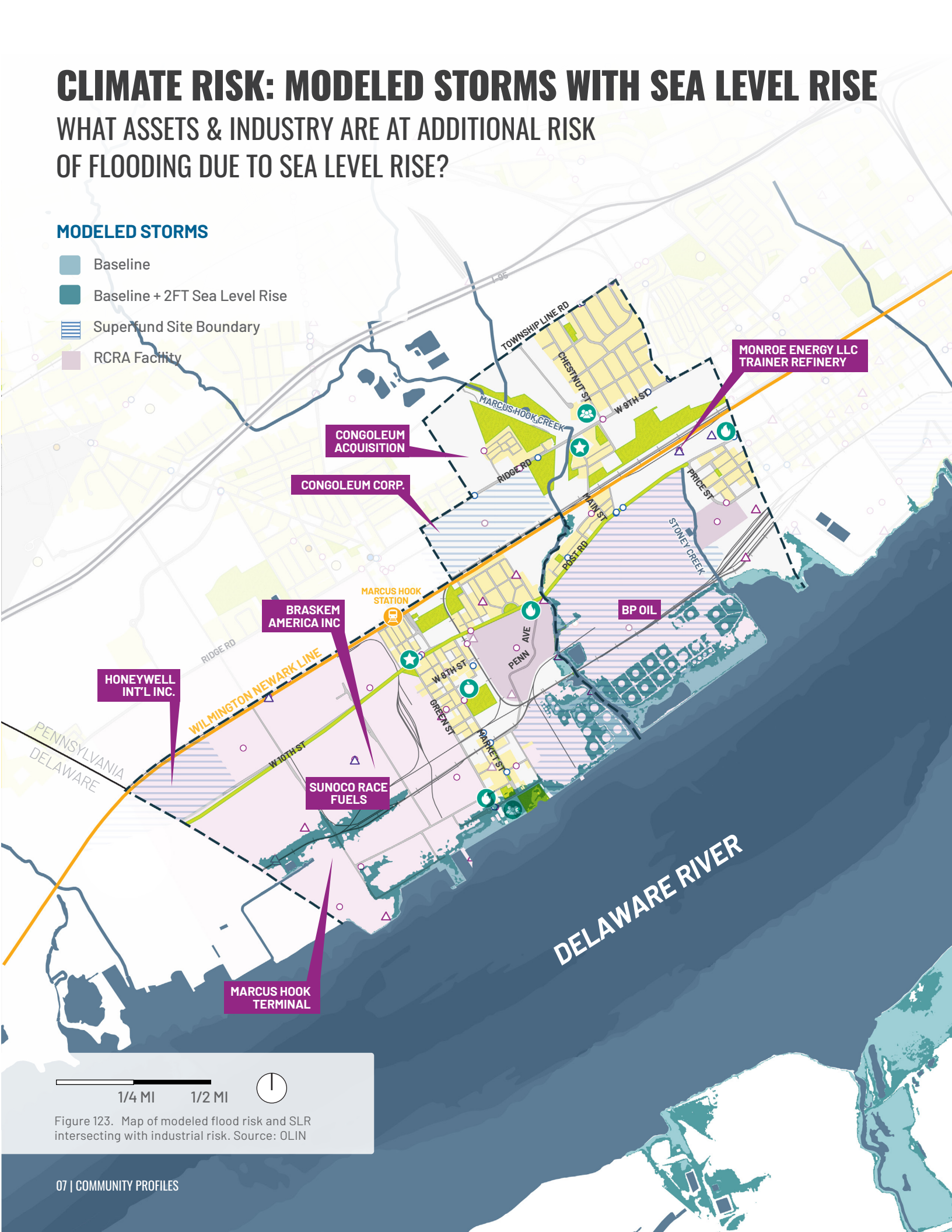


Figure 123. Map of modeled flood risk and SLR intersecting with industrial risk. Source: OLIN

Modeled Storms with Future Sea Level Rise

Figure 113 shows the +2 foot sea level rise scenario and merges the flooding impacts of three modeled storms: Hurricane Ida (2021), Hurricane Isaias (2020), and Hurricane Sandy (2012). Areas shaded with light blue are those that likely flooded during these past storms, while areas shaded with darker blue are those that may flood if and when similar storms occur in the coming decades with expected sea level rise.

In all modeled storm events, the impact of +2 feet sea level rise is primarily observed along the coastline and creek corridors with the impacts of Hurricane Sandy being greatest. Sea level rise is likely to significantly increase flood impacts of coastal storms at the Marcus Hook Terminal, Curt Weldon Community Center, and Market Square Memorial Park in Marcus Hook, and the Monroe Energy (Trainer Refinery) in Trainer.



Figure 125. High tide at the Marcus Hook Terminal. Source: OLIN



Figure 124. High tide at Market Square Memorial Park. Source: OLIN

RECOMMENDATIONS

WHAT CAN BE DONE TO REDUCE IMPACTS OF CURRENT & FUTURE FLOODING AND EXTREME HEAT?

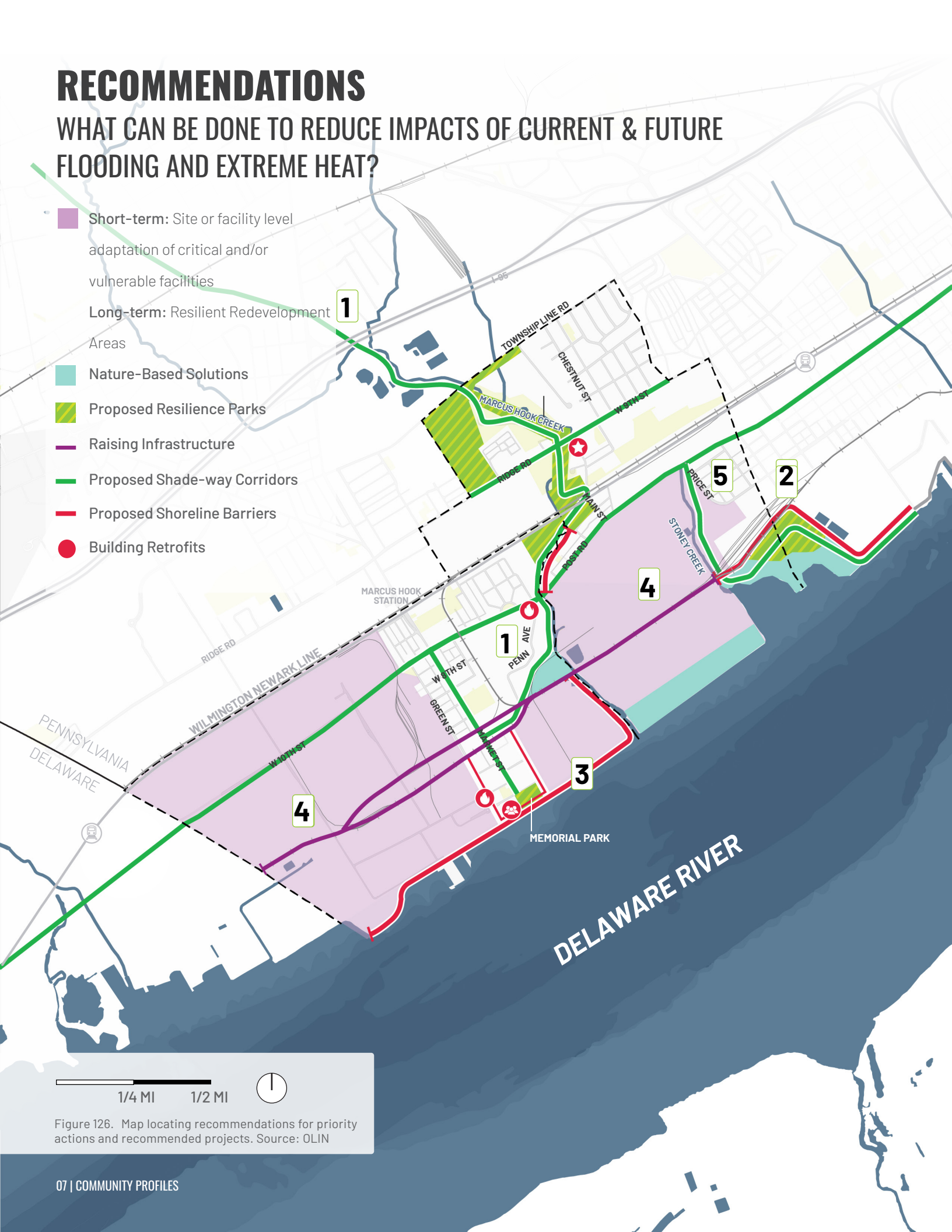


Figure 126. Map locating recommendations for priority actions and recommended projects. Source: OLIN

PRIORITY ACTIONS

- **Evacuation routes (Integrated with the Connective Park and Community Strategy) and Early Warning Systems**

Improve signage and resilience of evacuation routes with warning systems for both weather and industrial hazards.

- **Review Facility Emergency Management Plans to Address Public and Environmental Risk**

Increase public awareness and preparedness for risks of industrial accidents.

- **Heat Island Mitigation**

Improve access to shaded open spaces, create a shared sprayground, and plant trees along key pedestrian routes.

- **Connective Park Space**

Expand on the East Coast Greenway with additional greenways along Marcus Hook and Stoney Creek.

- **Community Amenities**

Create shared resilient communities spaces to benefit the smaller residential populations in each municipality.

RECOMMENDED PROJECTS

1. Develop the Marcus Hook Creek / PECO Greenway Trail

First proposed in 2003 in the "Delaware County Renaissance Program: Planning Area 1 Action Plan", a Greenway has been proposed from Post Rd heading upstream on Marcus Hook Creek to the PECO powerline right-of-way. The projects would bring multiple benefits to both Trainer and Marcus Hook, including improved connectivity and recreation, better access to nature, and reduced flood risk.

2. Develop a park at the Trainer Waterfront Site

Spanning the Marcus Hook and Trainer waterfront is an approximately 25-acre open space owned by Monroe Energy but with no apparent refinery uses. Current access to the site is limited to a private road coming from the Monroe (Trainer Refinery), however, public access may be possible with a bridge over the adjacent rail yard or through the adjacent DELCORA Wastewater Treatment Plant in Chester. The site is the only known undeveloped open space along the entire Marcus Hook, Trainer, and Chester Waterfronts. Given the large size of the site, development of waterfront access and other park amenities could be combined with a levee and wetlands to help protect adjacent facilities.

3. Retrofit Market Square Memorial Park

Market Square Memorial Park is one of two existing public parks along the Delaware River in Delaware County. The park is extremely low-lying and is already beginning to experience high-tide flooding. Retrofits to existing amenities and the construction of new amenities should anticipate more regular flooding to help ensure the park can remain operational, accessible, and safe during minor flood events. Anticipating long-term sea level rise, a study should be implemented to see how a levee or other shoreline barrier can be integrated with the park to help protect adjacent flood-vulnerable communities.

4. Trainer Refinery/Marcus Hook Terminal: Adaption and Resilient Redevelopment

The Refinery and the terminal are both major producers of fossil fuels and local emitters of pollution. Given their significant impact, a variety of projects are needed, ranging from increased monitoring to better emergency management procedures as well as the implementation of measures to reduce risks from industrial accidents and flooding. The terminal is also expanding part of its operations by adding 2.25 million gallon ethane storage tanks.[9] Long term, a site-specific decommission planning process should be started to anticipate the facility's eventual closure and to outline scenarios for its reuse in a way that best supports community needs. This would avoid the shortcomings in public policy and community engagement that have marked redevelopment planning for the former Philadelphia Energy Solutions (PES) Refinery site in Philadelphia.

5. 3rd Street/Wilcox Street Park

See Early Action Project (p152-153).

RECOMMENDATIONS

COMMUNITY RESILIENCE TOOLKIT FOR LOCAL PROJECTS



GREEN STORMWATER INFRASTRUCTURE

Identify further opportunities for green stormwater infrastructure GSI programs and areas for implementation.

There is little existing green stormwater infrastructure in Marcus Hook or Trainer and no additional municipal programs or incentives. Marcus Hook's 2023 Park Plan calls for a rain garden/retention pond at Williamson Field, but does not otherwise address green infrastructure or stormwater needs more broadly. In both municipalities, additional facilities should be located on publicly owned open space or rights-of-ways in upland locations, outside of flood and storm surge inundation areas and contaminated soils, and where infiltration, retention, and detention practices will be most effective.

» *See: Marcus Hook Borough Mini Parks, Recreation and Open Space (PROS) Plan (2023)*



COOLING CENTERS

Evaluate opportunities to retrofit an existing community facility into a cooling/resilience hub.

There are no facilities currently designated as cooling centers or resilience centers. An existing community space should be designated as an indoor cooling center that can serve both municipalities. If located and floodproofed properly, this new cooling center could be a broader community resiliency center, acting as the staging ground and home base for disaster recovery efforts. Existing facilities that are less flood vulnerable and that could be upgraded include Marcus Hook Borough Administration Office, the Marcus Hook Elementary School, and the new Borough of Trainer Municipal Complex.



WATERFRONT ACCESS & AMENITIES

Integrate flood mitigation measures at existing waterfront parks and prioritize safe access to the waterfront.

The Delaware River is currently accessible at Marcus Hook's Market Square Memorial Park where an adjacent closed public pier is currently being redesigned and planned to reopen. The pier project and future planning for the park must account for sea level rise and future storms to ensure continued access. Trainer does not currently have any waterfront access; however, access to an undeveloped site on the Trainer/Chester border is mentioned in various past plans. A study should be implemented to assess feasibility of possible future public access at this site.

» *See: Marcus Hook Borough Mini Parks, Recreation and Open Space (PROS) Plan (2023), Delaware County 2035 Open Space, Recreation, and Greenway Plan (2015), Renaissance Program: Planning Area 1 Action Plan (2003)*



TREE PLANTING

Expand the community tree planting program.

Although a participant in the Tree City USA program, Marcus Hook has the lowest percentage tree canopy of any municipality in Delaware County. While Trainer has more areas of existing tree canopy in its upland parks and open spaces, similar to Marcus Hook, developed areas have few street trees. Parks and open spaces in both communities have benefited from past volunteer and conservation tree planting efforts. Additional tree planting should be prioritized on publicly owned community facilities and open spaces upland of areas that frequently flood and where the shade and air quality benefits can be most beneficial.



SHADE-WAY CORRIDORS

Prioritize key corridors for more shade trees.

The proposed Marcus Hook Creek Greenway would create a vital shade and connectivity corridor, benefiting both municipalities and creating linkages inland to other parks and open spaces. An additional north/south shade-way along Market Street and Green Street will create shaded pedestrian connections from Market Square Memorial Park inland to residential areas and other community assets, while an east-west linkage along Post Road or Penn Avenue will create connections to the proposed Marcus Hook Creek Greenway. In Trainer, connections to the Marcus Hook Greenway can occur along Post Road with additional north/south linkages at Main Street and Price Street. In the long-term, a buffer along Trainer's Stoney Creek could allow for an additional shade-way corridor connecting inland areas to the waterfront.



SPRAY FOUNTAINS & SPLASH PADS

Integrate water features into existing community recreation areas.

While none currently exist in Marcus Hook or Trainer, a facility could be added at an existing or new upland park space. In Marcus Hook, Mickey Vernon, Centennial Park, or Williamson Field might be appropriate. In Trainer, Henry Johnson Park, Borough of Trainer Municipal Complex, the Wilcox Street (3rd Street) Park/Playground are potential locations.



BUILDING RETROFITS

Implement a building retrofit program targeted at flood risks.

No building or infrastructure retrofit program currently exists. In Marcus Hook, vulnerable public assets that should be retrofitted to minimize sea level rise and storm impacts include the low-lying Market Square Memorial Park and adjacent pier as well as the recently reopened Curt Weldon Community Center. Further inland, the recently constructed Marcus Hook Fire Department building may be vulnerable to flooding from Marcus Hook Creek. Specific facilities and equipment may need to be raised or otherwise protected from flooding at the Marcus Hook Terminal and in Trainer at the Monroe Refinery.



DEPLOYABLE/TEMPORARY BARRIERS

Evaluate feasibility of deployable or temporary barriers in locations susceptible to flooding.

There are no current known plans for deployable or temporary barrier systems in Marcus Hook or Trainer. These systems are appropriate at critical infrastructure and community facilities and/or in narrow pathways of localized flooding.



ENVIRONMENTAL MONITORING & MODELING

Work with neighboring boroughs and industries to create a comprehensive database with real-time environmental information.

Municipal departments across Marcus Hook and Trainer, as well as in coordination with industrial facilities, should work to create a comprehensive database that collects information on various environmental factors like weather, flood risks, and pollution levels. The database can be used to facilitate appropriate responses and management in the event of a disaster.



PAVEMENT REDUCTION

Study potential underutilized paved spaces for depaving and Green Stormwater Infrastructure installations.

There are no known municipal-led projects or policies for reducing pavement (impervious surfaces) in Marcus Hook or Trainer. Underutilized paved and compacted areas on larger industrial sites should be studied for their potential to be planted and/or used for green infrastructure to hold or infiltrate water during flood events.

RECOMMENDATIONS

EARLY ACTION PROJECT



3RD STREET/WILCOX STREET PARK

SITE CONTEXT

Located just northeast of the Trainer Refinery and uphill of Stoney Creek, the 3rd St/Wilcox St Park is located in Trainer neighborhood along the border with Chester. The small park lot exists in a gap block of Wilcox St between Union St to the north and 3rd St to the south. The park is divided into thirds with a small kids playground at its center and a patch of grass and sidewalk connecting it to the streets at both the north and south of the park. The northern portion of the site at Union St is more flat, quiet, and features a small plaza along its sidewalk making it an ideal area for further activation.

DESIGN CONCEPT

The storybook walk, which is a short curated walk that displays the pages from a storybook, opens up off of an existing sidewalk and small plaza space and meanders past a diversity of wet and dry meadow plants. Small stone or log stepping stones allow crossing over the center planted area. Cut-through paths at the northern and southern edge of the storybook walk help to better integrate it with the neighborhood and playground area. This project was completed on July 29th 2025.



Figure 130. 3rd Street/Wilcox Street Park on opening day. Source: OLIN

PROJECT COMPONENTS

Nature Storybook Walk
- Information stands
- ADA stone fines path
- Site furnishings

Planting
- Trees
- Shrubs/groundcover

LONG-TERM RECOMMENDATIONS:

Additional tree planting should occur with a focus on resilient shade trees. If feasible, a small splash pad and a shade structure at the southern portion of the site would ensure this community space stays heat resilient into the future. Long-term improved pedestrian connections downhill across Price Street to Stoney Creek could connect this site to the proposed Stoney Creek Greenway.

RECOMMENDATIONS
REGIONAL ACTIONS



RAISING EDGES/SHORELINES: LEVEEES & FLOOD BARRIERS

Evaluate existing berms at industrial facilities against modeled flood risk. Study feasibility of a neighborhood-specific levee to protect against future flooding.

No levees, berms, or other raised shorelines exist or are planned for Marcus Hook. In Trainer, the National Levee Database notes the Delaware River Tank Farm Dike surrounding a portion of the Monroe Refinery's tank farm adjacent to the river. A continuous levee/berm along the Delaware River might be possible from just south of Marcus Hook at Naamans Creek then continuing up the shoreline to Marcus Hook Creek and the Trainer border. North of the creek, the existing tank farm levee should be studied for reinforcement to account for sea level rise and more severe storms.

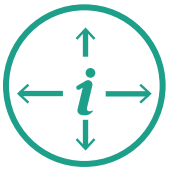
A more local levee/berm/sea wall should be studied at Market Square Memorial Park that would extend inland as needed to protect the Marcus Hook community from flood events. Furthermore, site/facility-specific levees may be needed at the Trainer Waterfront site to help reduce flood risk at the adjacent DELCORA stormwater treatment plant and inland along Marcus Hook Creek on the Trainer-side just north of Post Road. Additional site or facility-specific levees for runoff containment and flood protection should be considered for flood vulnerable areas containing hazardous material or chemicals.



RAISING INFRASTRUCTURE

Prioritize shoring up public areas and public access points.

Sea level rise alone may begin to impact Market Square Memorial Park, the adjoining fishing pier, and the more southern portions of Market Street. To the extent possible, these sites should have key utilities, equipment, access, and service drives as well as entries/exits and paths of egress raised to minimize the impacts of more frequent flooding and inundation.



CENTRALIZATION OF CLIMATE RISK INFORMATION

Establish a public, centralized platform to integrate information across municipalities and industry.

Marcus Hook and Trainer should have a designated clearinghouse that collects all climate-related information and tracking, including emergency management and evacuation responses, from all municipality agencies. Information from industrial facilities should also be integrated, as they have more up-to-date information on pollution levels, accidents, and any other relevant information. This allows municipalities to monitor flood risks and ensures a coordinated response in the face of an emergency. Residents will be able to access accurate, real-time information before, during, and after any incident.



NATURE-BASED SOLUTIONS

Evaluate possibility for living shorelines and wetlands at key waterfront locations.

No nature-based solutions (NBS) exist or are currently proposed in either Marcus Hook or Trainer. Generally, given the long history of industrial development right up against the Delaware River, little space remains in either community to develop larger NBS. Wetlands and living shorelines should be studied further at Market Square Memorial Park, the wetland impoundments ponds between the Monroe Refinery and the Delaware River, and the waterfront site in Trainer.

» *See: A Natural Heritage Inventory for Delaware County Pennsylvania (2011)*



IMPROVED CONNECTIVITY

Expand the creek system into a multi-use trail system connecting Marcus Hook and Trainer.

Though adjacent, the small communities of Marcus Hook and Trainer are separated by the Marcus Hook Creek and the large industrial land uses that dominate the first half mile inland of the Delaware River Waterfront. Developing the creek into a bike and pedestrian greenway will interconnect the communities and create new shared community spaces integrated with flood reduction measures. Extending the trail inland along the proposed PECO right-of-way trail would also connect Marcus Hook and Trainer to more inland communities in Delaware County. Bike and pedestrian enhancements should continue along the route of the East Coast Greenway along West 10th Street/Post Road (US Highway 13), Market Street in Marcus Hook, and Price Street in Trainer.

RECOMMENDATIONS

POLICY

EMERGENCY MANAGEMENT

EFFECTIVE COMMUNICATION SYSTEMS

A localized communication system can provide real-time notification of air quality concerns, industrial accidents, emergency planning, and any anticipated flooding. Marcus Hook's CodeRED communication system currently covers utility outages, threats to people, property and the environment, and other general information. The existing system should expand to include Trainer Borough and incorporate more nuanced information on upcoming climate events, flood preparation, and disaster recovery guidance. The boroughs should ensure all residents are aware of local emergency plans and have guidance on where to find information on emergency management.

ENVIRONMENTAL MONITORING POLICIES & INCENTIVES

In partnership with the County, State, and environmental organizations, Marcus Hook and Trainer should incentivize and prioritize investments in environmental monitoring throughout both communities given their proximity to major industrial hazards. Together, they should continue to monitor facilities' adherence to EPA-set standards for industrial pollution and provide robust information on a dedicated website.

ENVIRONMENTAL ADVISORY COUNCILS

The Environmental Advisory Councils of Marcus Hook and Trainer Boroughs, and Lower Chichester Township, collaborate to identify environmental issues, recommend conservation strategies, and promote sustainable land use across their communities. Operating under the Pennsylvania Act 148 of 1973, these voluntary councils advise local governing bodies and coordinate with various agencies to enhance environmental stewardship and public engagement.

STAYING IN PLACE

ANTI-DISPLACEMENT MEASURES

Marcus Hook and Trainer should continue to seek redevelopment opportunities that require affordable housing on vacant and redeveloping land. New housing should be prioritized on upland sites with less flood risk and adjacency to public transportation and community amenities. Other initiatives could include working with adjacent municipalities and/or Delaware County on a land bank. Relative to neighborhoods in Philadelphia, housing and development pressures and the risk of displacement are currently less severe in Marcus Hook and Trainer.

FAIR AND SAFE HOUSING PROGRAMS

Marcus Hook and Trainer should establish and enforce a municipal fair housing ordinance and help educate tenants and landlords on their rights and responsibilities.

WORKFORCE DEVELOPMENT & LAND INITIATIVES

The municipality should include access to high quality job opportunities and job training for any new developments, prioritizing local residents for jobs. The municipality should initiate a working group to anticipate growing employment sectors and work with local academic institutions and employers to provide periodic skills training at all age levels.

PHYSICAL INTERVENTIONS

GREEN STORMWATER INFRASTRUCTURE (GSI) POLICIES AND INITIATIVES

The municipality should establish a cross-borough GSI working group to advocate and enact GSI policies and incentives. The group can identify best incentivization tools for implementing GSI programs in vacant/underutilized land, including stormwater fee discounts, expedited permitting, grants, and rebate and installation financing. Work with industrial facilities to expand opportunities for stormwater storage to help address stormwater issues locally.

UPLAND MITIGATION OF CREEKS AND STREAMS

Marcus Hook and Trainer should coordinate with Delaware County agencies and neighboring municipalities to better steward Marcus Hook and Stoney Creeks and to implement more conservation, restoration, and green infrastructure throughout their watersheds.

IMPROVED FLOODPLAIN CONSTRUCTION STANDARDS

Set more stringent standards for municipal projects and new development, like increasing the minimum buffer distance from floodplain boundaries or limiting development in the 1% (100-year) FEMA floodplain. The City can implement tools and incentives for private landowners and developers to discourage building in the floodplain. The municipality should also periodically review floodplain and building elevation standards against the most current FEMA flood predictions and risk data to update standards as needed.

STORM DRAIN INFRASTRUCTURE & MAINTENANCE

Study existing stormwater infrastructure capacity and support public works, streets, and other government department training and maintenance programs.

INDUSTRY

ARMOR, RAISE, PROTECT

Marcus Hook and Trainer should evaluate facilities with the capabilities to enact near-term protection plans and incentivize retrofit programs.

Specific facilities and equipment that are vulnerable to sea level rise flooding on the Marcus Hook Terminal and Trainer's Monroe Refinery sites should be elevated or otherwise protected. There may be extensive underground pipelines and other buried industrial infrastructure that should be removed or raised in order to avoid impacts from sea level rise or a larger flood event.

EVACUATION ROUTES & LOCAL RECOVERY PLANS

A lack of available public resources is often a limitation in establishing offices dedicated to emergency response and planning. In smaller boroughs like Marcus Hook and Trainer, there should be a designated official responsible for organizing local emergency responses and coordinating with active industrial facilities and neighboring municipalities to create a local recovery and emergency response plan in the event of a disaster. The boroughs need to review current evacuation routes alongside state and industrial facility evacuation plans and facilitate outreach programs with the public to ensure all residents have the most current information.

SITE-SPECIFIC DECOMMISSION PLANNING

The municipality should plan for the eventual closure and/or redevelopment of the major fossil fuel facilities in the community including the Marcus Hook Terminal and the Trainer Refinery. This planning should include a community-based vision for land-use, job creation, and waterfront access.

CHESTER

In many ways, Chester's story reflects broader patterns and trends of American industrial development. It has experienced boom and decline and continues to search for economic revitalization and environmental and social justice.

HISTORY

Chester was first settled in 1644 by Swedish settlers and is the oldest city in Pennsylvania, serving as William Penn's landing place in the New World.[10] The city's story is deeply intertwined with the country's manufacturing heritage and history. Located on the Delaware River, Chester's strategic location made it attractive for various manufacturing and industrial centers, including machinery, metals, locomotives, textiles, and shipbuilding. The presence of growing industry and proximity to major rail and maritime transportation attracted new residents as people flocked to the city for jobs and opportunities, fueling a steady population growth.

Chester's transformation into a peak industrial center came during the World Wars. Shipbuilding became a major backbone of the city's manufacturing industry, employing tens of thousands of workers and supporting a thriving middle-class; the city's population peaked at around 66,000 by 1950.[11] Significant companies operating in the city in the mid-20th century include Sun Ship, Scott Paper Company, Baldwin Locomotive Works, Ford Motor Company, and American Viscose Corporation. However, by the late 1950s, Chester began to experience an economic downturn as manufacturing and industrial jobs moved out of the city or closed operations. Between 1950 and 1980, the city lost a third of its jobs. Population declined as well, with numbers falling steadily to less than 35,000 by 2020.[12]

Today, Chester's industrial heritage remains visible in its landscape, from former shipyards and industrial land occupying waterfront space to factory buildings and power plants dotted throughout the city. This industrial past has left a complex legacy, much like its neighboring boroughs of Marcus Hook and Trainer. Contamination remains a challenge and poses further risk with climate change and future flooding. Operating industrial plants, like the Reworld (formerly Covanta) municipal waste incinerator, create ongoing pollution concerns. Despite the devastating health toll of these polluting facilities, the City's financial challenges continue the speculation of privatization of City services and the siting of additional new industrial facilities, potentially perpetuating recent decades of environmental injustice.

Chester's location within the region and county remains a large asset. Chester is less than 20 miles to Philadelphia and acts as a regional hub with major rail lines and roadway connections, including Amtrak, Interstate 95 and 476, as well as connections to New Jersey via the Commodore Barry Bridge. The current population remains predominantly Black and young, with a fairly low unemployment rate.

As Chester emerges from bankruptcy, it can build on the work of community groups and begin to implement planned infrastructure and community benefit projects with climate adaptation in mind.

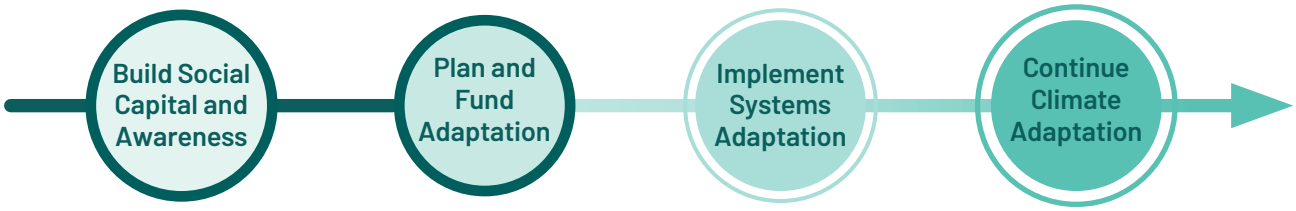
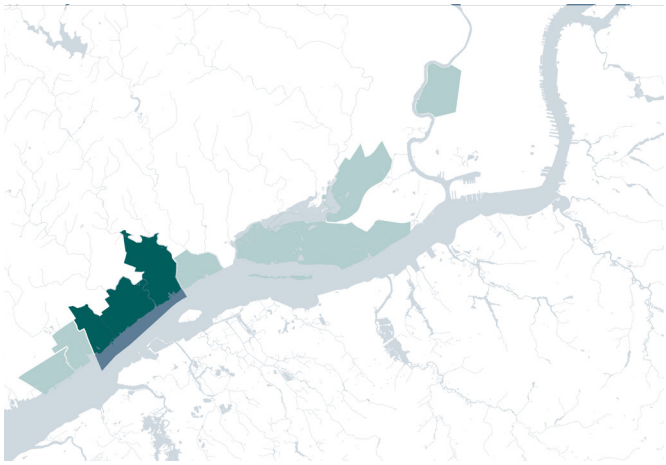


Figure 131. Diagram illustrating the steps towards climate adaptation. Source: OLIN

CHESTER

BY THE NUMBERS



DATA: ACS COMMUNITY SURVEY, 2022

RACE & ETHNICITY

70.5%
NON-HISPANIC BLACK

11.1%
HISPANIC / LATINO

MEDIAN AGE

30.8

POPULATION

33,940
TOTAL

6,600
DENSITY per sq mile

INCOME

28.5%
BELOW POVERTY LINE

HOUSING

34%
OWNER-OCCUPIED UNITS

66%
RENTER-OCCUPIED UNITS

LANDUSE

21.9%
OPEN SPACE

7.7%
INDUSTRIAL



Figure 132. Waterfront trail looking towards the Commodore Barry Bridge. Source: OLIN



Figure 133. Chester Creek and Eyre Park. Source: OLIN

COMMUNITY PROFILE

CHESTER WEST

The Chester West waterfront is characterized by a small industrial area and also the Subaru Park Stadium, both of which are susceptible to flood events. The industrial area is close to a residential neighborhood and both lie between rail lines. There are larger industrial neighborhoods further inland beyond Martin Luther King Park and Memorial Park.

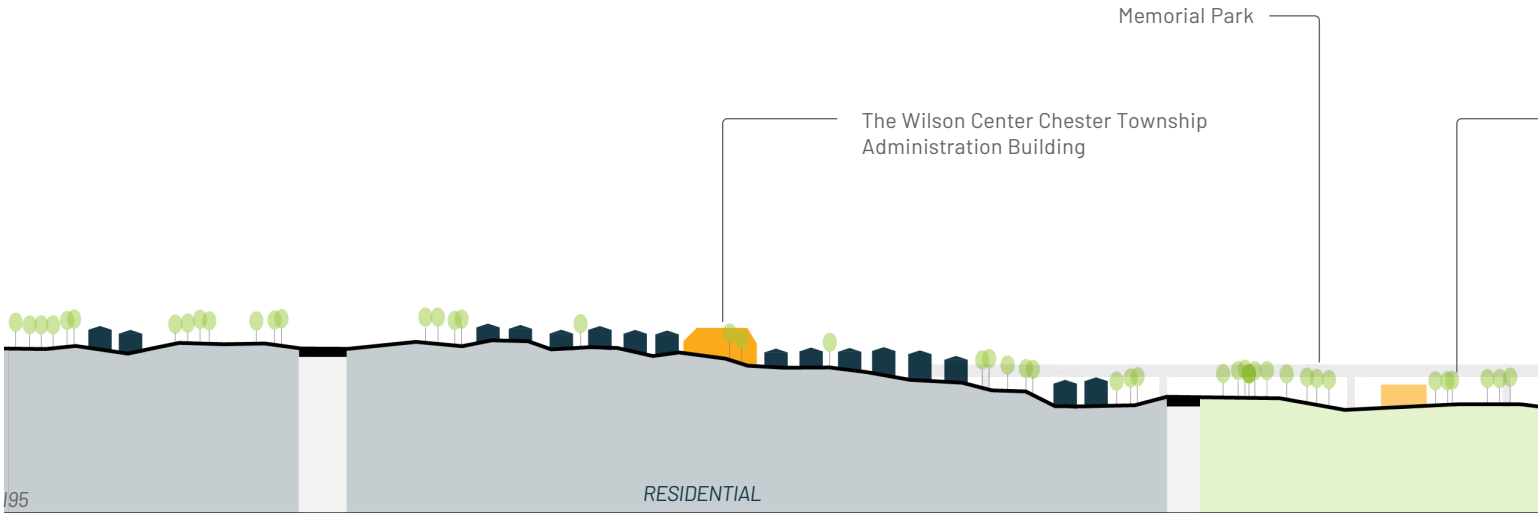


Figure 134. Illustrative section through Chester West depicting typical land use. Source: OLIN

CHESTER EAST

Chester East has a larger active industrial area that is lower lying than that of Chester West. The downtown area has mixed-use residential pockets with significant cultural and public institutions and an elevated rail line that cuts through it. The Deshong Park beyond the residential zone is cut through by Chester Creek and is overlooked by the hospital district and the Crozer Arboretum on higher ground.

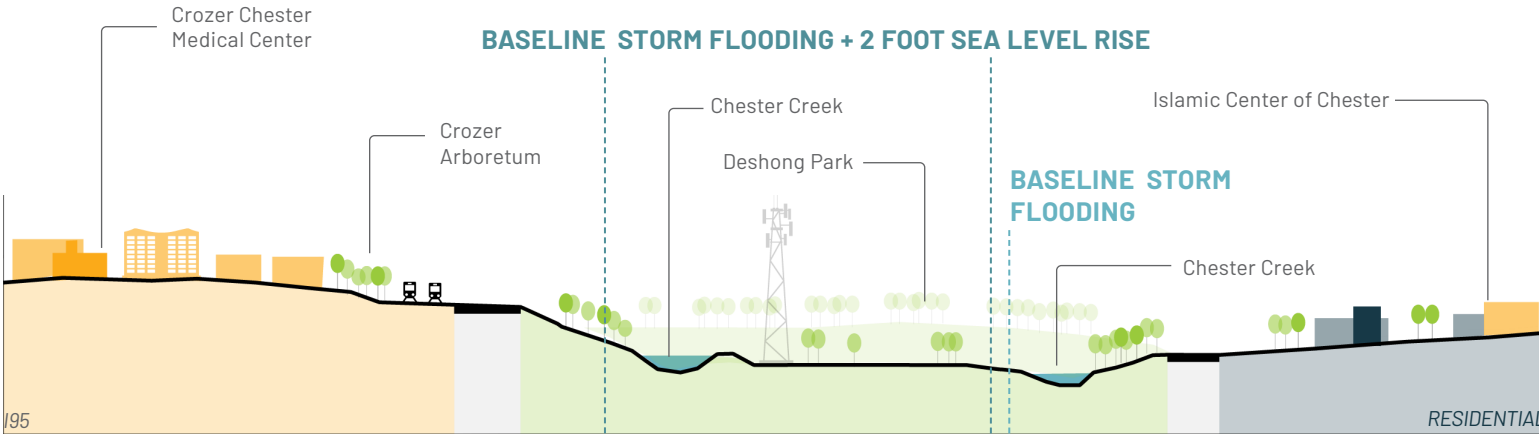
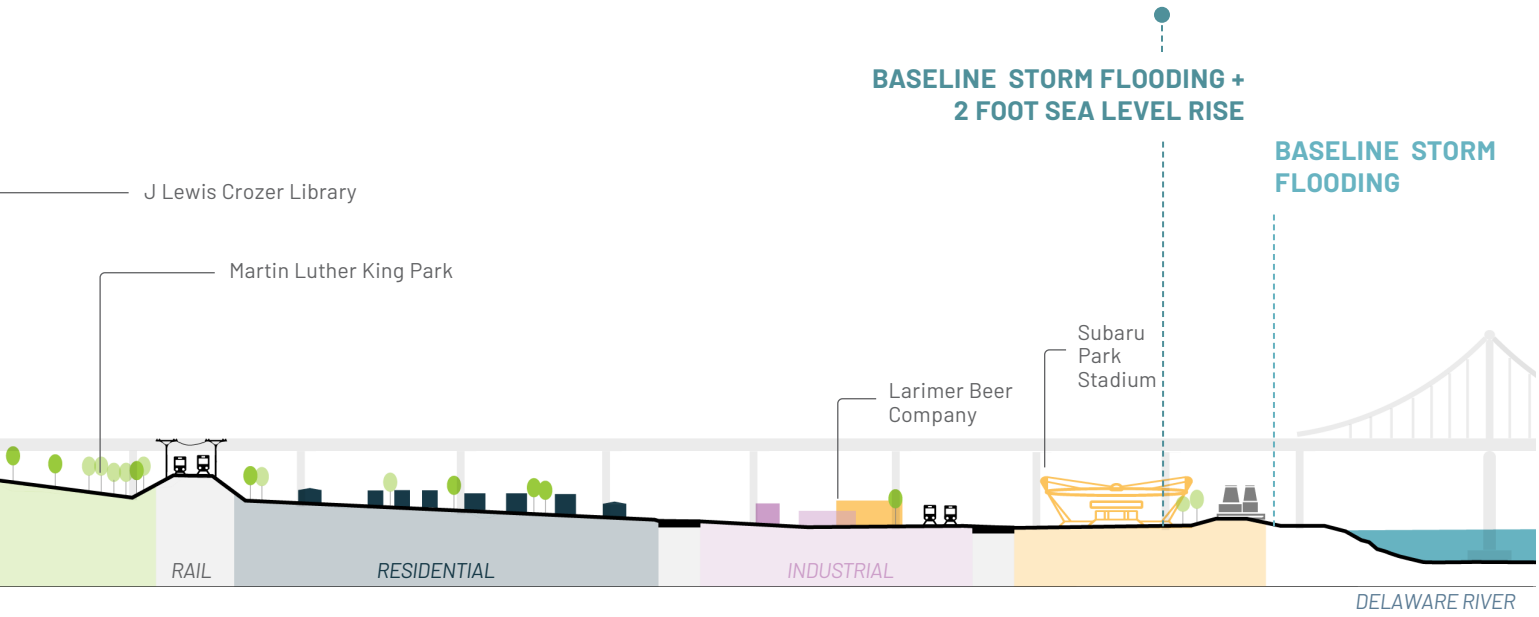


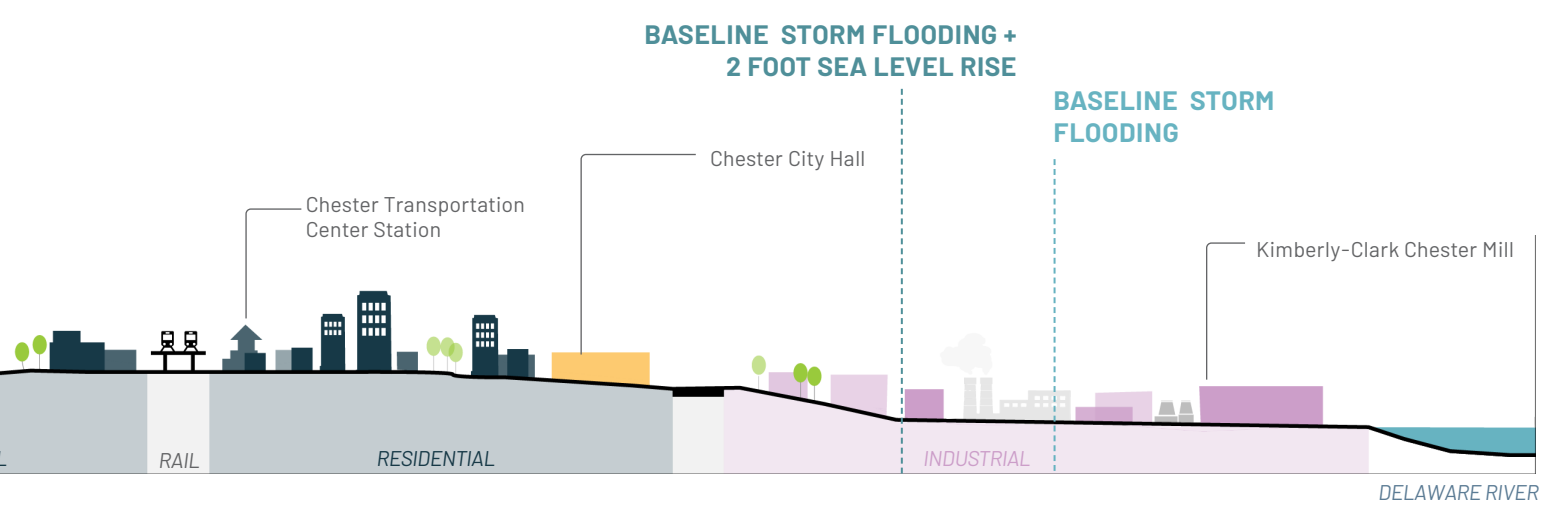
Figure 135. Illustrative section through Chester East depicting typical land use. Source: OLIN

**VERTICALLY SCALED 500%*

IN A MODELED STORM SURGE + 2 FOOT SEA LEVEL RISE SCENARIO, FLOODWATERS IMPACT THE INDUSTRIAL AREA AND THE SUBARU PARK STADIUM



IN A MODELED STORM SURGE +2 FOOT SEA LEVEL RISE SCENARIO, FLOODWATERS AFFECT MOST OF THE INDUSTRIAL AREA AS WELL AS AREAS ALONG CHESTER CREEK



COMMUNITY ASSETS

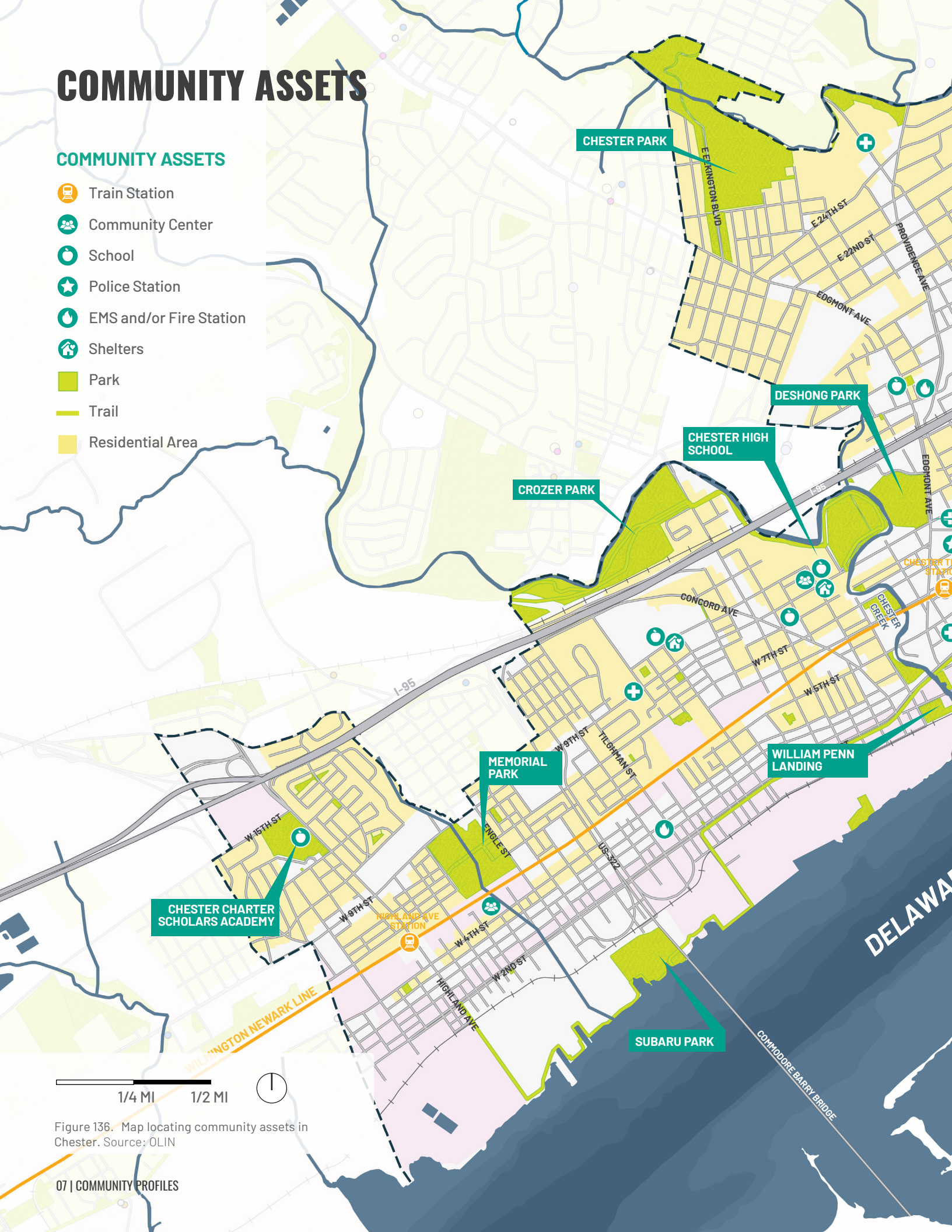


Figure 136. Map locating community assets in Chester. Source: OLIN



Chester is home to a number of larger open spaces within the city and a network of green spaces along Chester and Ridley Creeks connecting to a larger open space network upstream. Within the city, there are 247 acres of parkland that includes six parks like Sun Village Park and Memorial Park, as well as 23 neighborhood play areas. From past engagement, residents have expressed interest in enhancing programming opportunities, safety, and access at these parks while revitalizing unused spaces like Deshong Park.

Chester has one of the more accessible waterfronts in comparison to other focus communities. Anchored by Subaru Park, the Philadelphia Union soccer team stadium and former Superfund site, the Chester Riverfront Trail runs for approximately 1.35 miles, beginning near the Evonik industrial facility, running under the Commodore Barry Bridge, and terminating at the southwestern edge of the Reworld (formerly Covanta). Various plans, including the Chester Waterfront Master Plan, have highlighted the potential to connect the waterfront's existing trail to the East Coast Greenway to further enhance connectivity.



Figure 137. William Penn Landing Site. Source: OLIN



Figure 138. Memorial Park. Source: OLIN

CONTAMINATION IN THE AREA

INDUSTRIAL SITES

- EPA Risk Management Program Site
- PADEP Water Pollution Control Site
- PADEP Air Emission Plant

BROWNFIELD SITES

- EPA Underground Storage Tank
- RCRA - Active Site
- NPL Superfund Site
- PADEP Aboveground Storage Tank
- Superfund Site Boundary
- RCRA Facility



Figure 139. Map identifying industrial facilities and brownfield sites in Chester. Source: OLIN

Like its neighboring communities Marcus Hook and Trainer, many of the hazardous facilities in Chester are located along the waterfront. Many of these land use decisions stem from the late 20th century, when investors began looking to Chester for locations of toxic and hazardous waste treatment facilities as state landfills neared capacity. Chester was deemed a suitable area then as there was abundant vacant land from industrial decline, leaving opportunities for these types of hazardous waste facilities to move in.

Reworld (formerly Covanta)

The Reworld (formerly Covanta) facility is a resource recovery and solid waste management facility located on Chester's waterfront. The facility takes in municipal waste from several East Coast cities and processes more than 1,230,000 tons of waste annually; only 1.6% of the trash burned is from Chester. It is one of the largest trash incinerators in the U.S with one of the highest maximum daily burning capacity rates in the country. The site has operated as an incinerator since its inception in the 1990, continually emitting pollutants like nitrogen oxides, sulfur dioxide, and particulate matter.[13] U.S. Environmental Protection Agency data from 2014 revealed that the facility released more nitrogen oxides and four times more sulfur dioxide than any other municipal waste incinerator in Pennsylvania.[14]

Delaware County Regional Water Authority (DELCORA)

DELCORA is a wastewater treatment facility that serves the Greater Philadelphia population.[15] The facility often exceeds its pollution caps; in 2015, the company paid a $1.375 million fine for releasing untreated sewage into the Delaware River. At the time, EPA estimated that DELCORA annually released 740 million gallons of untreated sewage into water sources, creating both environmental and human harm.[16] As of 2024, the EPA and U.S. Department of Justice signed an agreement with DELCORA to significantly reduce the amount of sewage discharges allowed by the facility to minimize environmental damage and exposure to raw sewage in nearby communities.[17]



Figure 140. Reworld (formerly Covanta) Facility in Chester. Source: OLIN

CURRENT & MODELED FLOOD RISK

FEMA FLOOD HAZARD ZONES

- FEMA 1% Annual Chance of Flooding (100-Yr Flood)
- FEMA 0.2% Annual Chance of Flooding (500-Yr Flood)
- FEMA Floodway
- NOAA: Modeled Category 3 Hurricane Storm Surge (SLOSH)

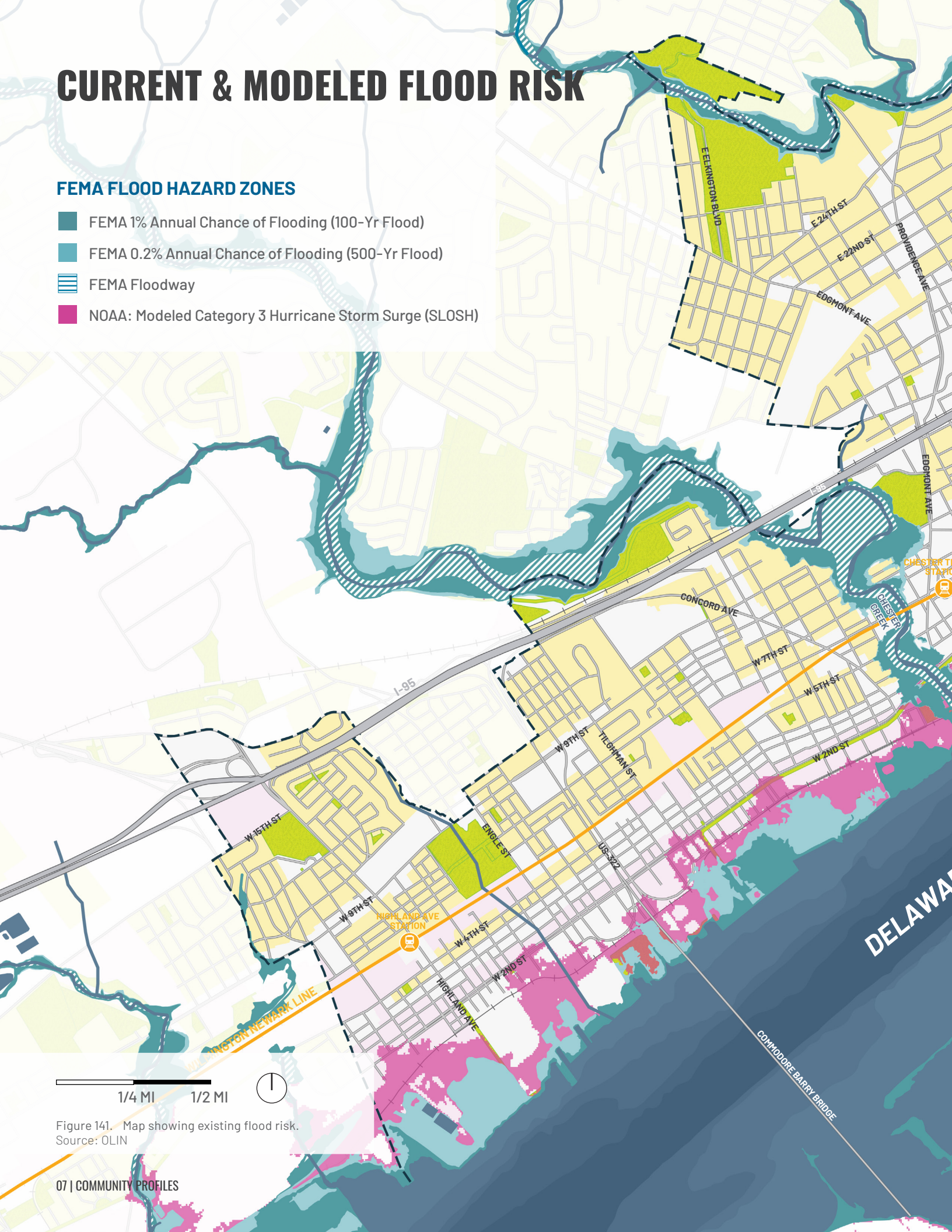
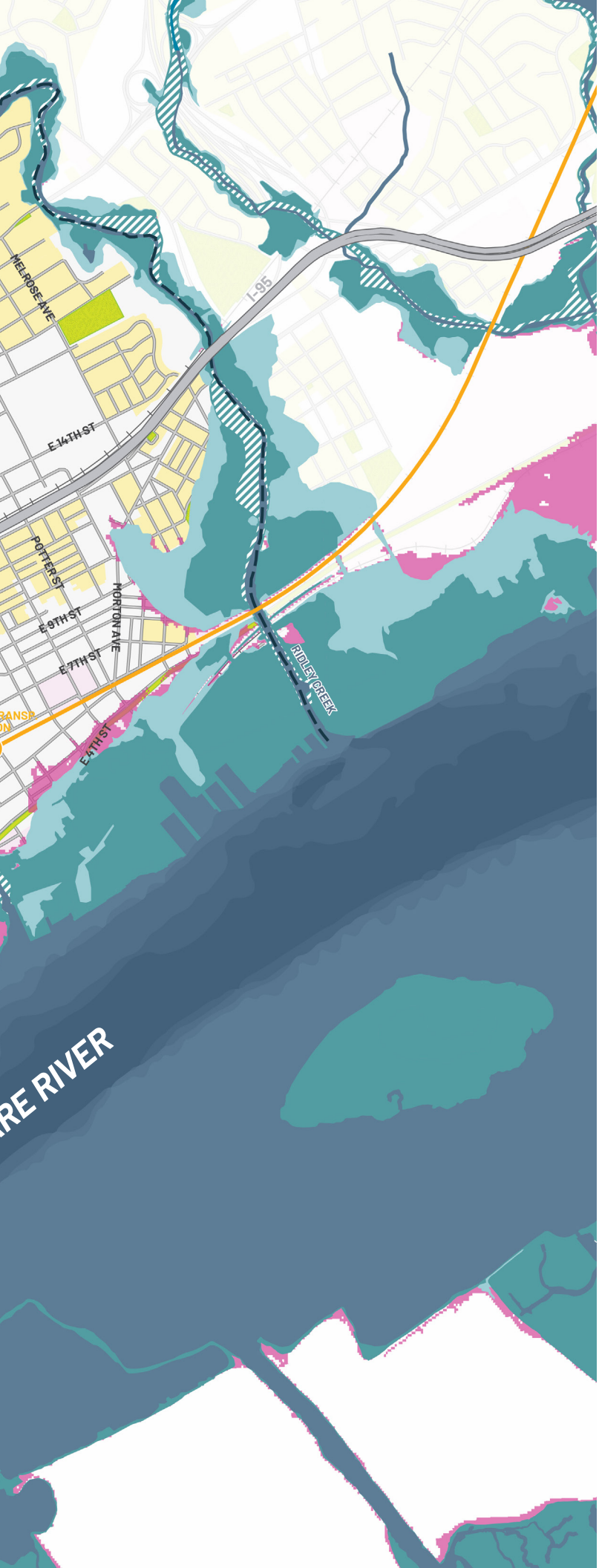


Figure 141. Map showing existing flood risk.
Source: OLIN



Flood Risk

Chester faces risk of flooding from various sources, including fluvial flooding from the Delaware River, Chester Creek, and Ridley Creek, coastal flooding from the tidal Delaware River, and pluvial flooding inland on low-lying sites. In the future, sea level rise and increased rainfall events are expected to increase the area and impacts of flood hazards.

Current Mapped Flood Risk

The Federal Emergency Management Agency (FEMA) flood hazard areas most impact facilities along the Delaware River waterfront and areas adjacent to Chester and Ridley Creeks. The waterfront facilities pose concerns of a Natural Hazard-Triggered Technological Accident event, such as releasing chemicals into the environment and in a worst-case scenario, forcing evacuations and creating long-lasting health and economic impacts. These facilities include DELCORA, Reworld, and Evonik. Near the creek, the FEMA mapped flood areas impact mostly vacant or open spaces; however, there are pockets of residential areas that will be susceptible to flooding. A Category 3 storm event pushes flooding further inland and begins to reach more residential areas north of West 2nd Street.

Various community assets and facilities are also impacted by current flood risks. These include the Chester Riverfront, Chester Community Charter School, and the Eddystone Fire Department.

Extreme Heat

Due to lack of tree canopy, large areas of impervious surfaces, and numerous air pollution sources, communities throughout Chester experience the urban heat island effect with air temperatures higher than the regional average. Similar to other communities throughout the region, heat waves in these areas are expected to last longer and occur more frequently due to climate change.

FLOOD ANALYSIS

WHAT CURRENT ASSETS & INDUSTRY ARE AT RISK FROM CURRENT & FUTURE FLOODING?

MODELED STORMS

- Baseline
- Baseline + 2FT Sea Level Rise
- Superfund Site Boundary
- RCRA Facility

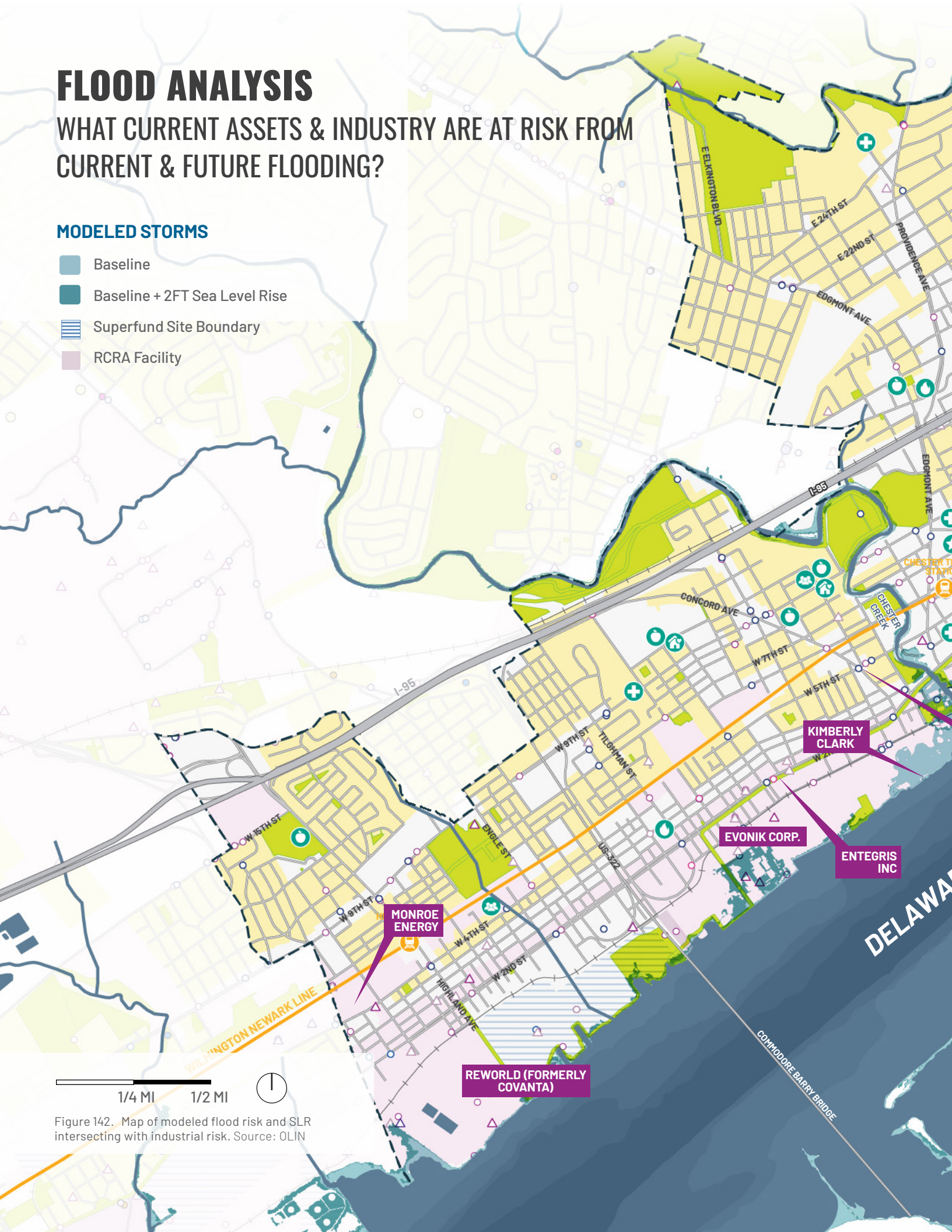


Figure 142. Map of modeled flood risk and SLR intersecting with industrial risk. Source: OLIN



Modeled Storms with Future Sea Level Rise

The map to the left shows a +2 foot sea level rise scenario and merges the flooding impacts of three modeled storms: Hurricane Ida (2021), Hurricane Isaias (2020), and Hurricane Sandy (2012). Areas of the map shaded in light blue were likely flooded during these past storms, while areas shaded with darker blue that are those may flood if and when similar storms occur in the coming decades with expected sea level rise.

In these modeled storm events, the impact of future sea level rise is primarily seen along the Delaware River coastline and to a certain degree along the creeks. Sea level rise brings additional flood risks to low-lying industrial facilities and warehouses, namely Evonik (a chemical plant), Kimberly Clark (manufacturing and distribution center), and ReWorld (formely Covanta)(waste management). Storms and additional sea level rise not only bring the risk of flooding, they also bring the risk of additional impacts like high wind and precipitation that can also cause industrial accidents.



Figure 143. Evonik Facility along the Delaware River. Source: OLIN



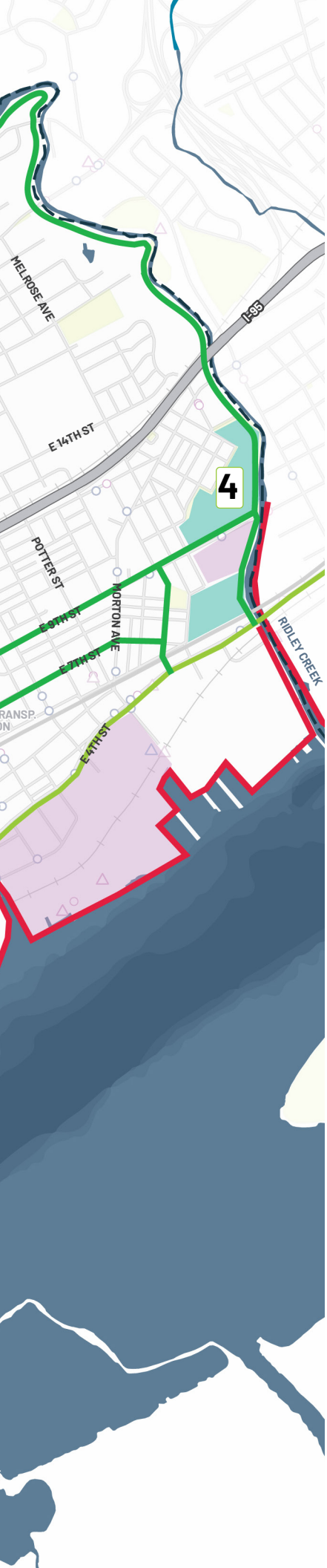
Figure 144. Kimberly Clark Facility along the Delaware River. Source: OLIN

RECOMMENDATIONS

- **Short-term:** Site-or facility-level adaptation of critical and/or vulnerable facilities
- **Long-term:** Resilient Redevelopment Areas
- Nature-Based Solutions
- Proposed Resilience Parks
- Raising Infrastructure
- Proposed shadeway Corridors
- Proposed Shoreline Barriers



Figure 145. Map locating recommendations for priority actions and recommended projects. Source: OLIN



PRIORITY ACTIONS

- **Continue Redevelopment without Displacement or Creating New Risk**

As Chester recovers from past neglect, redevelopment along the waterfront and elsewhere must continue without creating new industrial or flood risks and without putting new housing or infrastructure in harm's way.

- **Expand and Maintain Community Amenities**

Many existing parks and community facilities lack basic maintenance. As new facilities are built, maintenance must be prioritized along with the repair of existing facilities to ensure these amenities effectively serve the community.

- **Create More Connective Park Spaces**

Expand on the East Coast Greenway and continue developing connections to the waterfront as well as east-west pedestrian and bike paths connecting the city's existing parks.

- **Heat Island Mitigation**

Improve access to shaded open spaces, create and maintain spraygrounds in existing parks, plant trees along key pedestrian shade-way routes, and ensure that existing cooling centers are equipped with back-up energy and are available overnight during heat emergencies.

- **Evacuation and Early Warning Systems**

Improve signage and resilience of evacuation routes with warning systems for both weather and industrial hazards.

RECOMMENDED PROJECTS

1. Chester Creek Trail Extension

Long proposed, Delaware County should prioritize extending the Chester Creek Trail through downtown Chester, connecting it to the creek's mouth at the Delaware River. The project would improve waterfront access for Chester and could be coupled with flood mitigation measures while also better connecting Chester to more inland communities.

2. Crosstown Connectivity: 7th/9th Street Recreation Corridors and the East Coast Greenway

Proposed in the 2018 Resilience Through Recreation Plan, 7th Street, 9th Street, and/or the East Coast Greenway could all be improved as shaded pedestrian and bike routes linking Memorial Park, Deshong Park, and Sun Village Park.

3. Waterfront Retrofit and Resilient Redevelopment

The redevelopment of Chester's waterfront, guided by the 2020 Chester Waterfront Master Plan and the 2022 Chester Vision 2035 Comprehensive Plan, is essential to a thriving and resilient Chester. However, future development must better account for the risk of flooding, the potential of the waterfront to reduce inland flood risk, and the need to maintain and expand public access.

4. Sun Village Park and Green Infrastructure

Chester should continue to build-out its 2017 Green Stormwater Infrastructure Plan to reduce inland flooding and extreme heat. Along with the recommendations of the 2018 Resilience Through Recreation Plan, Sun Village Park should continue to be invested in as a community amenity and as a resilient park space. In addition to green infrastructure, the park can be modified to create a mix of levees and floodplain wetlands along Ridley Creek to better manage floodwater.

RECOMMENDATIONS

COMMUNITY RESILIENCE TOOLKIT FOR LOCAL PROJECTS



GREEN STORMWATER INFRASTRUCTURE (GSI)

Continue to build on the framework laid out in the City's Green Stormwater Infrastructure Plan and work with the Stormwater Authority when identifying GSI interventions.

The plan outlines several green stormwater infrastructure (GSI) projects implementable in different areas of the city; notably, Memorial Park was identified as a significant opportunity for a demonstration project with rain gardens and stormwater bump outs. Other projects include enhancing PA 291 with GSI such as a vegetated center median, which can mitigate stormwater runoff and provide visual quality and safety. Potential sites were identified with appropriate GSI interventions and future GSI projects should consult the plan. In general, facilities should be located on publicly owned open space or rights-of-ways in upland locations, outside of flood and storm surge inundation areas or contaminated soils, and where they will be most effective.

» *See: City of Chester Green Stormwater Infrastructure Plan (2017)*



COOLING CENTERS

Expand existing cooling centers to be broader community resiliency centers.

There are several existing cooling centers within Chester: The Salvation Army, J. Lewis Crozer Library, Booker T. Washington Community Center, Chester Senior Center, and Access Chester Community Center. These centers serve an important function during extreme heat events; however, their purpose can broaden to become community resiliency centers that can act as the home base for any future disaster recovery efforts.



WATERFRONT ACCESS & AMENITIES

Prioritize access from inland areas to the waterfront and expand trail connections with careful study relative to increased risk from sea level rise and flooding.

Improving connectivity and access should be prioritized to ensure everyone has safe, easy access to this open space amenity. Turn existing street connections, like Engle Street, into an extension of the open space network by making these streets into shade-way corridors with ample planting and GSI as possible. This also includes identifying further public access points, including the waterfront scrapyard site located between the Trainer Refinery and DELCORA Wastewater Treatment plant, which requires a further feasibility study. The Chester Waterfront Master Plan further outlines future development at the waterfront, including a renovated public waterfront park that expands on the green space provision adjacent to the stadium. Any development and design considerations should be overlaid with future flooding models and sea level rise to accommodate and plan for future risks.

» *See: Chester Waterfront Master Plan (2020), Resilience through Recreation (2018), Delaware County 2035 Open Space, Recreation, and Greenway Plan (2015)*



TREE PLANTING

Work with the Chester City Shade Tree Commission to identify priority areas and streets for street tree planting.

While parks and creek corridors in Chester have decent tree canopy coverage, additional tree planting should be prioritized in local streets and in connector streets to key assets like the waterfront for both thermal comfort and air quality benefits. These plantings should be done in partnership with the city's Shade Tree Commission, which works to educate and inform residents about the benefits of trees and holds volunteer tree planting events. Additional community organizations have also worked to plant trees. New street tree plantings should also consider implementing as much green stormwater infrastructure, like stormwater tree trenches, as outlined in the Chester Stormwater Plan.

» *See: City of Chester Green Stormwater Infrastructure Plan (2017)*



SHADE-WAY CORRIDORS

Identify and transform key corridors with appropriate shade trees and shade structures.

Past plans identify several key corridors for corridor improvements: PA 291 (also known as the Industrial Heritage Corridor), the East Coast Greenway, Highland Avenue, Edgemont Avenue, Engle Street, 22nd Street, 9th Street, and 3rd Street. These should be prioritized as shade-way corridors as they are major connections within Chester and link to community assets. Other connections should be considered as secondary priorities, like the Chester Creek Trail, which is already vegetated to some degree.

» *See: Resilience through Recreation (2018), Chester Vision 2035 (2023)*



SPRAY FOUNTAINS & SPLASH PADS

Integrate water features into existing and well-used recreation areas.

While no active spray fountains or splash pads exist in Chester, there are several existing parks and recreation areas that would be well-suited for a water feature. These include Sun Village Park, Memorial Park, Barry Bridge Park, and Chester Park. Other open spaces without existing playgrounds, like Deshong Park, or planned park spaces could also be well-suited for a water feature but would first require a more comprehensive park or recreation space design.

» *See: Resilience through Recreation (2018)*



BUILDING RETROFITS

Implement building retrofit programs and zoning ordinances that address flood risks in areas vulnerable to current and future flooding.

There are no general municipal or county building and/or infrastructure retrofitting programs in Chester that address building vulnerability in the face of climate change. Initial actions to implement a retrofit program should work in tandem with Chester's Community Construction and Public Works Department, which are supported with Community Development Block Grant Funds from the U.S. Department of Housing and Urban Development. Vulnerable residential, industrial, and cultural buildings should be shored up against current and future sea level rise and storm impacts. These include but are not limited to any buildings along Chester Creek and the Chester Water Authority Distribution Center.



DEPLOYABLE/TEMPORARY BARRIERS

Evaluate the feasibility of deployable or temporary barriers in locations susceptible to flooding.

There are no current known plans for deployable or temporary barrier systems in Chester. These systems are appropriate at critical infrastructure and community facilities and/or in narrow pathways of localized flooding.



ENVIRONMENTAL MONITORING & MODELING

Create a city-wide database that has real-time information on environmental and climate factors.

Chester does not currently host its own environmental information. Municipal departments should work to implement a city-wide database that provides current data on environmental and climatic factors. This can also include emergency management guides for residents and businesses on how to respond and react in the event of a natural disaster.

» *See: Delaware County: 2016 Hazard Mitigation Plan*



PAVEMENT REDUCTION

Study potential underutilized paved spaces for depaving and green stormwater infrastructure installations.

Underutilized paved spaces, like the asphalt parking lot at Chester Recreation Facility, should be considered for depaving and installing green stormwater infrastructure and/or vegetation. Reduction of impervious surfaces can aid stormwater management and local flooding issues.

RECOMMENDATIONS

EARLY ACTION PROJECT



SUN VILLAGE PARK

SITE CONTEXT

Located along the western banks of Ridley Creek, Sun Village Park is a large neighborhood park that offers a mix of recreational and community-supporting facilities, access to nature, and ease of access for residents on the East side of Chester as well as across Ridley Creek in Eddystone. Most of the park is in the Ridley Creek floodplain and is vulnerable to creek and tidal surge flooding from the nearby Delaware River.

The early action project focuses on improving the upper terrace of the site adjacent to Curry Street. And Thomas Street which is out of the floodplain, most adjacent to the neighborhood, and underneath the extensive existing mature tree . The goal of this project was to better connect it to the recently constructed playground to the south along 9th Street with a nature storybook walk and other art installations.

DESIGN CONCEPT

The storybook walk begins at the upper terrace near Thomas Street, here and throughout southeast along an existing sidewalk that leads to 9th Street. Just past the existing tennis courts, the trail turns south, meandering through existing trees to create an accessible pathway to the playground. An additional ADA sidewalk constructed by the City of Chester then connects that playground directly to 9th Street.



Figure 146. Sun Village Park celebrations. Source: CAC.

PROJECT COMPONENTS

Nature Storybook Walk
- Storybook stands
- ADA stone fines path
- Site furnishings

Management of Existing Trees

Planting
- Trees
- Shrubs/groundcover

LONG-TERM RECOMMENDATIONS:

A larger storybook walk loop could be created by adding an alternative trail alignment west of the tennis court that was studied (see plan below).

The lower portion of the site (field) could be managed to process and clean stormwater as well as store and slow flood waters coming down Ridley Creek or small surges up from the Delaware River.

RECOMMENDATIONS
REGIONAL ACTIONS



RAISING EDGES/SHORELINES: LEVEEES & FLOOD BARRIERS

Study the feasibility of both a continuous levee and a neighborhood-specific levee to protect against future flooding.

A levee from the late 20th century was built to protect Chester from Chester Creek after the floods of 1971. However, that levee has easily been breached by other flood events, including an event in 1999 from Hurricane Floyd. Since then, no future plans have been made for permanent levees or berms along the Delaware River or along the creeks, which are also susceptible to flooding. Studies should be conducted to evaluate the efficacy of a levee along the Delaware River, which would ideally connect downstream with any studies for Marcus Hook and Trainer. A levee along the Delaware River would be instrumental in protecting industrial facilities from flooding, which are typically located along the waterfront in Chester. Shoreline hardening and levees are costly, so strategically locating them will be critical in any first step and ensuring they have adaptive capacity will be key as climate projections change over time.

Meanwhile, more local barriers should be studied along Chester Creek, where flood models show flooding of some residential areas and into some existing open spaces like Deshong Park. Smaller levees or berms that account for current flood predictions may be easier to implement; however, careful study will be needed to evaluate the benefits against any incidental risks downstream.

» *See: City of Chester Vision 2020 Climate Adaptation Planning Elements*

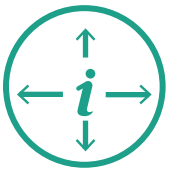


RAISING INFRASTRUCTURE

Identify strategic areas for raising infrastructure.

Costs to raise infrastructure can be prohibitive. The City should strategically identify a few key sites, infrastructure, and facilities vulnerable to flooding for raised protection, alongside sites that may be designed in their current condition to accommodate floods (like Subaru Park or other open spaces along the waterfront).

Special consideration should be given to the low-lying, local CSX rail lines as freight trains often store hazardous chemicals. Raising portions of the transportation infrastructure that are flood-vulnerable can also begin to work in tandem as a localized levee/berm. Further consideration is also needed for specific facilities and equipment, which need to be elevated or otherwise protected. See the policy page on page 178 for further detail on industrial recommendations.



CENTRALIZATION OF CLIMATE RISK INFORMATION

Establish a public, centralized platform to integrate information across City agencies and industry.

A designated clearinghouse that collects all climate-related information and tracking, including emergency management and evacuation responses, from all City agencies would allow Chester to monitor flood risks and ensure a coordinated response in the face of an emergency. Information from industrial facilities should also be integrated, as they have more up-to-date information on pollution levels, accidents, and any other relevant information. Hosting this information on a public website allows residents to access accurate, real-time information before, during, and after any incident.



NATURE-BASED SOLUTIONS

Consider existing parks and vacant open spaces for retrofitting and implementing larger interventions.

While there are no current or proposed nature-based solutions (NBS) in Chester, there are both existing assets and currently vacant spaces that would be suitable for larger interventions. The Chester Riverfront and waterfront Subaru Park have the potential to be designed to accommodate flooding and stormwater, while vacant land adjacent to the flood-susceptible Chester Creek can be considered for land conservation or transformation into a wetland. Other sites previously identified for interventions include tidal wetlands at the mouth of Crum Creek.

Meanwhile, at a more local scale, NBS also include interventions such as green stormwater infrastructure installations like rain gardens, depaving, and tree planting. A comprehensive evaluation of appropriate NBS at the local and regional scale can begin to address current and future flood risks.

» *See: A Natural Heritage Inventory for Delaware County Pennsylvania (2011), City of Chester Vision 2020 - Climate Adaptation Planning Elements*



IMPROVED CONNECTIVITY

Continue implementing previously identified trail connections and support the expansion of multimodal connectivity.

Continuing to develop, maintain, and improve connectivity of the East Coast Greenway (ECG) is key to linking Chester to a larger regional network and to its neighbors, Marcus Hook and Trainer. Improvements and future ECG trails should consider additional tree planting to create a comfortable, shaded experience as well as green stormwater infrastructure projects to help mitigate flooding. The Chester Creek Trail-ECG Connector is another priority, as this north-south connector links the ECG north up to the Chester Creek trail system. This connector runs downstream along Chester Creek from Incinerator Road into Crozer Park and across the creek into Deshong Park, before terminating at the ECG. Alongside this trail connection, improvements should simultaneously be made at Crozer and Deshong Parks to create a connected system of trails and open spaces.

Other improvements could include safe crossings over Route 291 (3rd Street) to better connect Ethel Waters Park and the ECG, and revitalizing the Concord Road bridge and underpass. Overall, a better and more connected multimodal system with inter-neighborhood trails and greenway systems can provide access to recreation, improve neighborhood social interaction, and create opportunities for green stormwater infrastructure programs. Flooding and damage to streets can also make emergency access and evacuation difficult; enhancing street connections can also help reduce risk by adding redundancy.

» *See: Delaware County 2035 Open Space, Recreation, and Greenway Plan (2015)*

RECOMMENDATIONS

POLICY

EMERGENCY MANAGEMENT

EFFECTIVE COMMUNICATION SYSTEMS

Chester should develop place-based communication systems in conjunction with industrial facilities and relevant municipal agencies. A localized communication system can provide real-time notification on air quality concerns, industrial accidents, emergency planning, and any anticipated flooding. The City should ensure all residents are aware of local emergency plans and have guidance on where to find information on emergency management.

ENVIRONMENTAL MONITORING POLICIES & INCENTIVES

In partnership with the County, State, and environmental organizations, Chester needs to incentivize and prioritize investments in environmental monitoring given its proximity to major industrial hazards. The City should continue to monitor facilities' adherence to EPA-set standards for industrial pollution and provide robust information on its website.

CHESTER COMMUNITY IMPROVEMENT PROJECT: ARBOR ESTATES HOUSING DEVELOPMENT

The Chester Economic Development Authority and Riverfront Alliance formed a collaboration to expand economic opportunities and improve quality of life. In 2017, the collaboration partnered with the Chester Community Improvement Project (CCIP) to develop four new units of affordable housing known as the Arbor Estates development. CCIP is also responsible for housing acquisition and rehabilitation projects in the city. [18]

STAYING IN PLACE

ANTI-DISPLACEMENT MEASURES

The City should establish and enforce a municipal fair housing ordinance to help educate tenants and landlords on their rights and responsibilities. Identify priority neighborhoods where action is needed to preserve affordable housing for existing low- to middle-income residents. Other tools include working with adjacent municipalities and/or Delaware County on a land bank and supporting community development corporations in ensuring safe housing and increasing affordable housing in the city.

FAIR AND SAFE HOUSING PROGRAMS

The City should seek and incentivize redevelopment and infill opportunities that require affordable housing on vacant land. New housing should be prioritized on upland sites with less flood risk and adjacent to public transportation and community amenities. Expand funding for the Chester Economic Development Authority Home Buyers Assistance Program to assist more first-time homebuyers and future public-private partnerships.See Arbor Estates Housing Development as an example.

WORKFORCE DEVELOPMENT & LAND INITIATIVES

Chester should include access to high quality job opportunities and job training for any new developments, prioritizing local residents for jobs. The City should initiate a working group to anticipate growing employment sectors and work with local academic institutions like Widener University to provide periodic skills training at all age levels.

PHYSICAL INTERVENTIONS

GREEN STORMWATER INFRASTRUCTURE (GSI) POLICIES AND INITIATIVES

Chester should establish a green stormwater infrastructure working group to advance implementation of the Green Stormwater Infrastructure plan and develop community partnerships. The group can identify the best incentivization tools for implementing GSI programs in vacant/underutilized land, including stormwater fee discounts, expedited permitting, grants, and rebate and installation financing.

UPLAND MITIGATION OF CREEKS AND STREAMS

Chester should coordinate with Delaware County agencies and neighboring upland municipalities to better steward Chester Creek and to implement more conservation, restoration, and green infrastructure throughout the watershed.

IMPROVED FLOODPLAIN CONSTRUCTION STANDARDS

The City should set more stringent standards for municipal projects and new development, like increasing the minimum buffer distance from floodplain boundaries. The City can implement tools and incentives for private landowners and developers to discourage building in the floodplain. The City should also periodically review floodplain and building elevation standards against the most current FEMA flood predictions and risk data to update standards as needed.

STORM DRAIN INFRASTRUCTURE & MAINTENANCE

In conjunction with the green stormwater infrastructure program implementation, the City should study existing stormwater infrastructure capacity and review past flood and overflow events to identify where storm drain infrastructure needs to be updated. Support public works, streets, and other government department training and maintenance programs.

INDUSTRY

ARMOR, RAISE, PROTECT

Chester should evaluate facilities with the capabilities to enact near-term protection plans and incentivize retrofit programs.

EVACUATION ROUTES & LOCAL RECOVERY PLANS

The City's Office of Emergency Management should work with active industrial facilities and neighboring municipalities to create a local recovery and emergency response plan in the event of a disaster. Review current evacuation routes alongside state and industrial facility evacuation plans and facilitate outreach programs with the public to ensure all residents have the most current information.

SITE-SPECIFIC DECOMISSION PLANNING

Chester should plan for the eventual closure and/or redevelopment of the major fossil fuel facilities in the community.

EASTWICK

Eastwick's modern history reflects its relationship to the environment, federal policies of redlining and urban renewal, and ongoing environmental injustices.

HISTORY

Originally a vast expanse of tidal marshes and wetlands, the land now known as Eastwick was home to Lenni Lenape people for centuries prior to European colonization. In the 17th century, as colonizers began claiming the land and region, the landscape gradually transformed through various drainage and land reclamation efforts. Still, the area has always been characterized by its close proximity to water, including the Schuylkill River, Cobbs Creek, and Darby Creek.

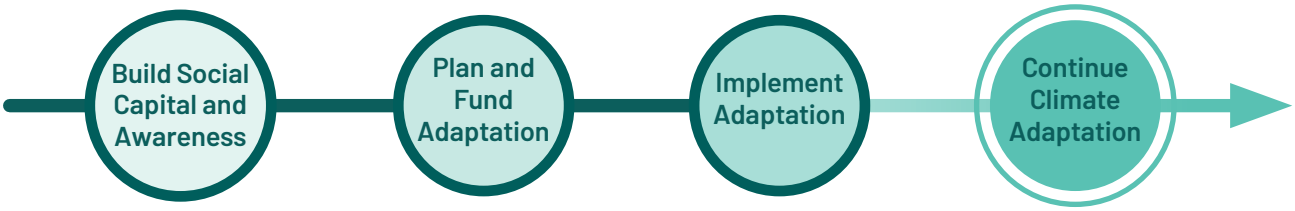
Eastwick's modern history reflects its relationship to the environment, federal policies of redlining and urban renewal, and ongoing environmental injustices. Through the 1950s, Eastwick was one of the only racially integrated neighborhoods in the city of Philadelphia and was described as a self-sufficient neighborhood. Residents and visitors were attracted to the open fields and the semi-rural neighborhood earned the nickname "the Meadows."[19]

Following World War II, city planners and private developers targeted the area for large-scale redevelopment under the guise of "urban renewal," declaring the area blighted, forcing thousands of working-class residents out of their homes and breaking up tight-knit communities.[20] Under the push for redevelopment, wetlands were filled in to create more buildable land for new housing, destroying vital natural habitats and flood protections in the process. The extensive 1,660 acres of wetlands, now protected by John Heinz National Wildlife Refuge, used to cover up to 5,700 acres and were capable of absorbing flooding overflow from Darby and Cobbs Creeks.[21] As a low-lying neighborhood, Eastwick was already susceptible to floods, but the loss of natural flood barriers exacerbated this vulnerability.

Industrial landscape does not dominate Eastwick as much as it does in Marcus Hook, Trainer, and Chester, but industry is still present thanks to the neighborhood's proximity to the Philadelphia International Airport and tank farms. Environmentally hazardous sites form the basis of much of Eastwick; new houses built during the "urban renewal" era were often built on top of contaminated industrial sites which leaked toxic chemicals into the soil and groundwater.[22] Residents today continue to contend with environmental injustice from constant flooding threats, exacerbated by climate change and air pollution from neighboring highways and industrial facilities.

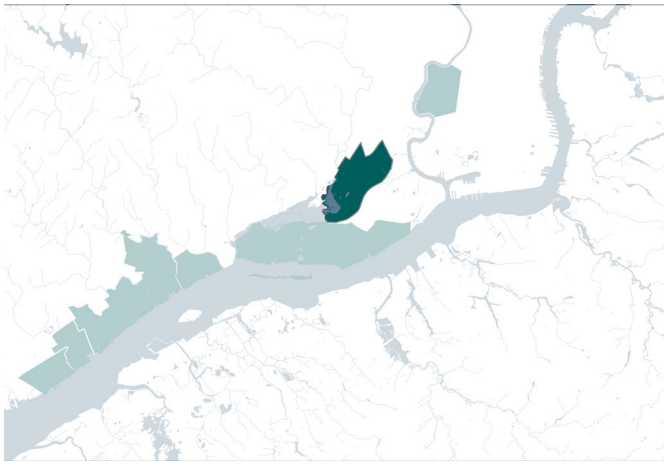
Eastwick today is home to 12,000 residents and is a majority Black neighborhood. With its status as an "environmental justice community", the neighborhood has been the focus of various initiatives over the years, including Eastwick Flood Resilience Strategy, the Lower Eastwick Public Land Strategy, and plans by the US Army Corp of Engineers for a levee along Cobbs Creek. The neighborhood is abutted by Philadelphia International Airport to the south and John Heinz National Wildlife Refuge to its southwest, while wide streets like 84th Street and Lindbergh Boulevard bifurcate the neighborhood.

After decades of community activism and with planning and funding well underway, its time to implement flood risk reduction measures that will make the community more climate adaptive.



EASTWICK

BY THE NUMBERS



DATA: ACS COMMUNITY SURVEY, 2022

RACE & ETHNICITY

76%
NON-HISPANIC BLACK

4%
HISPANIC / LATINO

MEDIAN AGE

37.4

POPULATION

12,000
TOTAL

6,000
DENSITY per sq mile

INCOME

24%
BELOW POVERTY LINE

HOUSING

30%
OWNER-OCCUPIED UNITS

70%
RENTER-OCCUPIED UNITS

LANDUSE

37.5%
OPEN SPACE

13.7%
INDUSTRIAL



Figure 147. Houses adjacent to the Clearview Landfill and the nearby Cobbs Creek. Source: OLIN

COMMUNITY PROFILE

EASTWICK

Eastwick is characterized by low-lying residential neighborhoods adjacent to the Philadelphia International Airport and the John Heinz National Wildlife Refuge. Darby Creek cuts through Eastwick before joining Cobbs Creek to meet the Delaware River. The Clearview Landfill lies close to Darby creek, a residential pocket, and buildings that hold historical significance for the community.

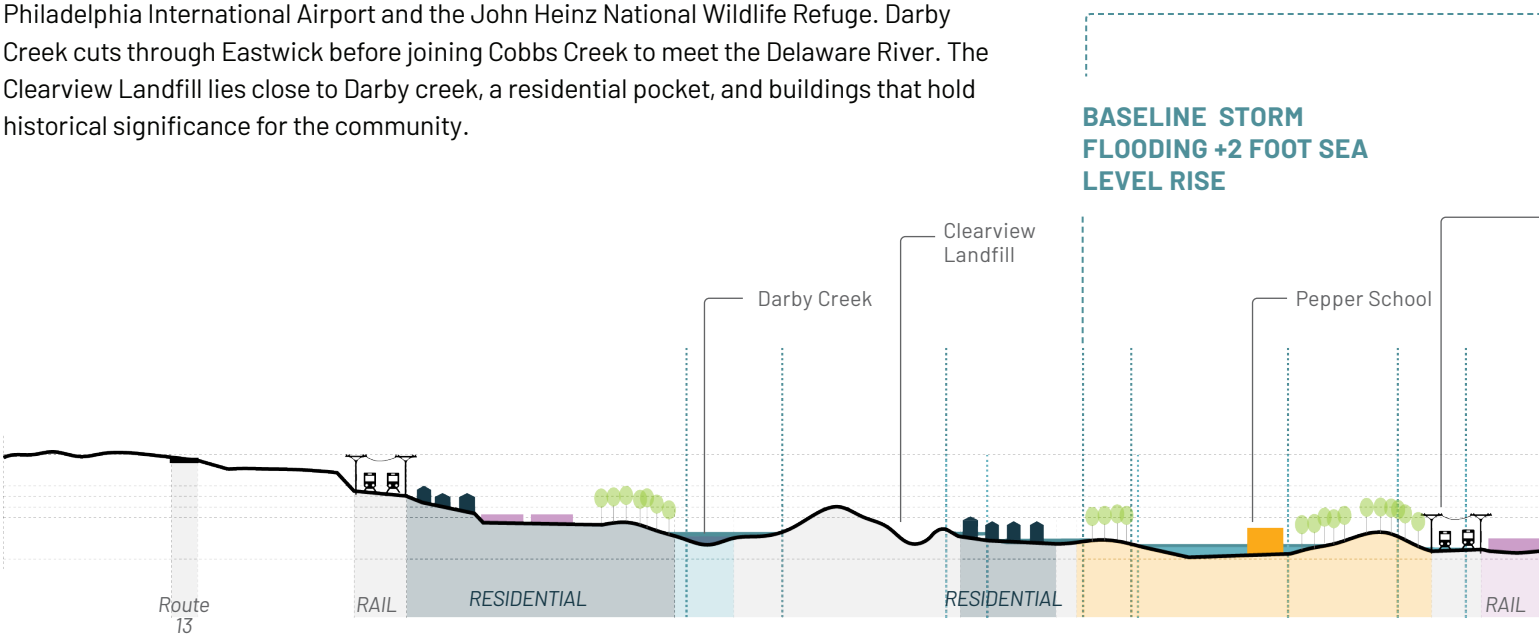


Figure 148. Illustrative section through Eastwick depicting typical land use. Source: OLIN

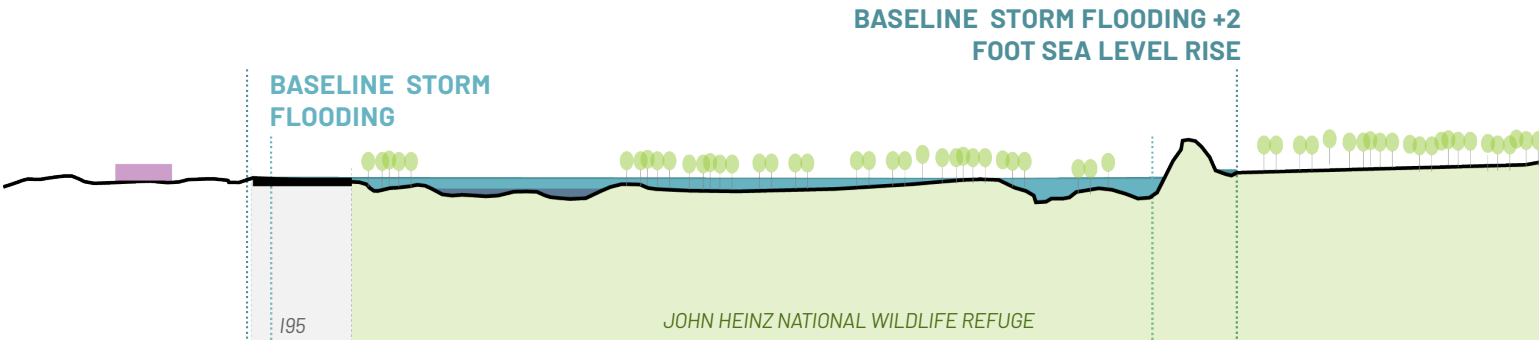
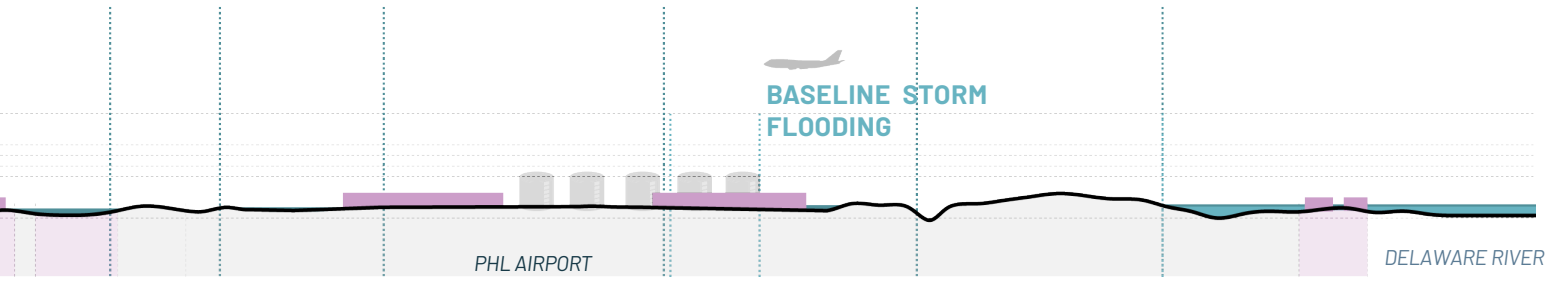


Figure 149. Illustrative section through Eastwick and John Heinz National Wildlife Refuge depicting typical land use. Source: OLIN

**VERTICALLY SCALED 500%*

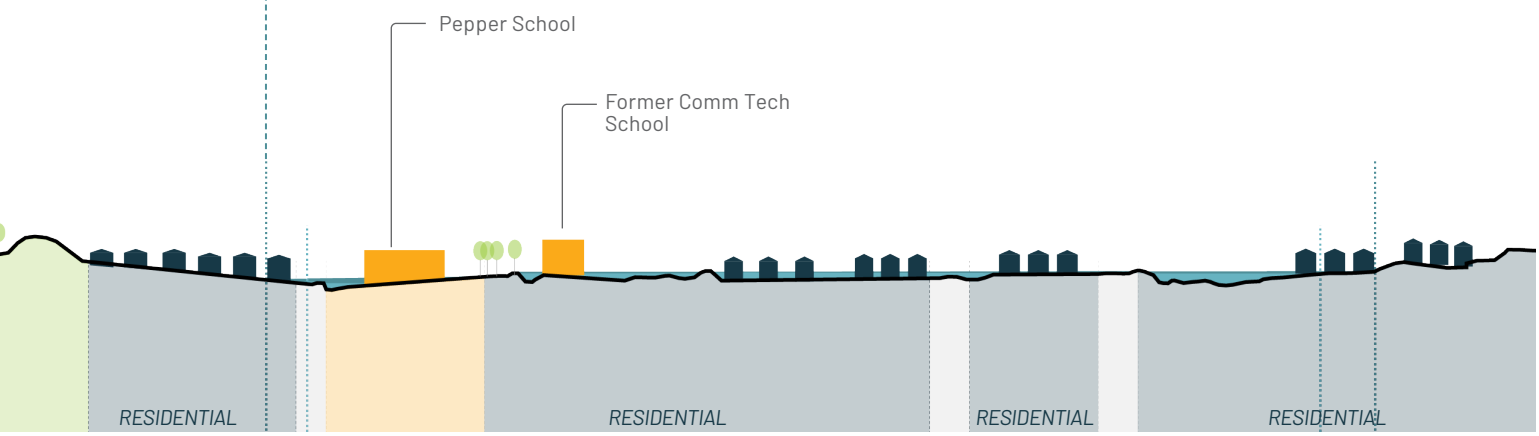
IN A MODELED STORM SURGE +2 FOOT SEA LEVEL RISE SCENARIO, THE FORMER GEORGE W. PEPPER SCHOOL SITE IS SIGNIFICANTLY IMPACTED

Amtrak/SEPTA Wilmington-Newark Line



IN A MODELED STORM SURGE +2 FOOT SEA LEVEL RISE SCENARIO, THE FORMER GEORGE W. PEPPER AND COMM TECH SCHOOLS, AS WELL AS ADJACENT RESIDENTIAL COMMUNITIES, ARE FLOODED

BASELINE STORM FLOODING +2 FOOT SEA LEVEL RISE



COMMUNITY ASSETS

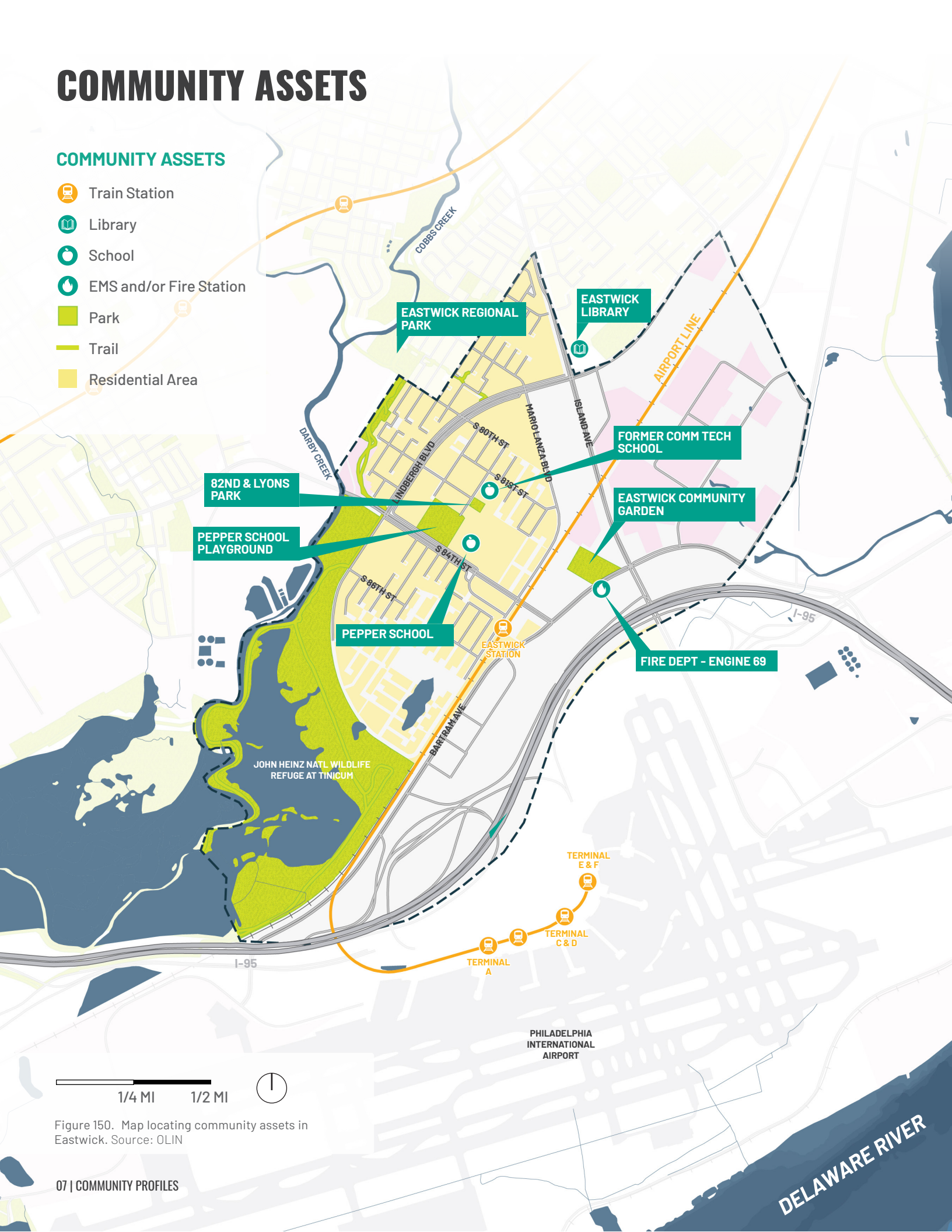


Figure 150. Map locating community assets in Eastwick. Source: OLIN

One of Eastwick's largest community assets is also one of Philadelphia's main assets: the John Heinz National Wildlife Refuge at Tinicum, which is part of the U.S. Fish and Wildlife Service's National Wildlife Refuge System and located at the southern edge of the neighborhood. The 993-acre refuge has more than 10 miles of trails and is home to freshwater tidal marshes, open waters, and mudflats, all of which support passive recreation and wildlife habitats.

Within the neighborhood, other open space assets consist of Eastwick Park, an unused space adjacent to the Clearview Landfill, and the seven-and-a-half acre Eastwick Community Garden. However, there is a shortage of play spaces in parts of Eastwick, particularly near the former Pepper School. Cultural assets include Cibotti Recreation Center and Eastwick Library.



Figure 152. Community event held at the site of the former Pepper School . Source: OLIN



Figure 151. Tidal and freshwater wetlands at the John Heinz National Wildlife Refuge at Tinicum help to reduce flood impacts to Eastwick while also providing a unique outdoor amenity with trails, fishing, and a nature center that hosts community events. Source: OLIN

CONTAMINATION IN THE AREA

INDUSTRIAL SITES

- EPA Risk Management Program Site
- PADEP Water Pollution Control Site
- PADEP Air Emission Plant

BROWNFIELD SITES

- EPA Underground Storage Tank
- RCRA - Active Site
- NPL Superfund Site
- PADEP Aboveground Storage Tank
- Superfund Site Boundary
- RCRA Facility

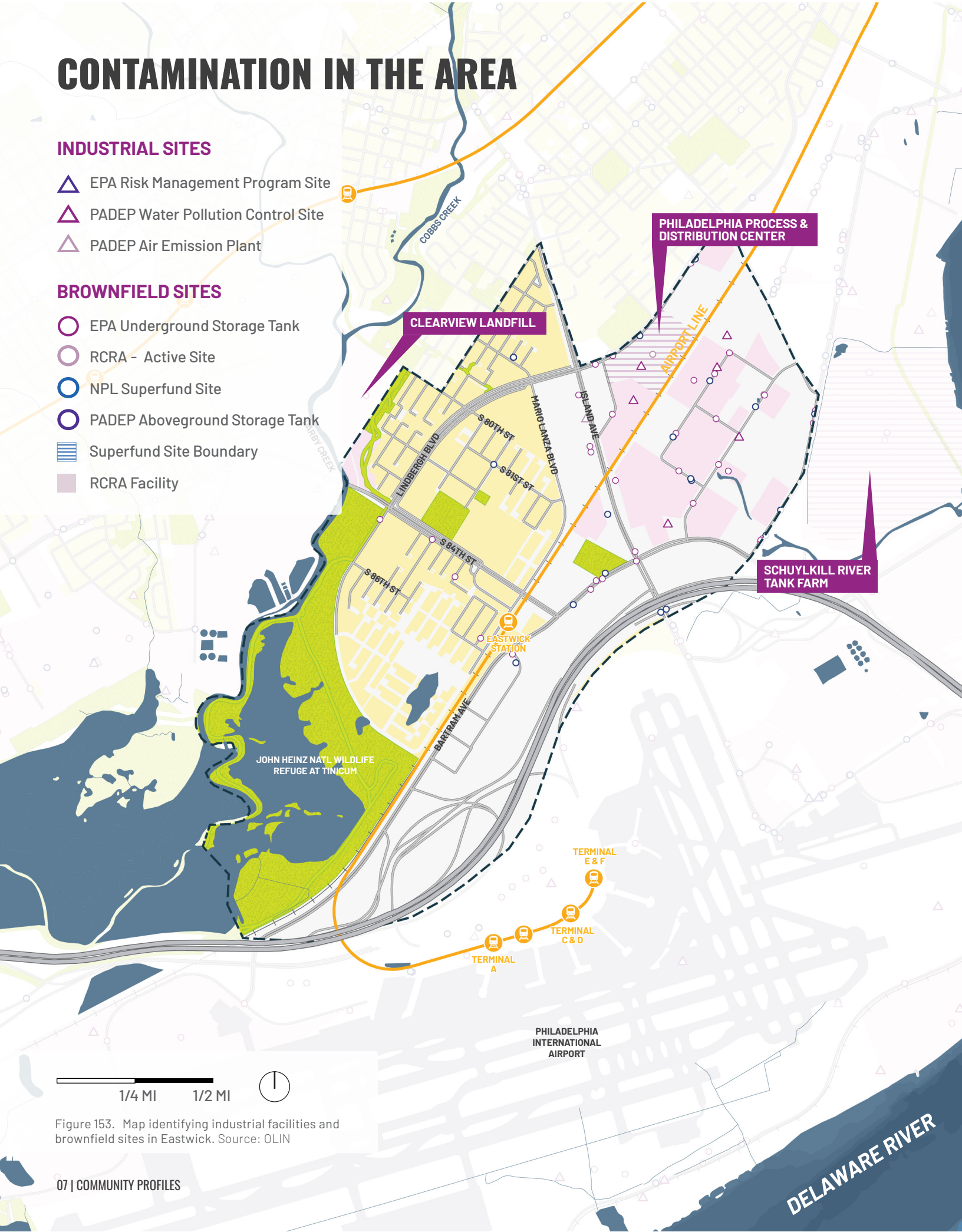


Figure 153. Map identifying industrial facilities and brownfield sites in Eastwick. Source: OLIN

Unlike the other focus communities, which are built right up to heavy industrial facilities, much of Eastwick's contamination risks are less apparent. However, the neighborhood's close proximity to the Philadelphia International Airport means that residents are constantly exposed to noise and air pollution, while general proximity to the Sunoco Schuylkill River Tank Farm and the former Philadelphia Energy Solutions (PES) Refinery site is another source of concern.

Clearview Landfill/Lower Darby Creek Area Site

The Lower Darby Creek Area Superfund site includes two landfills: the Clearview Landfill and the Folcroft Landfill, the former of which is located in north Eastwick and abuts Eastwick Park and residential areas. The Clearview Landfill was once used for municipal and industrial waste disposal, operating without a permit between the 1950s and 1970s. During the "urban renewal" development of residential areas, many homes were built on contaminated soils and residents often bought property without knowing the full extents of toxicity and its ramifications on their health. Soil contaminants include polychlorinated biphenyls, arsenic, pesticides, and heavy metals. Active cleanup is ongoing; the landfill is now capped and planted while the U.S. Environmental Protection Agency is planning remediation for contaminated groundwater. [23]



Figure 155. Clearview Landfill adjacent to Eastwick.
Source: OLIN

Sunoco Schuylkill River Tank Farm

The Sunoco Schuylkill River Tank Farm is part of the former PES Refinery, which stretches across the Schuylkill River and up to Grays Ferry. The 211-acre site abuts the Eastwick boundary and is a product storage and shipment tank farm, containing and handling products like gasolines and liquefied petroleum gases. There is a current hazardous waste cleanup ongoing at the site and the main contaminants in the soil and groundwater are hydrocarbons and lead. [24]


Figure 154. Adjacent Sunoco Schuylkill River Tank Farm.
Source: OLIN

CURRENT & MODELED FLOOD RISK

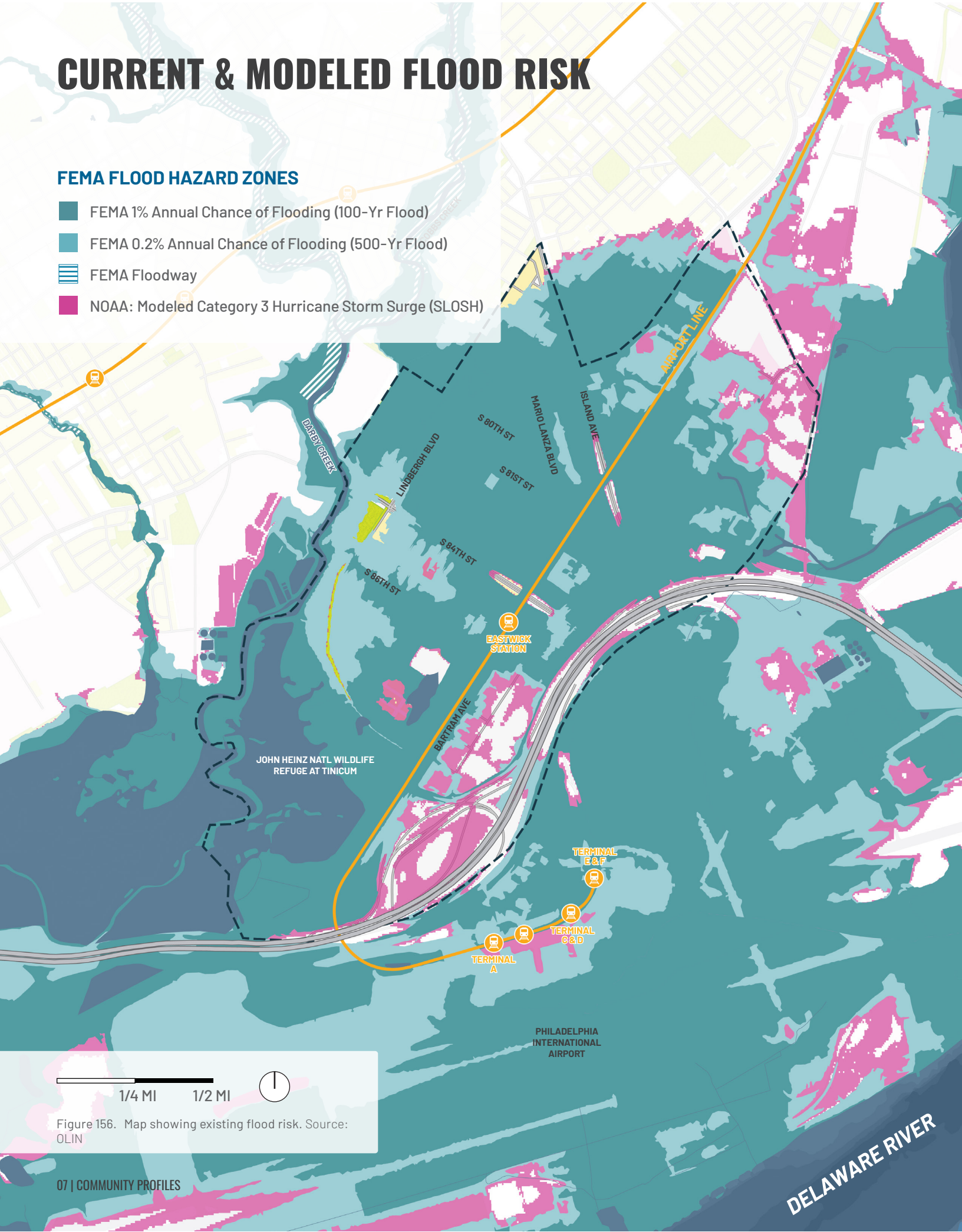


Figure 156. Map showing existing flood risk. Source: OLIN

Flood Risk

Eastwick is the most low-lying and flood-prone neighborhoods in Philadelphia. Its unique location between Darby and Cobbs Creeks, the Schuylkill River, and the tidal influence of the Delaware River result in a variety of flood sources and risks. While flood risks are current and real, in the future, sea level rise and increased rainfall events are expected to increase the area and impacts of flood hazards without adaptive measures.

Current Mapped Flood Risk

Nearly all of Eastwick is mapped as being in the Federal Emergency Management Agency (FEMA) 0.2% (500-year) floodplain with significant residential areas also mapped in the 1% (100-year) floodplain. Nearly all of Eastwick is also vulnerable to a large coastal storm surge event where water could push in from the John Heinz National Wildlife Refuge, the Delaware River, or the Schuylkill River via Mingo Creek. Industrial facilities on the northeast end of Eastwick (west of Island Avenue and south of Lindbergh Boulevard) are particularly vulnerable to Natural Hazard-Triggered Technological Accident events. Eastwick's adjacency to the Philadelphia International Airport, the closed Clearview Landfill, and two tank farms present the risk of contamination spreading from adjacent areas into the Eastwick community in a large coastal or river flood.

Various community assets and facilities are also impacted by these current flood risks. These include the former Pepper School and Playground, 82nd & Lyons Park, Eastwick Library, Eastwick Community Garden, Fire Dept Engine 69, and the SEPTA Eastwick Regional Rail Station and track.

Extreme Heat

Although Eastwick has more tree canopy than many neighborhoods throughout Philadelphia, there are still urban heat island hotspots where air temperatures are locally elevated and higher than the regional average. Similar to other communities throughout the region, heat waves in the area are expected to last longer and occur more frequently due to climate change.

FLOOD ANALYSIS

WHAT CURRENT ASSETS & INDUSTRY ARE AT RISK FROM CURRENT & FUTURE FLOODING?

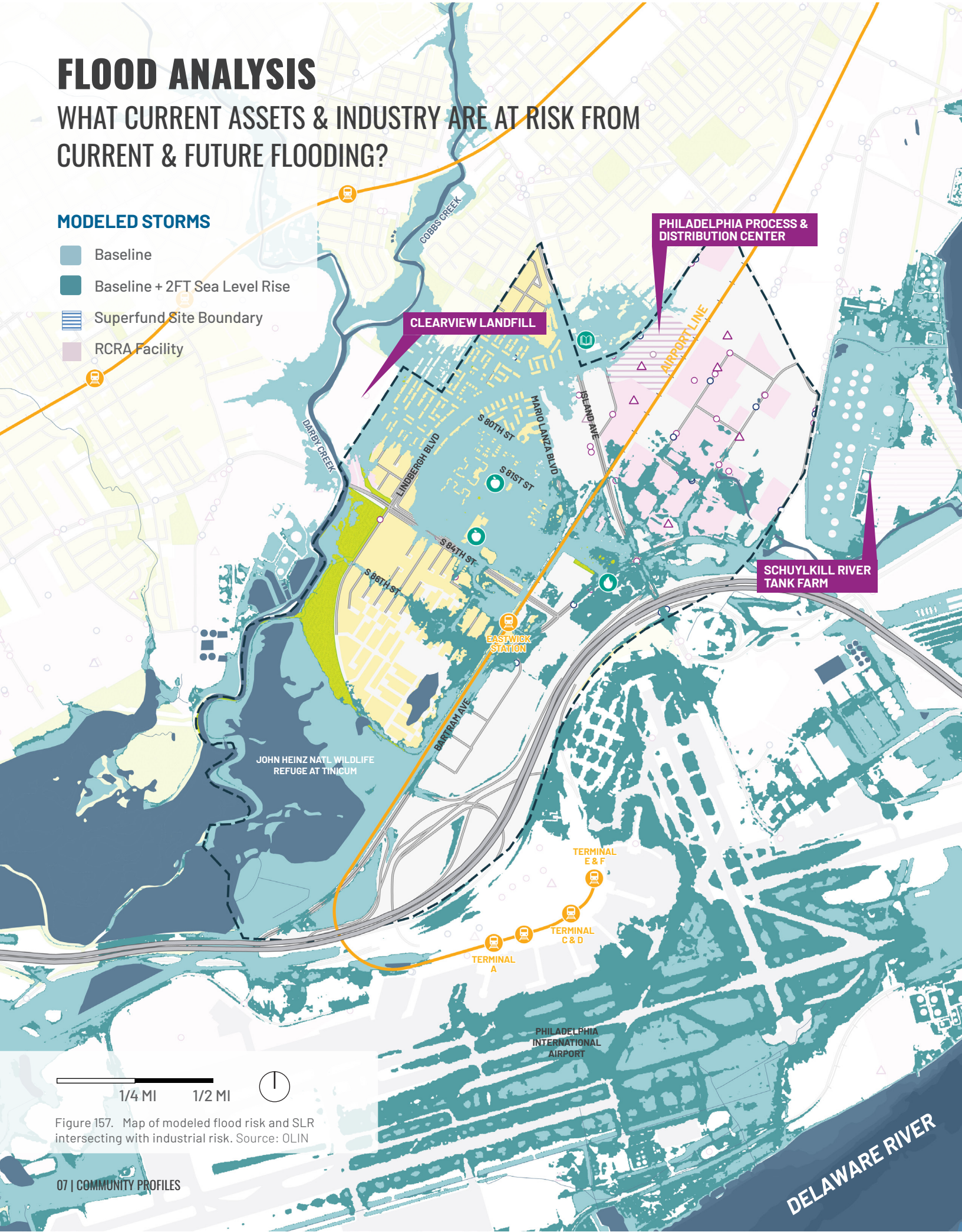


Figure 157. Map of modeled flood risk and SLR intersecting with industrial risk. Source: OLIN

Modeled Storms with Future Sea Level Rise

The map to the left shows a +2 feet sea level rise scenario and merges the flooding impacts of three modeled storms: Hurricane Ida (2021), Hurricane Isaias (2020), and Hurricane Sandy (2012). Areas shaded in light blue are those that likely flooded during these past storms, while those shaded in darker blue are additional areas that may flood if and when similar storms occur in the coming decades with expected sea level rise.

In these modeled storm events, the impact of future sea level rise is primarily seen in areas where the coastal flooding influence of the Delaware River is greatest. The overflowing of Darby and Cobbs Creeks in the modeled storms caused flooding at the baseline level throughout Eastwick. The impacts of sea level rise, however, are concentrated in the south and west of the community, due to coastal flooding from the John Heinz National Wildlife Refuge and the Schuylkill River via Mingo Creek.

Sea level rise brings additional flood risks to low-lying industrial facilities and warehouses in the southwest as well as the risks of contaminants spreading into the community from the nearby Philadelphia International Airport, the closed Clearview Landfill, and tank farms on either side of Eastwick, such as the Darby Creek Tank Farm. Storms and additional sea level rise also bring the risk of impacts like high wind and additional precipitation that can also cause industrial accidents at these facilities.

RECOMMENDATIONS

- **Short-term:** Site-or facility-level adaptation of critical and/or vulnerable facilities
- **Long-term:** Resilient Redevelopment Areas
- Nature-Based Solutions
- Proposed Resilience Parks
- Raising Infrastructure
- Proposed Shade-way Corridors
- Proposed Shoreline Barriers

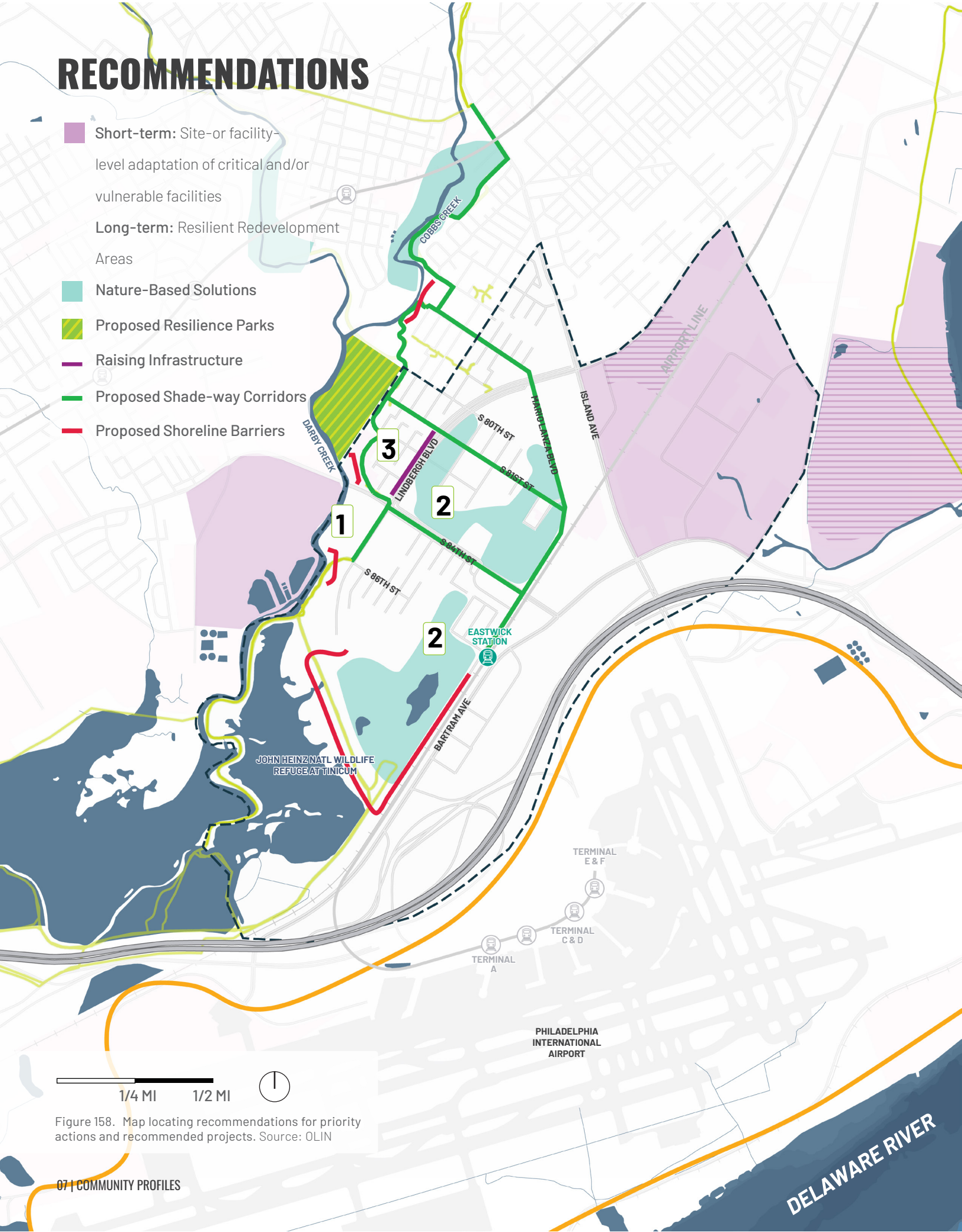


Figure 158. Map locating recommendations for priority actions and recommended projects. Source: OLIN

PRIORITY ACTIONS

- **Build on Community Organizing to Implement Planned Resilience Projects**

The Eastwick community has been dealing with flooding and environmental contamination and advocating for solutions and investment for decades. The ongoing Eastwick Flood Resilience Strategy project being led by the City of Philadelphia Office of Sustainability, along with the active involvement of the U.S. Army Corps of Engineers in implementing a levee along Cobbs Creek, are key steps forward in reducing the community's flood risk and increasing its resilienceresilience to climate change.

- **Prepare for increased flooding from sea level rise and storm surge**

While a majority of current flooding in Eastwick is caused by the overflowing of Cobbs Creek, hydraulic models show that, in the future, sea level rise will increase the risk of coastal flooding from the south. While the immediate priority is addressing riverine flooding caused by Cobbs Creek, planning should begin now on projects that can address future flood risks.

RECOMMENDED PROJECTS

1. The Eastwick Levee(s)

The construction of a levee along Cobbs Creek northeast of the Clearview Landfill is essential for lowering much of the river and coastal flood risk in Eastwick while allowing most residents to stay in their current homes. The ongoing study of the project by the U.S. Army Corps of Engineers should include a review of impacts and any needed mitigation up- and downstream of the levee site, as well as any additional levees needed to reduce the risk of overtopping the banks in other locations.

2. Nature-Based Solutions: Wetland Storage

Wetlands can help reduce the impacts of waves and coastal flooding and, further inland, can also help absorb and hold rainwater, reducing pluvial flooding caused by excessive rain. Wetlands and other nature-based solutions reduce some flooding while creating natural benefits such as clean air, natural habitats, and new community space. Wetlands are possible along Cobbs Creek (upstream of the levee site), between Eastwick and the John Heinz National Wildlife Refuge at Tinicum, and at the Pepper Bowl site—a former school that the City proposes converting into a wetland park. Further, residents have expressed a need for a hybrid facility at the Pepper Bowl site that could function as a recreational space when not inundated.

3. Retrofit Vulnerable Critical Infrastructure

Many buildings and facilities in Eastwick are vulnerable to flooding and require minor to significant retrofits to reduce the impacts of flooding. In addition to these building-level modifications, some major roads and evacuation routes including 84th Street., Lingbergh Boulevard., Bartram Avenue., Elmwood Avenue, and Island Avenue may need to be elevated or otherwise retrofitted to reduce flooding. Some of these streets might be suitable as cloudburst streets, which are multifunctional streets designed to drain water, to more effectively convey excess stormwater.

RECOMMENDATIONS

COMMUNITY RESILIENCE TOOLKIT FOR LOCAL PROJECTS



GREEN STORMWATER INFRASTRUCTURE

Continue to work with relevant City agencies to evaluate best locations for green stormwater infrastructure projects.

Many flood mitigation projects recommended for Eastwick focus on larger scale interventions. However, community desires for more public and active spaces should include green stormwater infrastructure elements, which can aid in localized, day-to-day flooding concerns and increase stormwater capacities in larger storm events. Facilities should be located on publicly owned open space or rights-of-way in upland locations, outside of flood and storm surge inundation areas, and contaminated soils, and where infiltration, retention, and detention practices will be most effective.

» *See: Eastwick from Recovery to Resilience*



COOLING CENTERS

Establish a designated cooling center in Eastwick.

Currently, no cooling centers exist in Eastwick. The City also designates Free Libraries as places of respite; Eastwick Public Library serves this purpose. However, there should be a designated cooling center that can serve multiple purposes when not needed as thermal relief. If located and floodproofed properly, this could act as a broader community resiliency center and a home base for disaster recovery efforts.



WATERFRONT ACCESS & AMENITIES

Continue prioritizing trail access that provide connections to larger ecological and open spaces.

While Eastwick does not have direct waterfront access, its location near John Heinz National Wildlife Refuge, Cobbs Creek, and Bartrams Garden provides the opportunity for good trail connectivity. Currently funded projects include the Cobbs Creek Trail Extension and a feasibility study for the Tinicum East Coast Greenway. Potential future projects should be evaluated at the Clearview Landfill for a long-term recreational space and trail connection to John Heinz.



TREE PLANTING

Plant trees along key corridors to prioritize pedestrian comfort.

As part of the remediation project at Clearview Landfill, many trees have been planted at the former landfill site. Eastwick also has a fairly dense tree canopy coverage. However, there are opportunities for further tree planting along key corridors like 84th Street and Lindbergh Boulevard as well as future open spaces to aid with thermal comfort and mitigate air pollution.

» *See: Philly Tree Plan (2023)*



SHADE-WAY CORRIDORS

Connect places within Eastwick and to other recreational assets like John Heinz National Wildlife Refuge with shade-way corridors.

Planned trails and connective links within Eastwick, like the East Coast Greenway, should also be considered as shade-way corridors. Providing additional shaded spaces and thermal comfort along pedestrian-oriented routes can encourage usage of these connection routes while also ensuring that thermal mitigation of the urban heat island effect is addressed.

» *See: Eastwick Trails Feasibility Study (2015)*



SPRAY FOUNTAINS & SPLASH PADS

Maintain existing spray grounds and consider adding additional water features at future recreational spaces.

Currently, there is a public sprayground at Eastwick Regional Park and just outside Eastwick's neighborhood boundary at J. Francis Finnegan Playground. Maintenance should be a priority for these existing water features as they can become key tools for mitigating extreme heat while also providing recreational benefits. Any future developments of park spaces or recreational spaces should also consider the addition of a water feature.



BUILDING RETROFITS

Ensure all residents are aware of existing municipal guides for flood-proofing homes and work with relevant City agencies to continuously update the guides as new climate projections emerge.

Philadelphia has multiple building retrofit and design guidelines, including ones that specifically address various types of flooding and for those living in Eastwick. These guides should be advertised and available to any current and future residents, including information on any assistance available. Relevant City agencies should continue to work on ensuring any flood-related design and building guidelines are up-to-date on current climate and flood projections.

» *See: Flood Ready Home Guides (OOS Guide for Eastwick), Flood Recovery Grant Program from Eastwick United CDC, A Guide to Flooding in Philadelphia (2017)*



DEPLOYABLE/TEMPORARY BARRIERS

Evaluate feasibility of deployable or temporary barriers in locations susceptible to flooding.

The U.S. Army Corps of Engineers is currently in the midst of a feasibility study for a permanent levee at Cobbs Creek, while the City is planning a Near-Term Flood Barrier Project, which uses a temporary HESCO barrier to mitigate moderate flooding. Outreach and consistent communication between government officials, the U.S. Army Corps of Engineers, and Eastwick residents is a priority as these barriers and levees get implemented.

» *See: Eastwick Flood Risk Management Study (2023), Eastwick: From Recovery to Resilience (City website)*



ENVIRONMENTAL MONITORING & MODELING

Ensure residents are aware of the various monitoring systems available.

Eastwick has several environmental monitoring systems in place, from air monitoring (via the City as well as via non-profits like the Clean Air Council and Philly Thrive) to flood emergency warning systems tailored for Eastwick residents. These various monitoring systems should be centralized in one location for ease of information and to ensure all residents are aware of the information available to them.

» *See: City of Philadelphia Air Quality Monitoring Network, Clean Air Council, Thrive Air Monitoring*



PAVEMENT REDUCTION

Study potential underutilized paved spaces for depaving and green stormwater infrastructure installations.

There are areas of impervious surfaces in Eastwick that can be considered for depaving and installation of green stormwater infrastructure programs, including areas concentrated along the commercial and industrial lots along Island Avenue.

RECOMMENDATIONS
REGIONAL ACTIONS



RAISING EDGES/SHORELINES: LEVEEES & FLOOD BARRIERS

Monitor implementation and design of proposed levees.

As progress continues for both the HESCO temporary barriers and the feasibility study of the Cobbs Creek Levee from the U.S. Army Corps of Engineers, the City and U.S. Army Corps of Engineers need to have constant monitoring of implementation and provide updates on any design evaluations.

While a permanent levee provides flood risk reduction, there is also a potential to provide multiple resiliency co-benefits by integrating nature-based solutions and recreational spaces. These can include pedestrian and bike paths adjacent and on top of the levee, playing fields, rain gardens, and additional planting. Doing so will integrate the levee more seamlessly into the neighborhood and turn it into an asset, instead of a standalone structure.

» *See: Eastwick Flood Risk Management Study (2023)*

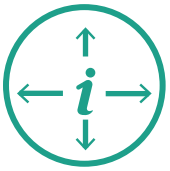


RAISING INFRASTRUCTURE

Identify strategic areas for raising infrastructure, prioritizing major roads and evacuation routes.

Costs to raise infrastructure can be prohibitive. The City should strategically identify key sites, infrastructure, and facilities vulnerable to flooding to either be raised for protection or adapted to accommodate floods.

In Eastwick, elevation of major roads and evacuation routes should be prioritized. This includes 84th Street, Lindbergh Boulevard, Bartram Avenue, Elmwood Avenue, and Island Avenue. Residents have previously observed incidents of whole road segments being inundated, effectively trapping them in their homes. Alongside raising these key routes, local street connections and additional flood protection and mitigation measures need to be implemented to ensure that residents are able to access any evacuation routes in times of emergency.



CENTRALIZATION OF CLIMATE RISK INFORMATION

Expand public information sharing.

The City should have a designated clearinghouse that collates all climate-related information and tracking, including emergency management and evacuation responses, from all City agencies. This ensures a coordinated response across all City agencies in the face of an emergency and that residents are able to access accurate, real-time information before, during, and after any incident. Information can then be broken down by neighborhood to ensure that residents are able to access neighborhood-specific information easily.

For Eastwick, the Office of Emergency Management has already implemented a pilot program for emergency alert systems through ReadyPhiladelphia. If not done so already, surveys should be taken to assess the system's effectiveness and next steps for improvement and full implementation.

NATURE-BASED SOLUTIONS

Work with the City to identify sites suitable for nature-based solutions pilot projects and where possible, integration of nature-based solutions into ongoing flood mitigation efforts.

When paired with other resiliency measures, nature-based solutions can provide environmental, economic, and social benefits. Ongoing flood mitigation efforts in Eastwick like the Cobbs Creek Levee can begin to integrate nature-based solutions programs into their design and implementation, enhancing both quality of life and benefits to residents. The City should also work to identify a site suitable for a pilot project; the former Pepper school, an abandoned low-lying site vulnerable to floods, may be one of those sites. However, further study and engagement with current residents is needed to determine flood capacities and efficacy in flood mitigation, as well as community support.

The John Heinz National Wildlife Refuge currently leads most efforts on nature-based solutions in Eastwick, although mostly within the Refuge's boundaries, such as the 55-acre Henderson restoration that reconnects tidal marshlands. Partnering with John Heinz for future nature-based solutions projects can help create a cohesive system of flood mitigation efforts that also support recreational and habitat benefits.

IMPROVED CONNECTIVITY

Continue expansion of connectivity projects and strengthen existing connections within Eastwick.

There are currently several trail expansion and connectivity projects ongoing in Eastwick: trail connections to John Heinz National Wildlife Refuge, a connection to the Eastwick Regional Rail Station, and the Island Avenue Improvement Project. There is also funding secured for a Cobbs Creek Trail Extension from Island Avenue to 80th Street. These inner-and inter-neighborhood connections are important for increasing connectivity within and out of Eastwick for transit access, recreational opportunities, and other public health and environmental benefits.

Local street connectivity to major routes and evacuation routes is critical in Eastwick. Flooding and damage to streets can also make emergency access and evacuation difficult; enhancing street connections can also help reduce risk by adding redundancy.

Various proposals have already been put forth for Eastwick. Ensuring that these proposals, like the levee, integrate co-benefits and prioritize continued communication with residents is key to building trust and bringing new dimensions of resiliency to the neighborhood.

RECOMMENDATIONS
POLICY

EMERGENCY MANAGEMENT

EFFECTIVE COMMUNICATION SYSTEMS

Philadelphia's Office of Emergency Management should continue to monitor the effectiveness and reach of its current place-based messaging program, Eastwick Alerts. Consider expanding the program to include communication on hazardous air quality information (considering the proximity of local junkyards) and other industrial accidents.

ENVIRONMENTAL MONITORING POLICIES & INCENTIVES

In partnership with the County, State, and environmental organizations, the City needs to incentivize and prioritize investments in environmental monitoring given Eastwick's proximity to major industrial hazards and polluters like the Philadelphia International Airport. The City should continue to monitor facilities' adherence to EPA-set standards for industrial pollution and provide robust information on its website.

EASTWICK ALERTS

Eastwick Alerts is a pilot place-based program and part of the Philadelphia Office of Emergency Management's free emergency alert system, ReadyPhiladelphia.

It sends alerts to Eastwick residents on upcoming storms that may result in flooding and of any current flooding as well as any recovery information.

To sign up for alerts: create a ReadyPhiladelphia account online or text READYPHILA to 888-777, and select "Eastwick" from subscription options.

STAYING IN PLACE

ANTI-DISPLACEMENT MEASURES

The City should enforce the Fair Housing Ordinance and work with local groups like Eastwick United Community Development Corporation to help educate tenants and landlords on their rights and responsibilities. Identify priority neighborhoods where action is needed to preserve affordable housing for existing low- to middle-income residents.

FAIR AND SAFE HOUSING PROGRAMS

The City should continue to expand access to its housing programs, such as Philly First Home, which offers assistance grants for first-time home buyers. The City should also allocate additional funding to address substandard housing, home rehabilitation and flood mitigation efforts. Residential redevelopment should be incentive only on upland, vacant sites that are not vulnerable to flooding.

WORKFORCE DEVELOPMENT & LAND INITIATIVES

The City should include access to high quality job opportunities and job training for any new developments in Eastwick, prioritizing local residents for jobs. It should further initiate a working group to anticipate growing employment sectors and work with local academic institutions and employers to provide periodic skills training and education at all age levels.

PHYSICAL INTERVENTIONS

GREEN STORMWATER INFRASTRUCTURE POLICIES AND INITIATIVES

The City should establish policies that require any new impervious surface to be offset with Green stormwater infrastructure. In collaboration with the Philadelphia Water Department, the City should develop a local Green stormwater infrastructure plan that works in conjunction with other flood mitigation measures in place, like the Cobbs Creek Levee, and identify incentivization tools and additional funding through grants for implementation.

UPLAND MITIGATION OF CREEKS AND STREAMS

The City should coordinate with upland townships and counties to implement the Darby Creek River Conservation Plan. Prioritize conservation, restoration, and green infrastructure throughout the watershed.

IMPROVED FLOODPLAIN CONSTRUCTION STANDARDS

The City should set more stringent standards for municipal projects and new development, like limiting new construction within the 1% (100-year) FEMA floodplains. It can implement tools and incentives for private landowners and developers to discourage building in the floodplain. The City should also periodically review floodplain and building elevation standards against the most current FEMA flood predictions and risk data to update standards as needed.

STORM DRAIN INFRASTRUCTURE & MAINTENANCE

The City should study existing stormwater infrastructure capacity and review past flood and overflow events to identify where storm drain infrastructure needs to be updated. Support public works, streets, and other government department training and maintenance programs.

INDUSTRY

ARMOR, RAISE, PROTECT

The City should evaluate facilities with the capabilities to enact near-term protection plans and incentivize retrofit programs.

EVACUATION ROUTES & LOCAL RECOVERY PLANS

The City should work with local residents to understand current obstacles to access for evacuation routes, as past flood events have inundated local roads before. Establish a local recovery and emergency response plan specific to Eastwick, including information on gathering places and disaster relief. Review current evacuation routes alongside state and industrial facility evacuation plans and facilitate outreach programs with the public to ensure all residents have the most current information.

SITE-SPECIFIC DECOMMISSION PLANNING

The City should plan for the eventual closure and/or redevelopment of the major fossil fuel facilities in the community.

GRAYS FERRY

Grays Ferry is changing, but the legacy of health harms and contamination from the closed PES Refinery continue to plague the neighborhood.

HISTORY

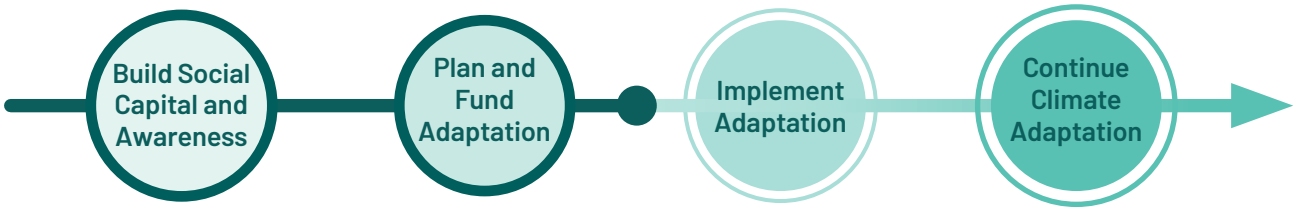
Situated along the eastern banks of the Schuylkill River, the area known today as Grays Ferry was once home to Lenni Lenape."[25] After European settlement, the area's location on the river proved to be a vital transportation link and helped establish Grays Ferry as an important commercial hub in early Philadelphia history.

In the 18th century, Grays Ferry was also known for its pleasure gardens known as Grays Gardens. However, 19th century industrialization transformed the neighborhood as factories, mills, and warehouses proliferated along the waterfront.[26] While remnants of this botanic history remain through Bartram's Gardens (located across the Schuylkill River), the neighborhood fabric became much more oriented towards manufacturing.

For many years, Grays Ferry was overshadowed by its neighbor, the 1300-acre Philadelphia Energy Solutions (PES) Refinery, formerly known as the Atlantic Refining Company. Philadelphia emerged as a major petroleum hub in the mid-19th century due to its location on the Schuylkill River. Refineries, storage tanks, pipelines, and railway lines began to take hold. By 1891, 50 % of the world's illuminating fuel and 35 % of U.S. petroleum exports were coming from the Atlantic Refining Company.[27] At the same time, industrial growth attracted more residents to the area and, at the turn of the 20th century, the neighborhood had over 30,000 residents, many of whom were employed in local factories and in the petroleum industry. Residents grew up next to the Refinery, which had long contaminated the soils, air, water, and bodies of those living next to the complex. Studies have revealed troubling health outcomes such as high rates of cancer and asthma that derived from living in close proximity to the refinery.[28]

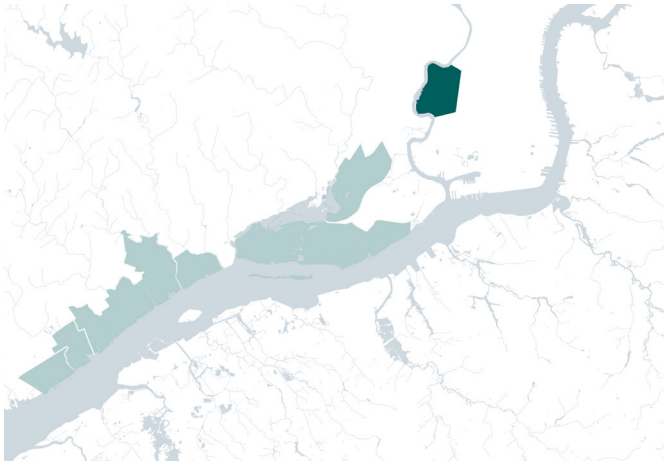
There are signs of shifting industries and other changes in Grays Ferry. Pennovation, a technology and innovation hub now anchors the northern portion of the neighborhood while a redevelopment of the former Refinery site aims to shed its petroleum past by turning it into a commercial and industrial complex.[29] Lingering impacts and risks of contamination still plague the neighborhood and its residents. Flooding and sea level rise remains a concern, as do other effects of climate change like extreme heat. Meanwhile, the neighborhood's proximity to Center City and University City means that younger, more affluent residents are starting to move into the predominantly non-White, working class, and older community.

Significant investments in industrial sites around Grays Ferry should be coupled with fairly negotiated community benefit agreements that can help ensure new projects are healthier and more climate adaptive.



GRAYS FERRY

BY THE NUMBERS



DATA: ACS COMMUNITY SURVEY, 2022

RACE & ETHNICITY

54%
NON-HISPANIC BLACK

8%
HISPANIC / LATINO

MEDIAN AGE

34.5

POPULATION

15,000
TOTAL

7,500
DENSITY per sq mile

INCOME

27%
BELOW POVERTY LINE

HOUSING

46%
OWNER-OCCUPIED UNITS

54%
RENTER-OCCUPIED UNITS

LANDUSE

30%
OPEN SPACE

14.8%
INDUSTRIAL



Figure 159. Former PES Refinery site. Source: OLIN



Figure 160. Industrial remnants in Grays Ferry. Source: OLIN

COMMUNITY PROFILE

GRAYS FERRY

Grays Ferry has a large low-lying area where former industry once stood along the Schuylkill waterfront. A rail freight line cuts through this industrial zone which slopes upwards to a residential neighborhood which is flanked by Route 76 and the 25th Street Viaduct on either side. There are smaller parks that dot the neighborhood such as the Smith Playground.

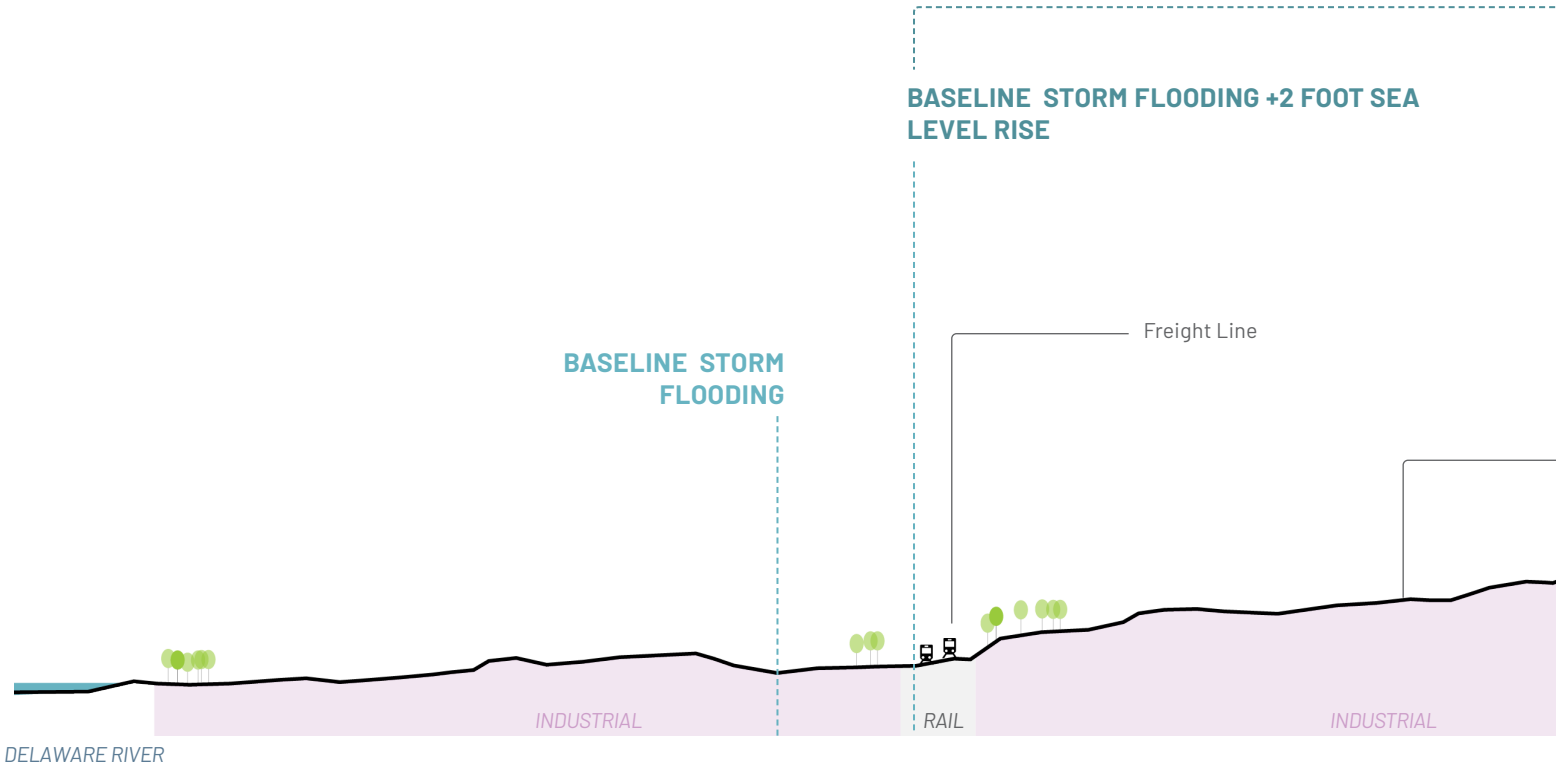
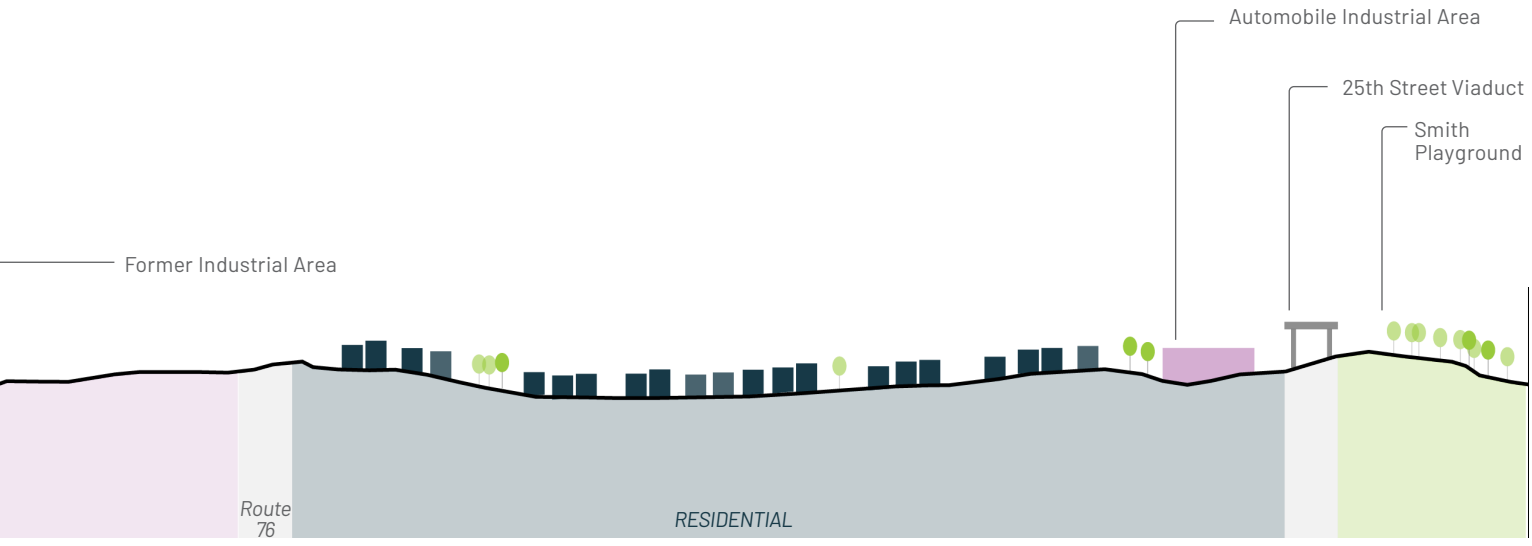


Figure 161. Illustrative section through Grays Ferry depicting typical land use. Source: OLIN

**VERTICALLY SCALED 500%*

IN A MODELED STORM SURGE +2 FOOT SEA LEVEL RISE SCENARIO, THE LOW LYING FORMER INDUSTRIAL AREA WILL BE IMPACTED



COMMUNITY ASSETS

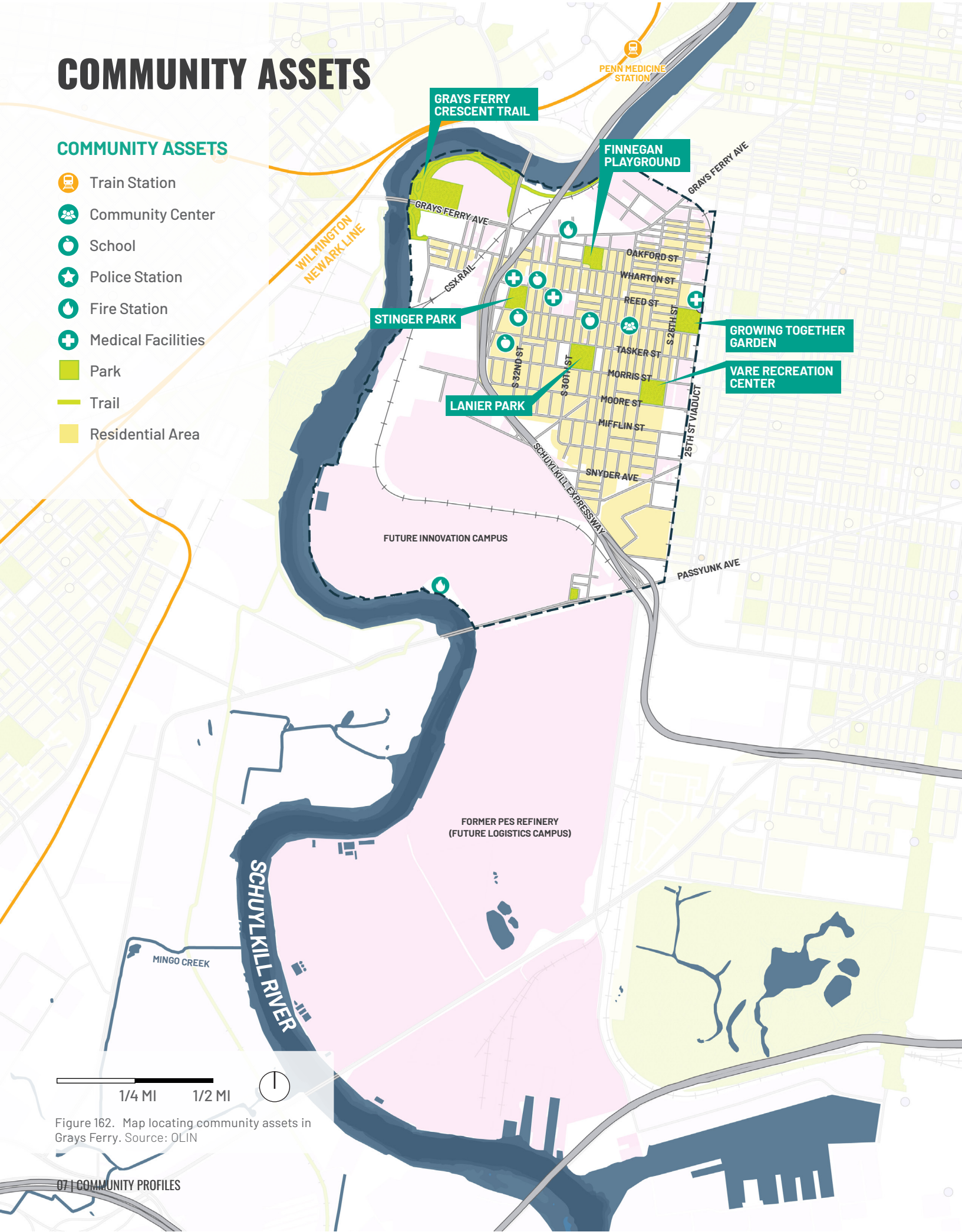


Figure 162. Map locating community assets in Grays Ferry. Source: OLIN

Grays Ferry's key community parks-Stinger Park, Finnegan Playground, Lanier Park, and Vare Recreation Center-are well integrated into the neighborhood and used heavily by residents. Vare Recreation Center recently received a $20 million investment through the Rebuild Initiative to renovate and revitalize the site's existing basketball courts, playing fields, and recreational building.[30]

Grays Ferry's proximity to the Schuylkill River also means that there is waterfront access and amenity space via the Grays Ferry Crescent Trail and park space, which occupies former industrial land. There are meadow and lawn areas as well as active recreation areas for skateboarding and fishing. Completed segments now connect the trail north to the Center City sections of the Schuylkill River Trail via the recently finished Christian to Crescent bridge, while final work is underway to link the trail south to Bartram's Mile via the nearly completed Schuylkill Crossing bridge. This will help address concerns that residents have expressed that the trail and park feel disconnected and isolated from the neighborhood; the difficulty of reaching the park has deterred people from using it more often.

Future open spaces may be available to Grays Ferry residents with the development of the HRP Group (formerly Hilco) site at the former PES Refinery. Current conceptual plans revealed to the public show waterfront trails and access; however, it is unclear how it will connect to the neighborhood and it's overall accessibility to the public.



Figure 164. Cleanup event at Stinger Square Park.
Source: Philadelphia Parks and Recreation


Figure 163. Growing Together Community Garden. Source: OLIN

CONTAMINATION IN THE AREA

INDUSTRIAL SITES

- EPA Risk Management Program Site
- PADEP Water Pollution Control Site
- PADEP Air Emission Plant

BROWNFIELD SITES

- EPA Underground Storage Tank
- RCRA - Active Site
- NPL Superfund Site
- PADEP Aboveground Storage Tank
- Superfund Site Boundary
- RCRA Facility



Figure 165. Map identifying industrial facilities and brownfield sites in Grays Ferry. Source: OLIN

Former PES Refinery/Bellwether District

The dominant industrial landscape of Grays Ferry is the 1300-acre, former PES Refinery site that lies immediately east and south of the neighborhood. Now a future commercial facility development known as the Bellwether District, the former oil refinery was the largest and oldest operating refinery on the East Coast and was used for petroleum transportation, storage, and processing.

More than 150 years of heavy industrial activity resulted in chronic air, soil, and water contamination, while major disasters like the 2019 fire that caused the facility to permanently shut down caused massive risks to human health and increased toxic emissions. Contaminants of notable concern include the air contaminant, benzene, and lead contamination in the soil, alongside other petroleum-related contaminants such as ethylbenzene and xylenes.[31] Early environmental investigations took place in the 1990s as part of the Resource Conservation and Recovery Act Corrective Action Permits and, in 2006, Sunoco formally submitted a Notice of Intent to Remediate to the Pennsylvania Department of Environmental Protection .[32] The full depth of contamination and hazards at the complex and in surrounding neighborhoods is hard to gauge and will likely be a cause of concern for many years to come.

Under the site's new ownership, HRP Group (formerly Hilco) is now responsible for all spills and contamination that have occurred there since 2012.[33] The developers plan to cap and raise the site, distributing soil across the site and using newly constructed barriers like building foundations and parking lots to help contain contaminants in the ground, which is also one of the main strategies to address flooding risks.



Figure 166. Regrading of on-site soils at the former PES Refinery. Source: OLIN

CURRENT & MODELED FLOOD RISK

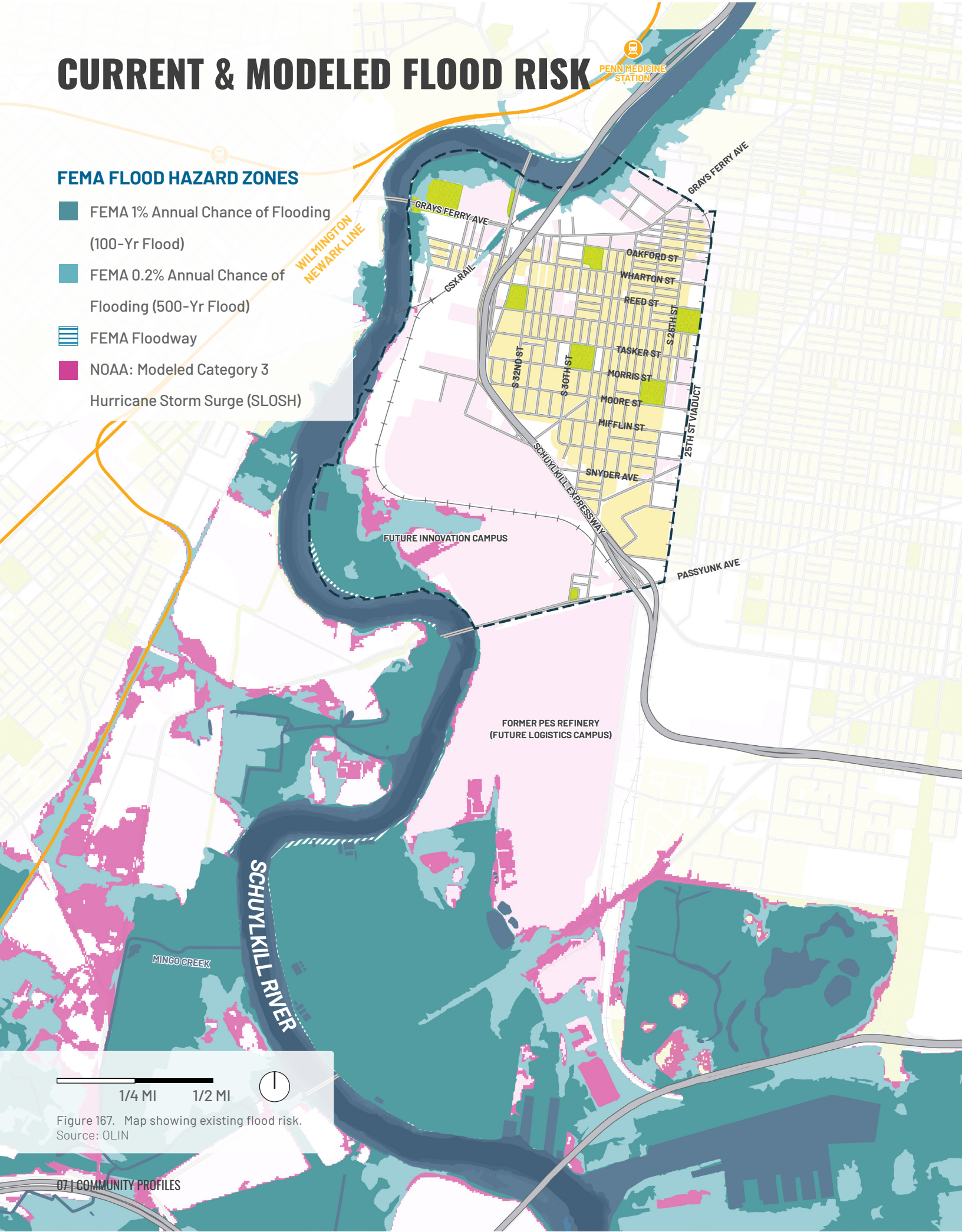


Figure 167. Map showing existing flood risk.
Source: OLIN

Flood Risk

Flooding in Grays Ferry is mostly fluvial, when large storm events produce heavy rains upstream causing the Schuylkill River to overflow its banks. Due to its large areas of impervious surfaces, inland flooding is also possible where water collects in low-lying areas or can't drain fast enough through the storm drain network. Sea level rise may lead to some minor increased flooding along the Schuylkill River.

Current Mapped Flood Risk

The Federal Emergency Management Agency's (FEMA) flood hazard areas are limited to areas along the Schuylkill River with some possible impacts along 34th Street and the freight rail line adjacent to the river. Much of the adjacent former Refinery site is located in the river's floodplain and is being elevated with fill. Additional studies are needed to determine how changing these floodplains may offset flood waters to other areas, increasing flood risk elsewhere.

Extreme Heat

Due to low tree canopy (5.5%), large areas of impervious surfaces, and numerous nearby air pollution sources, Grays Ferry is exposed to the urban heat island effect and air temperatures much higher than the regional average. Similar to other communities throughout the region, heat waves here are expected to last longer and occur more frequently due to climate change.



Figure 168. Schuylkill River along the former PES Refinery site. Source: OLIN

FLOOD ANALYSIS

WHAT CURRENT ASSETS & INDUSTRY ARE AT RISK FROM CURRENT & FUTURE FLOODING?

MODELED STORMS

- Baseline
- Baseline + 2FT Sea Level Rise
- Superfund Site Boundary
- RCRA Facility



Figure 169. Map of modeled flood risk and sea level rise intersecting with industrial risk. Source: OLIN

Modeled Storms with Future Sea Level Rise

Generally, the Grays Ferry neighborhood is elevated enough to not be significantly impacted by sea level rise. Of the baseline storm events, Hurricane Ida (2021) produced the most flooding in Grays Ferry, however the addition of 2 feet of sea level rise would mostly only increase flooding along the Schuylkill River south of Grays Ferry Avenue.



Figure 170. Much of the existing PES Refinery site is being regrading and raised up out of the floodplain, potentially displacing floodwater onto other nearby sites. Source: OLIN

RECOMMENDATIONS

Short-term: Site- or facility-level adaptation of critical and/or vulnerable facilities

Long-term: Resilient Redevelopment Areas

Raising Infrastructure

Proposed Shade-way Corridors

Proposed Shoreline Barriers

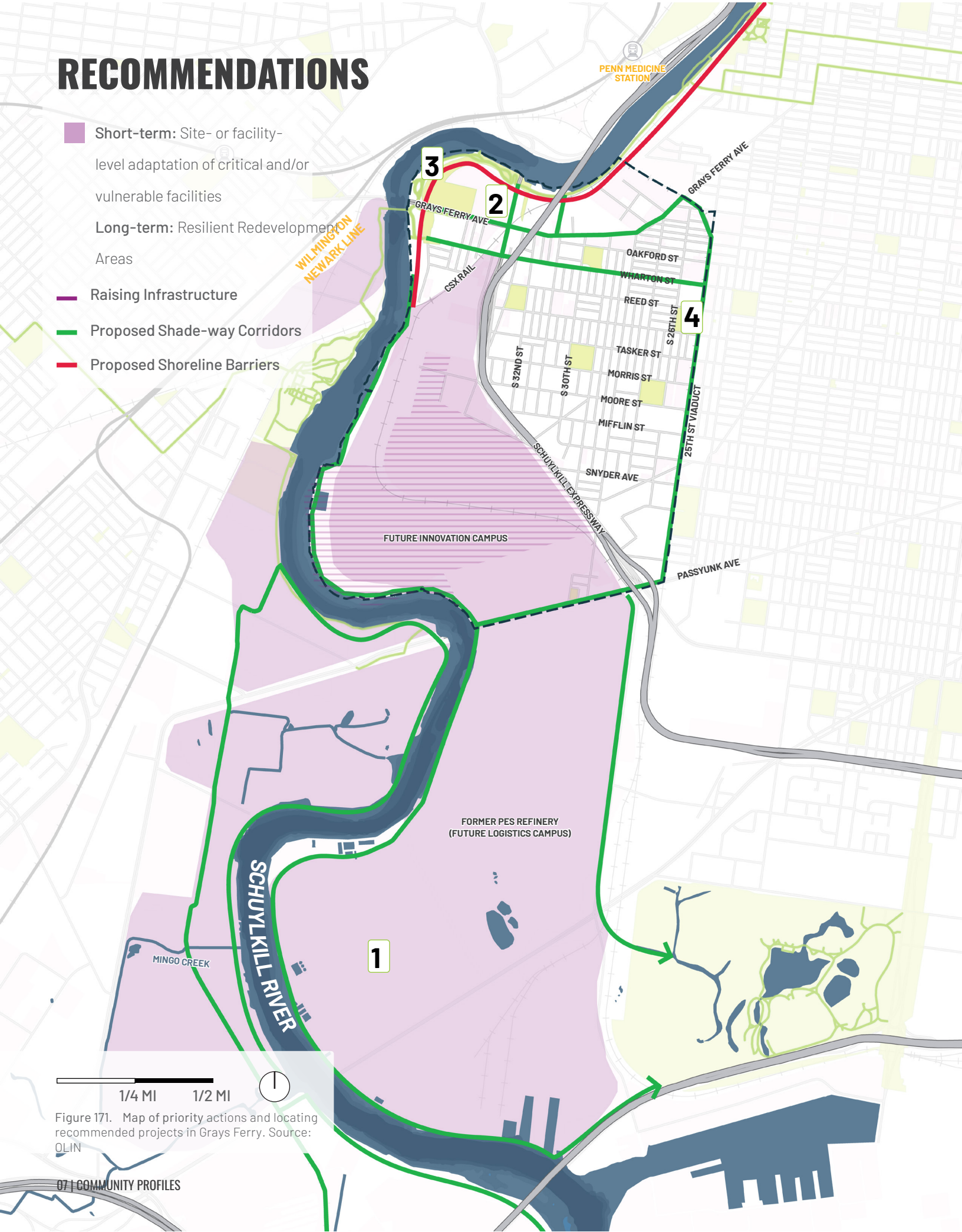


Figure 171. Map of priority actions and locating recommended projects in Grays Ferry. Source: OLIN

PRIORITY ACTIONS

- **Mitigate Against Extreme Heat**

Grays Ferry has just 5.5% tree canopy cover compared with the City goal of 30%. Tree planting should be prioritized on vacant and redeveloping sites as well as along key streets and the Schuylkill River. Improve access to shaded open spaces and the Schuylkill River, create additional spraygrounds and cooling/resilience centers and plant more trees along key pedestrian routes.

- **Reduce Inland Stormwater Flooding Hotspots**

Members of the Grays Ferry community have reported inland flooding hotspots where local street flooding and basement flooding are recurring issues. Additional green infrastructure and other stormwater reduction measures should be studied to reduce these impacts.

- **Improve Safe Connections to Regional Trails**

Grays Ferry is located close to downtown Philadelphia and the Schuylkill River, but many residents feel unsafe walking and biking. Additional investments such as protected bike lanes and reducing pedestrian crossing distances are needed at major roads and infrastructure that border the neighborhood.

- **Build on Community Organizing to Advocate for More Monitoring and Regulation of Adjacent Industrial Land Uses**

Grays Ferry was a fenceline community to the adjacent Refinery property for over a century. As it transitions to its next use, continued monitoring is needed of both the deconstruction and construction process as well as the future uses to ensure that pollution and contamination from the site do not continue to harm the adjacent community.

RECOMMENDED PROJECTS

1. Advocate for Resilient Redevelopment of the Former PES Refinery Site

Integrate nature-based solution at the shoreline, focusing on modeling and mitigating the impacts of site fill. Elevated portions of the site should be tied into adjacent levees or flood control structures to enhance resilience. Measures should be taken to protect low-lying freight rail lines, manage stormwater on-site, and prevent the mobilization of legacy contaminants during floods. Since Philadelphia Gas Works operates within the former PES Refinery site, steps must be taken to protect the facility to prevent a potential Natural Hazard-Triggered Technological Accident hazard. Renewable energy production should be incorporated with public access to a continuous riverfront landscape and efforts to exceed the City's goal of a 30% tree canopy coverage.

2. Schuylkill River Trail/East Coast Greenway Connections Improvements

Improved connections from the Grays Ferry neighborhood to the Schuylkill River Trail/East Coast Greenway. With the Christian to Crescent expansion now complete, the focus should turn to studying neighborhood connectors and shade-ways to complement the recently improved bike and pedestrian infrastructure along Wharton St, Grays Ferry Ave, and 34th St.

3. Schuylkill River Flood Risks Study and Possible Retrofits and Barriers

Hurricane Ida (2021) led to near-record flooding along the Lower Schuylkill River, inundating the Vine Street Expressway and the residential neighborhoods north of Grays Ferry including Fitler Square and Devil's Pocket. Building and infrastructure retrofits or a continuous levee or barrier extending into Grays Ferry and potentially south into the redeveloping Bellwether District should be considered to reduce future flood risk.

4. Growing Together Garden

See Early Action Project (p216-217).

RECOMMENDATIONS

COMMUNITY RESILIENCE TOOLKIT FOR LOCAL PROJECTS



GREEN STORMWATER INFRASTRUCTURE

Continue to work with City agencies and residents to prioritize best locations for green stormwater infrastructure projects.

There is one current, Philadelphia Water Department-initiated green stormwater infrastructure project in the design phase at Wharton Square for a rain garden. Other completed green stormwater infrastructure projects include locations at Stinger Square, Lanier Playground, and Vare Recreation Center. More public- and private-initiated projects should be considered at other open spaces like Donald Finnegan Playground, alongside tree planting and pavement reductions at streets that are commonly flooded.

» *See: Grays Ferry Healthy Corridors*



COOLING CENTERS

Evaluate the feasibility of an additional cooling and community center.

There are several spraygrounds in Grays Ferry but there is only one indoor center listed by the City, which is at the Greater Grays Ferry Senior Center, a Philadelphia Housing Authority Senior site. Existing indoor recreation centers should be considered for designation as a cooling center, like Vare Recreation Center. Grays Ferry residents have also expressed desire in prior engagement meetings for an additional resiliency and/or community center focused on senior and youth programs. An additional center can serve these social functions as well as serve as a cooling center and resiliency hub for any future disaster recovery efforts.



WATERFRONT ACCESS & AMENITIES

Prioritize safe access to the Grays Ferry Crescent Trail and Park and expand waterfront trails

The Grays Ferry Crescent Trail expansion is complete with connection to the larger Schuylkill River Trail network and to Bartram's Mile. However, residents have previously expressed safety concerns about accessing the current park and trail. Ensure there are safe road crossings, lighting, and viewsheds when accessing the waterfront park from the neighborhood, especially along Wharton Street and include more neighborhood access points.



TREE PLANTING

Collaborate with government agencies, non-profits, private organizations, and residents to prioritize tree planting programs in the neighborhood.

Grays Ferry was listed as a priority area in the Philly Tree Plan with only 5.5 % canopy cover in comparison to the City goal of 30 %. All tree planting efforts by any City agency or organization should work closely with residents to prioritize locations and ensure cooperation from any commercial, industrial, or otherwise private land owner.

» *See: Philly Tree Plan (2023)*



SHADE-WAY CORRIDORS

Prioritize shade along heavily trafficked corridors.

Alongside tree planting efforts, shaded areas should be prioritized along heavily trafficked corridors, including: Grays Ferry Avenue, Wharton Street, and 34th Street.



SPRAY FOUNTAINS & SPLASH PADS

Continue maintenance of existing spraygrounds.

There are several spraygrounds and water features already within Grays Ferry at William Lanie Park, Wharton Square, and Thomas B. Smith Recreation Center. Ensure there is continued maintenance and upkeep of these recreational assets.



BUILDING RETROFITS

Ensure all residents are aware of existing municipal guides for flood-proofing homes and work with relevant City agencies to continuously update the guides as new climate projections emerge.

Philadelphia has multiple building retrofit and design guidelines, including ones that specifically address the various types of flooding and for those living in Grays Ferry. These guides should be advertised and available to any current and future residents, including information on any assistance available. Relevant City agencies should continue to work on ensuring any flood-related design and building guidelines are up-to-date on current climate and flood projections.

» *See: Flood Ready Home Guides (OOS Guide for Eastwick), Flood Recovery Grant Program from Eastwick United CDC, A Guide to Flooding in Philadelphia (2017)*



DEPLOYABLE/TEMPORARY BARRIERS

Evaluate the feasibility of temporary barriers to protect critical infrastructure and facilities along the Schuylkill River shoreline.

No known levee or barriers are planned for the neighborhood or the redevelopment of the former Refinery site. However, officials and responsible agencies should evaluate future flood risk along the shoreline and its impact on critical infrastructure/facilities and whether temporary barriers are a feasible solution in this area.



ENVIRONMENTAL MONITORING & MODELING

Ensure residents are aware of the various monitoring systems available.

Various monitoring systems are in place for the areas around Grays Ferry, from community monitoring (Thrive Air Project) to City-mandated monitoring. Due to ongoing contamination concerns and ongoing construction work at the Bellwether District (former PES Refinery site), increased fenceline monitoring should be implemented and information made available to residents.

» *See: City of Philadelphia Air Quality Monitoring Network, Clean Air Council, Thrive Air Monitoring*



PAVEMENT REDUCTION

Study potential underutilized paved spaces for depaving and green stormwater infrastructure installations.

Areas of high imperviousness, like along the commercial and industrial lots north of Grays Ferry Avenue, west of I-76, and along South 25th Street, should be evaluated and studied for their potential for depaving and green stormwater infrastructure installations.

RECOMMENDATIONS

EARLY ACTION PROJECT



GROWING TOGETHER GARDEN

SITE CONTEXT

The Church of the Redeemer Baptist Growing Together Garden is located on a large lot along the western edge of Grays Ferry and is bordered by Reed Street to the north, 25th Street and the 25th Street Rail Viaduct to the east, Dickinson Street to the south, and 26th Street to the west. The site has a high point at its center while the western half has a grid of over 400 community garden plots that are reserved by gardeners. The site is fenced with locked gates for access at the corners of Reed and 25th Streets and at 25th and Dickinson Streets.

DESIGN CONCEPT

The project is organized around siting a new native plant garden at the corner of the lot at Reed and 26th Streets, where water from up to a fourth of the site drains. While trees were considered along the property boundary to provide south-facing shade along the Reed St sidewalk, due to stormwater and slope limitations, the garden focuses on native planting instead. Native plants that are suited to the climatic conditions are selected as they help contribute to the restoration of native ecosystems.



Figure 174. Tending to plants in the Growing Together Garden. Source: CAC.

PROJECT COMPONENTS

Picnic and Gathering Space
- Information stands
- Site furnishings

Native Garden Planting
- Shrubs/groundcover

LONG-TERM RECOMMENDATIONS:

This site should continue to be protected and preserved as a community garden space.

RECOMMENDATIONS

REGIONAL ACTIONS



RAISING EDGES/SHORELINES: LEVEEES & FLOOD BARRIERS

Evaluate strategic locations for levees, berms, or hardened shorelines.

Studies should be conducted to evaluate the efficacy of a levee along the Schuylkill River and along the Crescent River Park and Trail, which can provide some measures of flood protection. However, shoreline hardening and levees are costly and can cause downstream effects, so strategically locating them and ensuring they have adaptive capacity will be key as climate projections change over time.

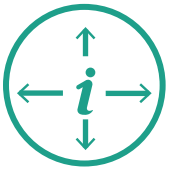
Meanwhile, more local barriers should be studied specifically for the upcoming commercial and industrial Bellwether District on the former PES Refinery site. Despite raising the site, flooding may still pose a problem and fortification of the Lower Schuylkill River may be required. The City, HRP Group (formerly Hilco), and other involved agencies should conduct further studies into how much additional flood protection is needed after elevating the site.



RAISING INFRASTRUCTURE

Consider elevating critical infrastructure at the waterfront.

In Grays Ferry, most of the flooding risk is located and contained to the waterfront areas. With most residential areas set back from the waterfront, only necessary, critical infrastructure should be raised. This includes freight lines connecting to the larger freight rail network and areas of Grays Ferry Avenue, which serves as major routes to other parts of the city in the event of an emergency.



CENTRALIZATION OF CLIMATE RISK INFORMATION

Establish a public, centralized platform to integrate information across city agencies and industry.

The City should have a designated clearinghouse that collects all climate-related information and tracking, including emergency management and evacuation responses, from all City agencies. This ensures a coordinated response across all City agencies in the face of an emergency and that residents are able to access accurate, real-time information before, during, and after any incident. Information can then be broken down by neighborhood to ensure that residents are able to access neighborhood-specific information easily.



NATURE-BASED SOLUTIONS

Identify shorelines and open space along the waterfront for larger nature-based solution installations.

Nature-based solutions (NBS) projects at the Grays Ferry Crescent Trail Park should be evaluated for their feasibility as future trail extensions are being built. In conjunction with a study of raised infrastructure and/or levees, riparian buffers and wetlands can be deployed in the area to help mitigate flooding. However, further study will be required at these locations as there has been a history of industrial use of the land with potential site contamination still lingering.

The City and the Philadelphia Water Department should continue to work to implement smaller NBS projects (like rain gardens, as mentioned in the toolkit) in community gardens, public parks, and right-of-ways.



IMPROVED CONNECTIVITY

Continue expansion of connectivity projects and strengthen neighborhood connections to the waterfront.

As multiple trail extension projects are completed or near completion in Grays Ferry (the Christian-to-Crescent trail and bridge, Bartram's Mile connector bridge), connectivity needs to be prioritized via safe access to these waterfront trails and spaces (see "Waterfront Access" in the toolkit section) to encourage expanded use. The City should also consider adding more on-road bike lanes and bike protection, especially along Grays Ferry Avenue, to encourage more bike use and multimodal connectivity to other areas in the city.

Grays Ferry faces potential, substantial transformation as gentrification, land use changes, and climate change reshape this once-industrial neighborhood. These regional recommendations need to be closely coordinated with smaller-scale local projects and policy changes to create a comprehensive resiliency strategy.

RECOMMENDATIONS

POLICY

EMERGENCY MANAGEMENT

EFFECTIVE COMMUNICATION SYSTEMS

Philadelphia's Office of Emergency Management should expand its place-based messaging program to include Grays Ferry (and eventually, all other communities particularly vulnerable to flooding and/or industrial impacts). Work with local advocacy groups to integrate local monitoring data on air quality.

ENVIRONMENTAL MONITORING POLICIES & INCENTIVES

In partnership with the County, State, and environmental organizations, the City needs to incentivize and prioritize investments in environmental monitoring given Grays Ferry's historic and current exposure to industrial pollution. Ensure all residents know where to access monitoring information and how to advocate for better compliance. The City should continue to monitor the Bellwether District development and its adherence to EPA-set standards for industrial pollution and provide ongoing information on its website.

ARLENE THORPE TOWNHOMES

In partnership with the Philadelphia Housing Authority, the Women's Community Revitalization Project (WCRP) completed a 27-unit affordable housing development in Grays Ferry. The land used to be City-owned lots which were donated to a community land trust, ensuring the townhomes remain affordable.

WCRP is subsidizing 12 units with a portion of the developer fees while Philadelphia Housing Authority is subsidizing the rest. Monthly rents range from $282 for a one-bedroom apartment to $890 for a three-bedroom unit.

STAYING IN PLACE

ANTI-DISPLACEMENT MEASURES

The City should enforce the Fair Housing Ordinance and establish a local community development corporation to help educate tenants and landlords on their rights and responsibilities. Identify priority neighborhoods where action is needed to preserve affordable housing for existing low- to middle-income residents.

FAIR AND SAFE HOUSING PROGRAMS

The City should continue to expand access to its housing programs, such as Philly First Home which offers assistance grants for first-time home buyers. The City should also allocate additional funding to address substandard housing and home rehabilitation and flood mitigation efforts. Residential redevelopment should be incentivized only on upland, vacant sites that are not vulnerable to flooding and in the Philadelphia Land Bank. Other tools include expanding public-private partnerships to fund affordable housing in the neighborhood, such as the recent partnership between the Philadelphia Housing Authority and the nonprofit Women's Community Revitalization Project to subsidize the Arlene Thorpe Townhomes.[34]

WORKFORCE DEVELOPMENT & LAND INITIATIVES

The City should include access to high quality job opportunities and job training for any new development in Grays Ferry, prioritizing local residents for jobs. It should initiate a working group to anticipate growing employment sectors and work with local academic institutions and employers to provide periodic skills training and education at all age levels. Continue implementation and monitoring of the Community Benefits Commitment (CBC) with HRP Group (formerly Hilco) to ensure all funding is allocated to local improvements and jobs.

PHYSICAL INTERVENTIONS

GREEN STORMWATER INFRASTRUCTURE POLICIES AND INITIATIVES

The City should establish policies that require any new impervious surface to be offset with green stormwater infrastructure (GSI). In collaboration with the Philadelphia Water Department, the City should continue exploring opportunities for GSI projects in Grays Ferry and identify incentivization tools and additional funding through grants for implementation.

IMPROVED FLOODPLAIN CONSTRUCTION STANDARDS

The City should set more stringent standards for municipal projects and new development, like limiting new construction within the 1% (100-year) FEMA floodplains. The City and HRP Group (formerly Hilco) should review building elevations and necessary fill required for the Bellwether District against most current FEMA flood predictions and risk assessments.

STORM DRAIN INFRASTRUCTURE & MAINTENANCE

The City should study existing stormwater infrastructure capacity and review past flood and overflow events to identify where storm drain infrastructure needs to be updated. Support public works, streets, and other government department training and maintenance programs.

INDUSTRY

ARMOR, RAISE, PROTECT

The City should evaluate facilities with the capabilities to enact near-term protection plans and incentivize retrofit programs.

EVACUATION ROUTES & LOCAL RECOVERY PLANS

The City should establish a local recovery and emergency response plan specific to Grays Ferry, including information on gathering places and disaster relief. Review current evacuation routes alongside state and industrial facility evacuation plans and facilitate outreach programs with the public to ensure all residents have the most current information..

SITE-SPECIFIC DECOMMISSION PLANNING

The City should plan for the eventual closure and/or redevelopment of the major fossil fuel facilities in the community.

ENDNOTES

1 "Borough History." Accessed November 14, 2024. https://marcushookboro.org/index.asp?SEC=13150BA2-FAEC-4FAB-8BB1-8E0DE1AB1960&DE=E911EDAD-D9F4-4988-ABFB-2C87177A7143&Type=B_BASIC.

2 "Brief History of Trainer." Accessed November 14, 2024. http://www.trainerboro.com/history/.

3 "Borough History."

4 "Brief History of Trainer."

5 US EPA, OLEM. "Hazardous Waste Cleanup: Sunoco Partners M & T- Marcus Hook Refinery in Marcus Hook, Pennsylvania." Overviews and Factsheets, February 4, 2016. https://www.epa.gov/hwcorrectiveactioncleanups/hazardous-waste-cleanup-sunoco-partners-m-t-marcus-hook-refinery-marcus.

6 US EPA. "TRI Facility Report: Braskem America Inc." Accessed November 14, 2024. https://enviro.epa.gov/facts/tri/ef-facilities/#/Facility/19061PSLNPBLUEB.

7 US EPA, OLEM. "Hazardous Waste Cleanup: Monroe Energy LLC (Formerly: BP Oil Incorporated) in Marcus Hook, Pennsylvania." Overviews and Factsheets, December 15, 2015. https://www.epa.gov/hwcorrectiveactioncleanups/hazardous-waste-cleanup-monroe-energy-llc-formerly-bp-oil-incorporated.

8 NOAA, and National Water Prediction Service. "Delaware River at Marcus Hook (IN MLLW)." Accessed November 14, 2024. https://water.noaa.gov/gauges/mrcp1.

9 Sunoco Partners Marketing Terminals L.P., Project Phoenix (Plan Approval 23-0119J), Energy Transfer, July 2019. https://files.dep.state.pa.us/RegionalResources/SERO/SEROPortalFiles/Community%20Info/SPMT/FINAL%20SPMT%20Phoenix%20PA23-0119J%20Application_NON-CONFIDENTIAL_r1.pdf.

10 City of Chester. "History of Chester | City of Chester." Accessed November 14, 2024. https://www.chestercity.com/about/.

11 Ibid.

12 Will, Sullivan. "Too Much Pollution for One Place," August 23, 2017. https://www.pbs.org/wgbh/nova/article/too-much-pollution/.

13 Ibid.

14 Energy Justice Network. "Covanta Trash Incinerator & Environmental Racism in Chester," n.d.

15 Will, Sullivan. "Too Much Pollution for One Place," August 23, 2017. https://www.pbs.org/wgbh/nova/article/too-much-pollution/.

16 Delcora. "DELCORA Enters Agreement with EPA." DELCORA, August 18, 2015. https://www.delcora.org/aug-18/.

17 US EPA. "Settlement to Improve Water Quality in Delaware River, Philadelphia-Area Creeks." Overviews and Factsheets, September 28, 2016. Pennsylvania. https://www.epa.gov/pa/settlement-improve-water-quality-delaware-river-philadelphia-area-creeks.

18 Ibid.

19 Ainsworth, Colin. "Arbor Estate Brings Affordable Housing to Chester – Delco Times." Daily Times. Accessed November 14, 2024. https://www.delcotimes.com/2019/05/17/arbor-estate-brings-affordable-housing-to-chester/.

20 Schuylkill River & Urban Waters Research Corps Archive. "Urban Renewal Era · The Eastwick Living History Project." Accessed November 14, 2024. https://schuylkillcorps.org/exhibits/show/eastwick-oral-history-project/urban-renewal.

21 SEGREGATION BY DESIGN. "Eastwick." Accessed November 14, 2024. https://www.segregationbydesign.com/philadelphia/eastwick.

22 "Urban Renewal Era · The Eastwick Living History Project."

23 Hurdle, Jon. "As Waters Rise, a Community Must Decide: Do We Stay or Go?" Yale E360. Accessed November 14, 2024. https://e360.yale.edu/features/chronic-flooding-eastwick-philadelphia.

24 US EPA. "Site Profile - Lower Darby Creek Area - Clearview Landfill." Accessed November 14, 2024. https://response.epa.gov/site/site_profile.aspx?site_id=5864.

25 US EPA, OLEM. "Hazardous Waste Cleanup: Sunoco Schuylkill River Tank Farm in Philadelphia, Pennsylvania." Overviews and Factsheets, February 4, 2016. https://www.epa.gov/hwcorrectiveactioncleanups/hazardous-waste-cleanup-sunoco-schuylkill-river-tank-farm-philadelphia.

26 Blackbottom. "History," April 14, 2010. https://theblackbottom.wordpress.com/communities/grays-ferry/history/.

27 Ujifusa, Steven. "An Irish Village in Philadelphia: Grays Ferry.." The Philly History Blog. Accessed November 14, 2024. https://blog.phillyhistory.org/index.php/2010/06/an-irish-village-in-philadelphia-grays-ferry/.

28 Schuylkill River & Urban Waters Research Corps Archive. "Grays Ferry Oral Histories." Accessed November 14, 2024. https://schuylkillcorps.org/exhibits/show/grays-ferry-oral-histories.

29 Tessum, Christopher W., David A. Paolella, Sarah E. Chambliss, Joshua S. Apte, Jason D. Hill, and Julian D. Marshall. "PM2.5 Polluters Disproportionately and Systemically Affect People of Color in the United States." Science Advances, April 2021. https://doi.org/10.1126/sciadv.abf4491.

30 Helmer, Madeleine. "Tracking The Evolution Of Industry At 34th And Grays Ferry." Hidden City Philadelphia, March 16, 2017. https://hiddencityphila.org/2017/03/tracking-the-evolution-of-industry-at-34th-and-grays-ferry/.

31 MacDonald, Tom. "Philadelphia Playground to Get $20 Million Dollar Rebuild." WHYY. Accessed November 14, 2024. https://whyy.org/articles/philly-20-million-rebuild-vare-rec-center/.

32 Environmental Integrity Project. "Monitoring for Benzene at Refinery Fencelines," February 6, 2020.

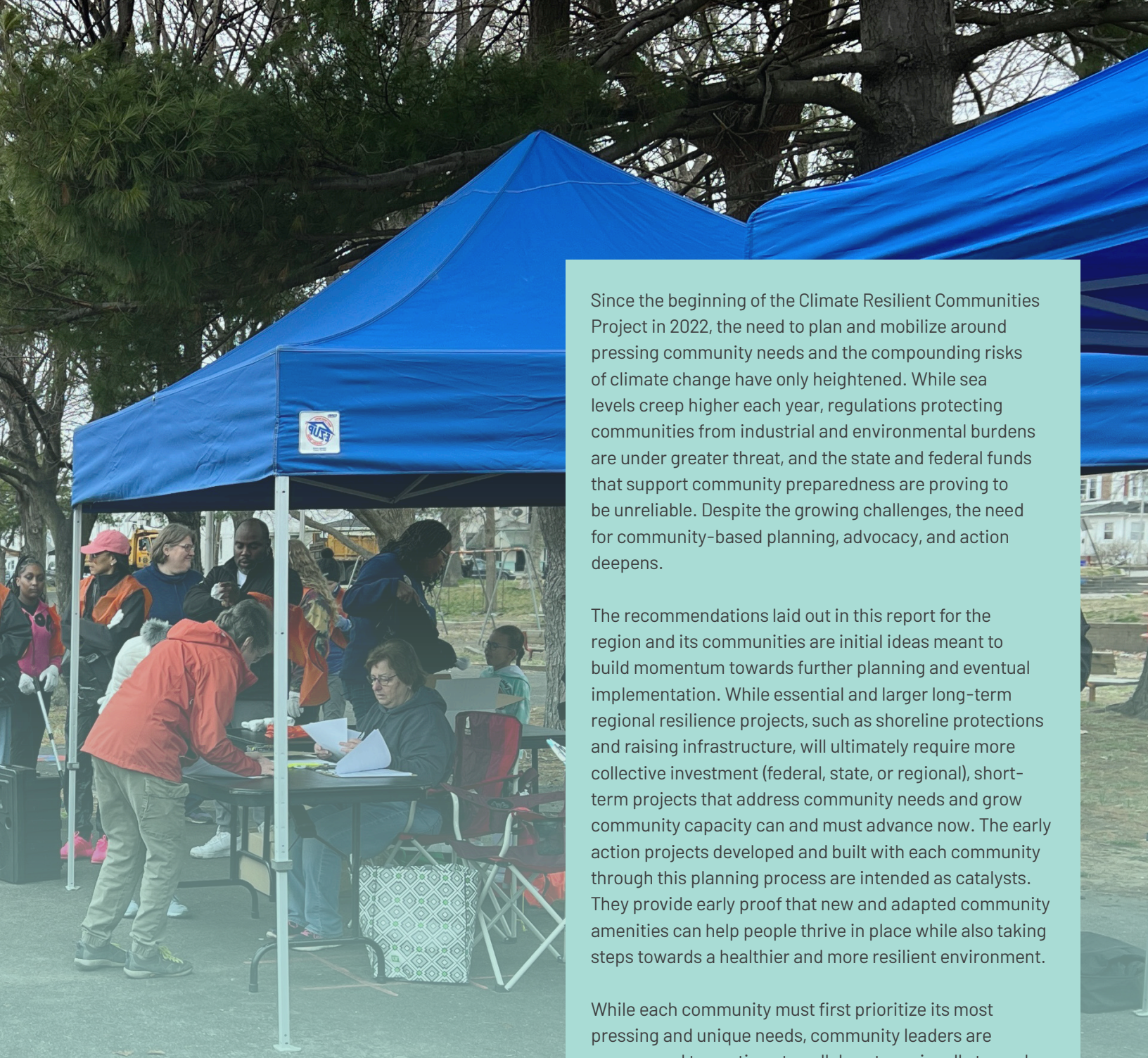
33 "Act 2 Documents - PRLR," February 11, 2019. https://phillyrefinerycleanup.info/act-2-documents/.

34 Moselle, Aaron. "Officials and Residents Celebrate Affordable Housing Development in Grays Ferry." WHYY (blog). Accessed November 14, 2024. https://whyy.org/articles/philadelphia-affordable-housing-development-arlene-thorpe-townhomes-grays-ferry/.



08

NEXT STEPS



Since the beginning of the Climate Resilient Communities Project in 2022, the need to plan and mobilize around pressing community needs and the compounding risks of climate change have only heightened. While sea levels creep higher each year, regulations protecting communities from industrial and environmental burdens are under greater threat, and the state and federal funds that support community preparedness are proving to be unreliable. Despite the growing challenges, the need for community-based planning, advocacy, and action deepens.

The recommendations laid out in this report for the region and its communities are initial ideas meant to build momentum towards further planning and eventual implementation. While essential and larger long-term regional resilience projects, such as shoreline protections and raising infrastructure, will ultimately require more collective investment (federal, state, or regional), short-term projects that address community needs and grow community capacity can and must advance now. The early action projects developed and built with each community through this planning process are intended as catalysts. They provide early proof that new and adapted community amenities can help people thrive in place while also taking steps towards a healthier and more resilient environment.

While each community must first prioritize its most pressing and unique needs, community leaders are encouraged to continue to collaborate regionally to pool resources and best practices, while advocating for larger investments from state and federal partners. This report is a first step in both documenting the shared climate and industrial risks of these communities and advocating for community-supported resilience strategies. More forums are urgently needed to bring together and focus the region on its shared risks and its duty to ensure the resilience of its communities.

Figure 175. Sun Village Park Keep Delco Beautiful Event. Source: OLIN.

APPENDIX

GLOSSARY

1% Flood (100-Year Flood)
A flood of a magnitude that has a 1 % chance of being equaled or exceeded in a given year (i.e. has a recurrence interval of 100 years, on average).

1% Floodplain (100-Year Floodplain)
Areas with a 1 % annual chance of flooding.

0.2% Flood (500-Year Flood)
A flood of a magnitude that has a 0.2 % chance of being equaled or exceeded in a given year (i.e. has a recurrence interval of 500 years, on average).

0.2% Floodplain (500-Year Floodplain)
Areas with a 0.2 % annual chance of flooding.

Base Flood Elevation
The elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year.

Cloudburst
A sudden and heavy downpour where a lot of precipitation falls in a short amount of time.

Coastal Flooding
When water inundates or covers normally dry coastal land as a result of high or rising tides or storm surges. Coastal flooding can occur by direct flooding, overtopping, or breaching a barrier. (Source: FEMA)

Community-Based Process
Varies among communities and project scope, but generally includes the following steps: initial community consultation; gathering data, observations, and analysis of primary issues; sharing those issues back to the community for further input; and implementation. (Source: Project for Public Spaces)

Compound Flooding
Caused by the combination of two or more flood drivers (pluvial, fluvial, riverine, coastal) occurring simultaneously or in close succession.

Environmental Justice
Just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other activities that affect human health and the environment. Environmental justice seeks to protect all people from disproportionate and adverse human health and environmental effects, risks, and hazards, including those related to climate change, the cumulative impacts of environmental burdens, and the legacy of racism or other structural barriers. Environmental justice also looks to have equitable access to a healthy, sustainable, and resilient environment for all. (Source: EPA)

Exposure
Refers to the presence of people, assets, infrastructure, and ecosystems located in hazard-prone areas. (Source: UNDRR)

Fenceline Community
Communities living immediately adjacent to highly polluting facilities (e.g. fossil fuel infrastructure or manufacturing facilities), and directly affected by traffic, noise, operations, and chemical and fossil fuel emissions. Many fenceline communities are disproportionately communities of color and/or low-income areas.

Flash Flooding
Flooding that begins within 6 hours, and often within 3 hours, of heavy rainfall or other cause. Influenced by intensity of rainfall, location and distribution of rainfall, land use, topography, vegetation types, soil type, and soil-water content. (Source: NWS)

Fluvial Flooding
Flooding that occurs when the stage of a river, creek, or stream exceeds the elevation of its banks. Also known as river flooding, or river, stream, and creek flooding.

Green Stormwater Infrastructure
A nature-based approach to managing stormwater runoff in ways that mimic the natural environment as much as possible, using plants, soil, and stone to filter and manage stormwater more effectively and reduce how much stormwater enters sewer systems. Tools include rain gardens, swales, stormwater planters, stormwater tree trenches, green roofs, stormwater bump outs, porous paving, infiltration trenches, and stormwater wetlands. (Source: PWD)

Groundwater Flooding
Flooding that occurs when the water table rises to levels that cause the inundation of the land surface or subterranean proprerty such as basements.

Heat Index
Refers to what the temperature feels like to the human body when relative humidity is combined with air temperature. Also known as “apparent temperature.” (Source: NWS)

HESCO Barrier
A temporary to semi-permanent flood control structure made of wire mesh and sand, soil, or gravel.

Hurricane - Category 1
Winds 74 to 95 miles per hour (miles per hour). Damage primarily to shrubbery, tree foliage, poorly constructed items, and unanchored mobile homes. Low lying coastal roads inundated. (Source: NOAA)

Hurricane - Category 3
Winds 111 to 130 miles per hour. Foliage torn from trees and large trees blown down. Poorly constructed items destroyed, damage to roofing materials, windows, and doors expected. Mobile homes destroyed and some structural damage to small buildings. Serious coastal flooding, many small structures destroyed; large structures damaged by waves and debris. Major erosion to beaches and massive evacuation of all residences within 500 yards of beach and single-story residences on low ground within 2 miles of shore. (Source: NOAA)

H&H Modeling
Hydrologic and hydraulic modeling. A study of movement of water, including the volume and rate of flow as it moves through a watershed, basin, channel, or man-made structure.

Natech
A natural hazard triggered technological accident. Involves the release of hazardous substances, fires, or explosions that have been triggered by a natural hazard event such as a hurricane, storm, or major flood. (Source: OECD)

Natural Hazard
Defined as environmental phenomena that have the potential to impact societies and the human environment. Includes coastal flooding, hurricanes, riverine flooding, strong winds, wildfires, heat waves, droughts, and earthquakes. (Source: FEMA)

Nature-Based Solutions(NBS)
A sustainable planning, design, environmental management and engineering practice that brings natural features or processes into the built environment to promote adaptation and resilience. NBS look to combat climate change, reduce flood risk, improve water quality, reduce urban heat, protect coastal property, and more. Co-benefits can also include lower costs, economic growth, green jobs, and public health. (Source: FEMA)

Non-Point Source
Non-point source pollution comes from many diffuse sources that contaminate air and water. Runoff moving over and through ground, picks up and carries natural and human-made pollutants before depositing them into lakes, rivers, wetlands, coastal waters, and groundwaters. Can include oil and toxic chemicals from urban runoff, sediment from eroding streambanks, and bacteria and nutrients from faulty septic systems. (Source: EPA)

Nor'easter
A storm along the East Coast and influenced by the winds over the northeast coastal area. Past nor'easters have caused economic, transportation, and human damage as well as coastal flooding. (Source: NWS)

Pluvial Flooding
Flooding that occurs when the intensity of precipitation exceeds the capacity of the land surface to infiltrate it and/or when the rate of runoff exceeds the conveyance capacities of natural and engineered systems. Often described as "urban" flooding.

Point Source
Point source pollution stems from a single, identifiable source of pollution from which pollutants are discharged, e.g. a pipe. Common types of point source pollution include factories like oil refineries and sewage treatment plants. Some discharge pollutants (known as effluents) directly into a waterbody while others treat effluents before they are released. The National Pollutant Discharge Elimination System (NPDES) program monitors and enforces permits that regulate point source pollution of water bodies. Permits are classified as major or minor based on discharge volume, waste characteristics, and other human and ecosystem health considerations. (Source: EPA)

Risk
The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society, or community in a specific period of time. Determined probabilistically as a function of hazard, exposure, vulnerability, and capacity. (Source: UNDRR)

Resiliency
The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management. (Source: UNDRR)
*Note: resiliency can carry many different definitions and incorporate different socio-economic aspects, e.g. social resiliency.

Social Vulnerability
The susceptibility of groups to the adverse impacts of natural hazards, which includes disproportionate death, injury, loss, or disruption of livelihood, and their ability to anticipate, withstand, and recover from adverse impacts. (Source: UNDRR)

Storm Surge
Abnormal rise in seawater level during a storm. Measured as the height of the water above the normal predicted astronomical tide and caused primarily by a storm's winds pushing water onshore. Amplitude of storm surge depends on the orientation of coast line with storm track, the intensity, size, and speed of storm, and local bathymetry. (Source: NOAA)

Stormwater Runoff
Generated from rain and snowmelt that flows over land or impervious surfaces (e.g. paved streets, sidewalks, building rooftops) and does not infiltrate into the ground. See non-point source pollution.

Sunny Day Flooding
Also known as high tide flooding. Influenced by rising sea levels and can cause road closures, overwhelmed storm drains, and damage to sidewalks and roads. (Source: NOAA)

Upland
Refers to locations elevated above lower-lying locations. Often used when discussing two locations within a watershed.

Urban Heat Island
Occurs where areas experience hotter temperatures within a city. Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies. Daytime temperatures in urban areas are about 1–7°F higher than temperatures in outlying areas and nighttime temperatures are about 2–5°F higher. (Source: EPA)

Vulnerability
Refers to the degree to which people, assets, and ecosystems are adversely affected by a hazard. Can be further expanded to include climate and social vulnerability. (Source: UNDRR)

Watershed
The land area that drains into a river or stream. An area of land that contributes runoff to one specific delivery point. Large watersheds may be composed of several smaller "sub-watersheds," each of which contributes runoff to different locations that ultimately combine at a common delivery point. Watersheds are usually bordered and separated from other watersheds by mountain ridges or other naturally elevated areas.

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EXISTING REGIONAL PLANNING

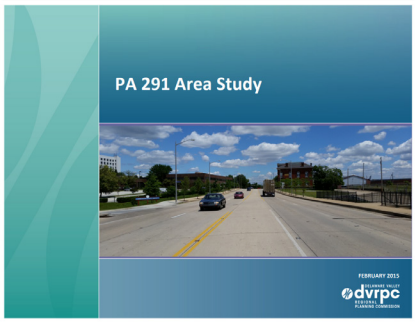


Title: Municipal Management of Extreme Heat

Date: May 2021

Prepared by: Delaware Valley Regional Planning Commission (DVRPC)

Summary: The report is part of the Municipal Implementation Tools, meant to implement the region's long-range plan, Connections 2045. The report provides analysis of temperature trends in Southeast Pennsylvania and projected trends of increased temperatures until 2099. It goes on to identify heat impacts and ways of mitigating extreme heat, from physical interventions like tree planting, green roofs, and cooling spaces, to policy interventions like design guidelines and zoning code ordinances.



Title: DVRPC PA 291 Area Study

Date: February 2015

Prepared by: Delaware Valley Regional Planning Commission (DVRPC)

Summary: The transportation study addresses the PA 291 corridor, which cuts through Chester and Eddystone. It addresses municipal concerns of improving access to the Delaware River waterfront, seeking a balance between a concentration of industry and impacts on residents, and creating a safe environment for corridor users. Main relevant recommendations suggest development of the Circuit Trails network and East Coast greenway, improving pedestrian crossing infrastructure, and prioritizing "Green Street" designs to manage stormwater runoff.

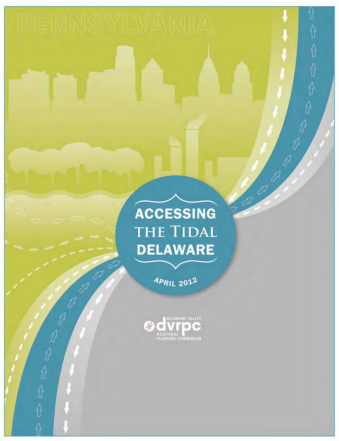


Title: A River Reconnected: The Challenges and Opportunities of Public Access to the Tidal Delaware River

Date: July 2021

Prepared by: Delaware Valley River Planning Commission (DVRPC)

Summary: The DVRPC study analyzes existing and ongoing public access projects in Philadelphia and Delaware County, including Marcus Hook. Identified ongoing projects in Marcus Hook include pier restoration and a planned greenway.



Title: Accessing the Tidal Delaware: Pennsylvania

Date: April 2012

Prepared by: Delaware Valley River Planning Commission (DVRPC)

Summary: The report identifies multimodal transportation projects along tidal Delaware River communities to improve access to the waterfront. Within the project boundary, the report located public access points in Delaware County including Market Square Memorial Park, Wharf at Rivertown (Chester), PPL Park Stadium, Barry Bridge Park, Chester City Boat Ramp, and John Heinz National Wildlife Refuge.



Title: Sea Level Rise Impacts in the Delaware Estuary of Pennsylvania

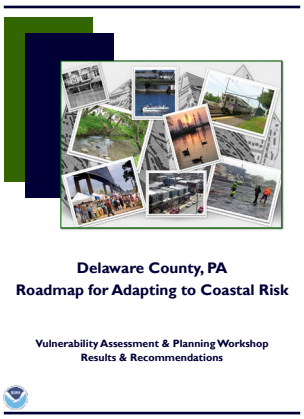
Date: 2004

Prepared by: Delaware Valley River Planning Commission (DVRPC)

Summary: The report examines potential loss of wetlands to sea level rise as well as identifying hazardous waste sites at risk of erosion, flooding, and inundation. As a result of sea level rise, hazardous waste sites exacerbate existing risks and create new risks of downstream contamination and erosion of waste piles, landfills, and other hazardous structures. Recommendations include designing for flood levels over the project's lifetime, redrawing flood maps to remain current, retrofitting operating facilities with flood mitigation measures, and ensuring inactive facilities are subject to the same levels of protection and cleanups.

This project builds on many past planning efforts at both regional and local levels related to climate, resiliency, emergency management, open space and recreation, and other related efforts. A review of these plans has supported the initial development of recommendations found in this chapter as well as priority actions and projects for each focus community. Local planning efforts can be found in Chapter 7.

EXISTING COUNTY PLANNING: DELAWARE COUNTY

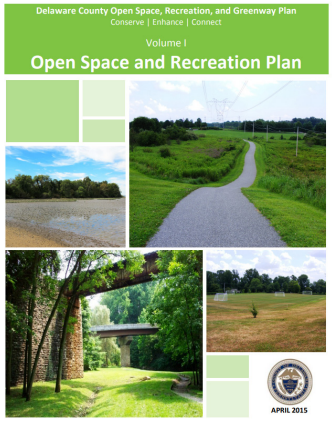


Title: Delaware County, Pennsylvania: Roadmap for Adapting to Coastal Risk

Date: 2011

Prepared by: NOAA Coastal Services Center, among others

Summary: This roadmap came out of a participatory process with community stakeholders identifying hazard and climate vulnerabilities and planning priorities. In Marcus Hook, flood risk to industrial facilities and associated hazardous material releases were highlighted alongside a lack of evacuation routes. An associated concern from flooded industrial facilities was job loss.

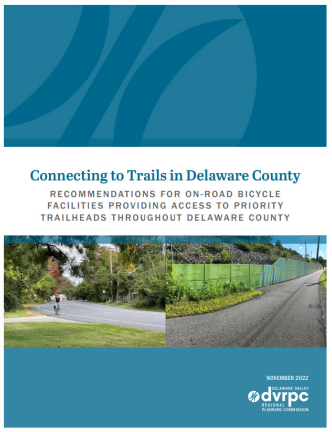


Title: Delaware County 2035 Open Space, Recreation, and Greenway Plan

Date: 2015

Prepared by: Delaware County Planning Department

Summary: This open space plan is a component plan of Delaware County 2035, and establishes three main goals: conserve natural and cultural resources, enhance environmental and/or recreational value, and connect natural features and people. The plan identified a need for the county to provide technical assistance and work with municipalities to identify and/or enhance open space assets, including trail connections.

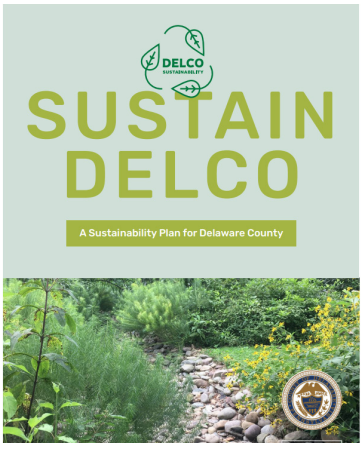


Title: Connecting to Trails in Delaware County

Date: November 2022

Prepared by: Delaware Valley Regional Planning Commission (DVRPC)

Summary: The study plans for on-road bicycle connections to existing and planned multi-purpose trails as well as proposing roadway improvements to improve cyclist and road user safety. Identified areas of focus include Chester Creek Trail, John Heinz Wildlife Refuge, Cobbs Creek Trail, and Darby Creek Trail.

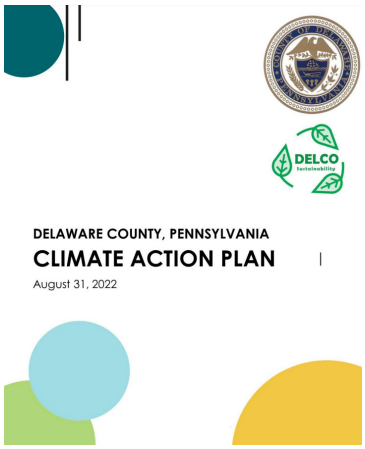


Title: Sustain Delco: A Sustainability Plan for Delaware County

Date: June 2023

Prepared by: Delaware County Office of Sustainability

Summary: The sustainability plan emphasizes four principles: economic sustainability, education, equity, inclusion and justice, and governance. It then focuses on identifying solutions to mitigating climate change and community adaptation in six sections: climate resiliency, natural resources, energy and efficiency, transportation, zero waste, and health and wellness. The plan includes updated county projections for temperature and flood risk.

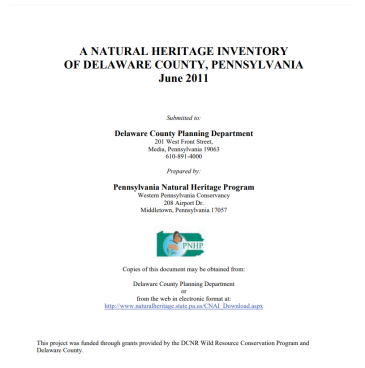


Title: Delaware County Climate Action Plan

Date: August 2022

Prepared by: Delaware Office of Sustainability

Summary: The Climate Action Plan informs the Delaware County Sustainability Plan. It found that the county generates 4.5 million tons of CO2 annually, with commercial and industrial usage as the largest contributor. The greenhouse gas inventory figures from the Climate Action Plan support baseline measures for action item progress in the Sustainability Plan.


A NATURAL HERITAGE INVENTORY
OF DELAWARE COUNTY, PENNSYLVANIA
June 2011

Submitted to:

Delaware County Planning Department
201 West Front Street,
Media, Pennsylvania 19063
610-891-4000

Prepared by:

Pennsylvania Natural Heritage Program
Western Pennsylvania Conservancy
208 Airport Dr.
Middletown, Pennsylvania 17057

Copies of this document may be obtained from:

Delaware County Planning Department
or
from the web in electronic format at:
http://www.naturalheritage.state.pa.us/CNAI_Download.aspx

This project was funded through grants provided by the DCNR Wild Resource Conservation Program and Delaware County.

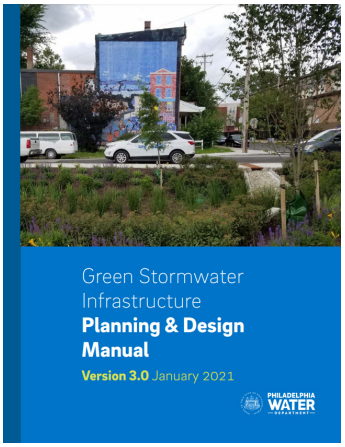
Title: A Natural Heritage Inventory for Delaware County Pennsylvania

Date: June 2011

Prepared by: Pennsylvania Natural Heritage Program

Summary: The report inventories locations of rare, threatened, and endangered species as well as the highest quality natural areas in the county. It then provides recommendations for both conservation and restoration actions. Included sites within the project boundary in the inventory are: Cobbs Creek, Darby Creek Mouth mudflat, John Heinz National Wildlife Refuge, and Marcus Hook to Commodore Barry Bridge.

EXISTING COUNTY PLANNING: PHILADELPHIA

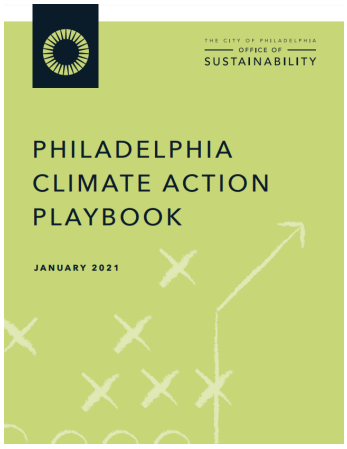


Title: Green Stormwater Infrastructure Planning & Design Manual

Date: January 2021

Prepared by: Philadelphia Water Department (PWD)

Summary: The Green City, Clean Waters (GCCW) plan, launched in 2011, aims to meet Philadelphia's Clean Water Act obligations by reducing combined sewer overflows through green stormwater infrastructure. Nearly ten years in, hundreds of green stormwater infrastructure projects have been implemented, with a goal to manage 35% of impervious areas by 2036. This manual offers guidance on planning, design, and technical requirements for these green stormwater infrastructure projects for Philadelphia Water Department staff and partners.



Title: Philadelphia Climate Action Playbook

Date: January 2021

Prepared by: City of Philadelphia Office of Sustainability (OOS)

Summary: This report outlines strategies to reduce greenhouse gas emissions and enhance resilience against climate impacts. It identifies key areas for action, including energy efficiency, sustainable transportation, and urban greening. The Playbook serves as a roadmap for City agencies, stakeholders, and residents, promoting collaborative efforts to achieve the City's climate goals.

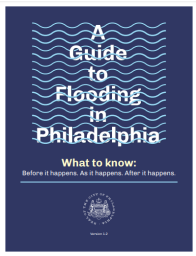


Title: Philly Tree Plan

Date: February 2023

Prepared by: Hinge Collective

Summary: This plan outlines strategies for tree planting, maintenance, and community engagement, focusing on areas of Philadelphia with low canopy coverage and uneven tree distribution. It targets a goal of 30% tree canopy coverage in every neighborhood over the next ten years. The plan serves as a guide for City agencies, residents, and organizations to work towards equitable tree planting to ensure all communities receive the environmental benefits of trees.

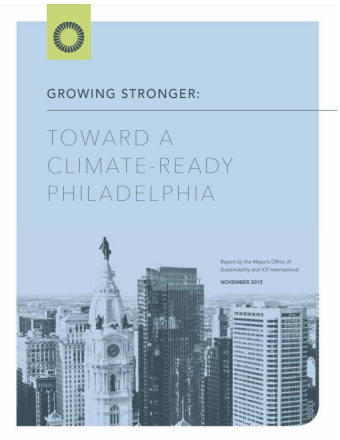


Title: A Guide to Flooding in Philadelphia

Date: September 2021

Prepared by: City of Philadelphia Flood Risk Management Task Force

Summary: The flood guide helps property owners and residents understand flood risks, and how to prepare, mitigate, and recover from any flooding.

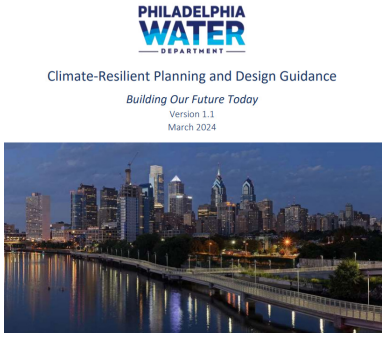


Title: Growing Stronger: Toward a Climate-Ready Philadelphia

Date: May 2016

Prepared by: City of Philadelphia Office of Sustainability, ICF International

Summary: The report identifies vulnerabilities, climate resilient strategies, and adaptation opportunities for city departments. It particularly focuses on risk mitigation through infrastructure and policy mechanisms.

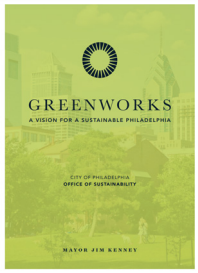


Title: Climate-Resilient Planning and Design Guidance

Date: January 2022

Prepared by: Philadelphia Water Department (PWD)

Summary: This report outlines strategies to enhance urban resilience through sustainable design practices. It serves as a resource for City agencies, developers, and community stakeholders to adapt to climate change impacts while ensuring equitable access to green spaces and resources.

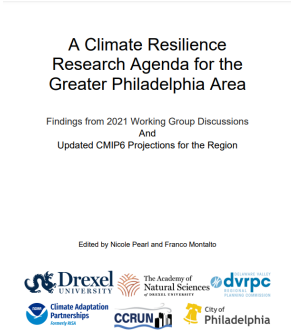


Title: Greenworks: A Vision for a Sustainable Philadelphia

Date: November 2016

Prepared by: City of Philadelphia Office of Sustainability (OOS)

Summary: Greenworks is a framework for advancing the city's sustainability goals such as energy efficiency, waste reduction, water conservation, and equitable access to green resources. The report serves as a roadmap for action for City agencies, businesses, and residents.

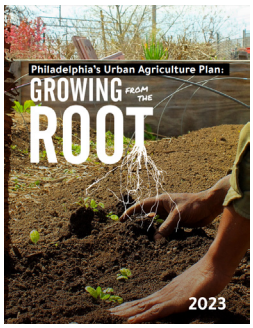


Title: A Climate Resilience Research Agenda for the Greater Philadelphia Area

Date: 2021

Prepared by: Nicole Pearl, Franco Montalto

Summary: This report outlines strategies for enhancing Philadelphia's climate resilient development strategies through community engagement, infrastructure improvements, and sustainability practices. It identifies key priorities such as reducing greenhouse gas emissions, improving public health, and enhancing equity in climate initiatives.



Title: Philly Urban Agriculture Plan

Date: April 2023

Prepared by: Philadelphia Parks and Recreation (PPR)

Summary: This plan establishes a 10-year framework for the development of urban agriculture and food justice initiatives in Philadelphia. It outlines strategies for improving vacant land use, supporting local growers, and integrating urban agriculture into planning efforts.

EXISTING NATECH PLANNING AND RESEARCH

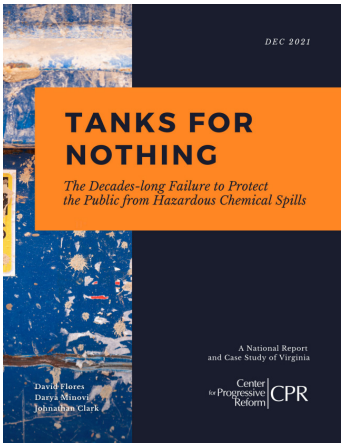


Title: Preventing Double Disasters

Date: July 2021

Prepared by: Center for Progressive Reform (CPR)

Summary: The report gives an overview of the EPA's Risk Management Program (RMP), which is responsible for preventing hazardous chemical incidents and protecting workers and communities. Across the U.S., the RMP regulates about 12,331 facilities but does not yet address climate change or require facilities to protect people from Natural Hazard-Triggered Technological Accident disasters. The analysis found that nearly 200 million people live in "worst-case scenario zones," 3,397 facilities are susceptible to flooding, and a further 870 facilities are exposed to coastal flooding. Recommendations include assessment of NaTech risks and implementation of prevention and mitigation measures at facilities (e.g. backup power), advance community notification and emergency response planning, monitoring and collection of real-time toxic air emission data, and expanding the RMP coverage to facilities in areas prone to natural disasters.

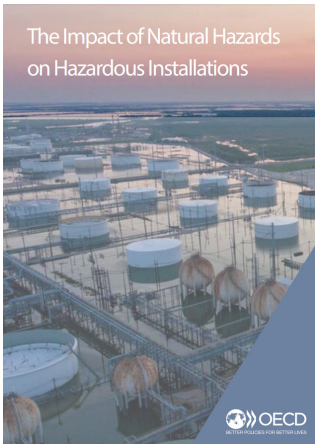


Title: Tanks for Nothing

Date: December 2021

Prepared by: Center for Progressive Reform (CPR)

Summary: The report uses Virginia as a case study to examine the risks of unregulated oil and waste aboveground (AST) and underground (UST) storage tanks. Analysis revealed that there is significant underreporting of hazardous spills. Climate change will intensify the risk of storage tank releases as floodwaters can carry dislodge and damaged tanks, releasing chemicals into communities and waterways. The report found that storage tank releases were most often attributed to rain, hurricanes, and floods and 30 percent resulted in evacuations.

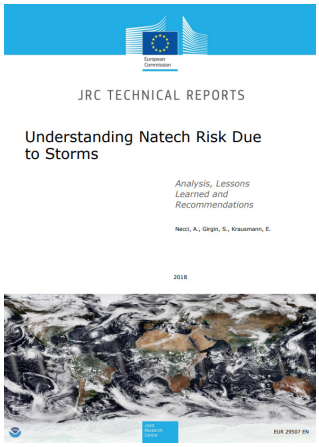


Title: The Impact of Natural Hazards on Hazardous Installations

Date: 2022

Prepared by: Organization for Economic Co-operation and Development (OECD)

Summary: The report introduces the risks and challenges associated with Natural Hazard-Triggered Technological Accident disasters and identifies several risks of flooding on hazardous sites: flotation of equipment and damage to connected parts or equipment; floating equipment or debris dragged along with the floodwaters and damaging sensitive equipment on site via collision; collapsing tanks or implosion of tanks; short circuits/power failure; toxic or flammable chemicals that react violently with water and release of chemicals into the water. Industry and public authorities are identified as primary actors in the management of NaTech risks, with recommendations for specific analysis of hazardous installations.



Title: Understanding Natech Risk due to storms

Date: December 2018

Prepared by: Joint Research Center, European Commission

Summary: The report analyzes case studies of past technological incidents with hazardous material releases and damage caused by storms. The analysis revealed that storage equipment is the most vulnerable to storm damage, with rain and floods triggering Natural Hazard-Triggered Technological Accident accidents with a high frequency. Storm predictions based on past events are not sufficient to be well-prepared for future storm-triggered Natural Hazard-Triggered Technological Accident events, revealing the vulnerabilities of relying on old climate modeling. Recommendations include early warning emergency systems; reviewing emergency plans and risk assessments on a regular basis; backup electric power supply; increasing safety factors to account for both actual and potential changes in the environment and climate; and local recovery plans in areas with a high density of industrial facilities to prepare for scenarios when there is insufficient resources for multiple disasters.

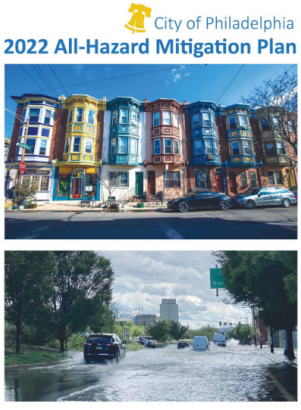


Title: Delaware County: 2016 Hazard Mitigation Plan

Date: December 12, 2016

Prepared by: Delaware County Planning Department

Summary: The 2016 update to the Hazard Mitigation Plan identifies various natural hazards posing a risk to Delaware County communities. Most relevant hazards and risks include floods and hurricanes. As of 2016, when the plan was published, there were 70 parcels in the Special Hazard Flood Area (SHFA) in Marcus Hook (out of 1,077), 119 parcels in Trainer (out of 964), and 517 parcels in Chester (out of 14,491). The plan also identifies at-risk critical facilities and hazardous material facilities in each community. Within Marcus Hook, Trainer, and Chester, there are a total of 17 EPA-designated hazardous material facilities and a combined 16,529 parcels within 1.5 miles of those facilities.



Title: Philadelphia All Hazard Mitigation Plan

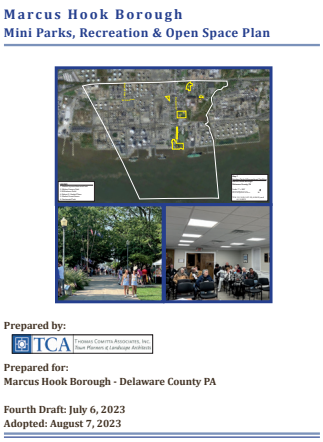
Date: May 2022

Prepared by: WSP

Summary: The plan is a city-specific approach to mitigate the impacts of potential natural and human-caused disasters and threats, including flooding and Natural Hazard-Triggered Technological Accident events. The three priorities identified in the plan are: equity, climate change, and integration of updated projections from the "Growing Stronger: Toward a Climate-Ready Philadelphia" report. Eastwick is identified as a "repetitive loss" neighborhood and one that will continue to experience significant flooding. The plan recommends addressing long-term flood-related hazards and vulnerabilities with a community-based planning approach (the lead agency identified for this effort is the Office of Sustainability), alongside improving communication strategies, developing further flood modeling studies, and others.

MARCUS HOOK & TRAINER

Due to the population size and municipal capacity, there has been less local planning for Marcus Hook and Trainer than other study area communities, with most plans being covered in larger county-wide or regional planning.

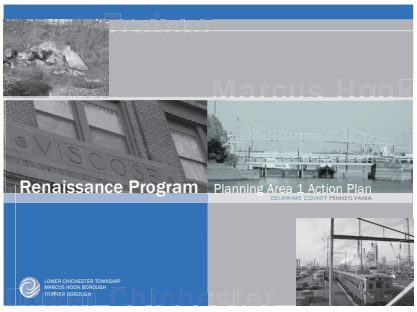


Title: Marcus Hook Borough Mini Parks, Recreation & Open Space Plan

Date: August 7, 2023

Prepared by: Thomas Comitta Associates

Summary: This plan identifies proposed enhancements to existing and proposed parks in Marcus Hook and is intended to be used as the foundation for grant applications at the federal and state funding levels. The plan provides a 10 to 20 year time horizon. The existing park system, including Market Square Memorial Park, Mickey Vernon Park, and Williamson Field, was noted as a strength, while challenges include lack of volunteer participation and funding.



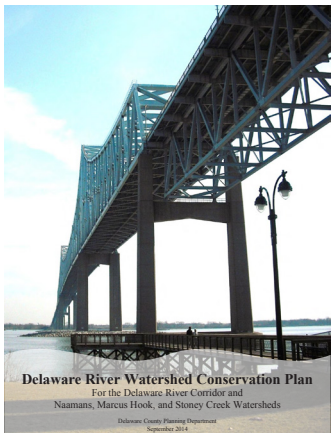
Title: Renaissance Program: Planning Area 1 Action Plan

Date: March 2003

Prepared by: Heyer, Gruel + Associates

Summary: Focused on Lower Chichester, Marcus Hook, and Trainer,

the Renaissance plan focuses on five primary planning goals: economic development, housing, infrastructure, transportation, and public safety. Secondary goals include open space and streetscapes, among others. The plan identifies connectivity within the study area and to the broader region as an important factor. Various redevelopment and new projects are proposed, including creating a new greenway and improving Route 131.

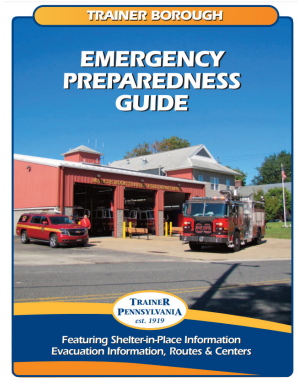


Title: Delaware River Watershed Conservation Plan

Date: September 2014

Prepared by: Delaware County Planning Department

Summary: The plan identifies flooding issues along tributaries like Chester and Darby Creeks, which occur due to timing of downstream flows and tidal effects. In Trainer and Marcus Hook, flooding stems most often from their downstream locations along with tidal fluctuations, extensive impervious surfaces, and insufficient upstream stormwater controls. Relevant recommendations include buffering industrial land uses with planting, conducting site-specific flooding studies, stream bank and riparian buffer restoration, and planning for risks to riverfront infrastructure associated with storm surges or sea level rise.

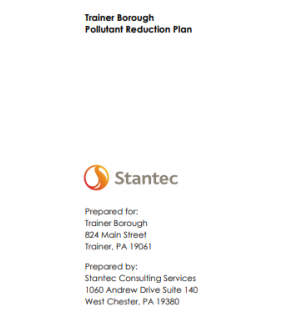


Title: Trainer Borough Emergency Preparedness Guide

Date: n/a

Prepared by: Trainer Borough

Summary: The emergency guide provides an overview to various potential accidents, including a brief introduction to petroleum pipeline leaks and how best to respond. The guide also highlights evacuation routes for the borough, with primary routes following Post Road, Main Street, Township Line Road, and Chichester Avenue to link up to Chichester Middle School and Chichester High School.



Title: Trainer Borough Pollutant Reduction Plan

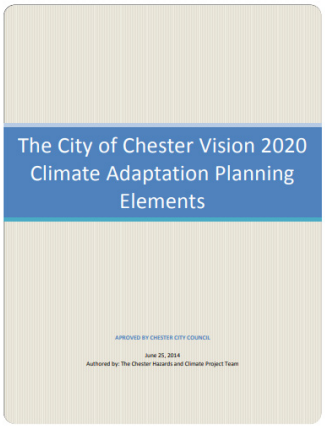
Date: August 2017

Prepared by: Stantec

Summary: The plan identifies various pollutant concerns from runoff into the the Delaware River and its tributaries, Marcus Hook Creek and Stoney Creek. It recommends stream restoration to Marcus Hook Creek within Henry Johnson Park to address pollutant reduction and estimates a preliminary cost of $94,500.

CHESTER

To date, there have been many planning efforts for the city on various issues like waterfront and trail access, economic development, and open space development. However, they remain fairly isolated; efforts like the 2022 Reimagining Chester Study aim to reconcile and unify these plans.

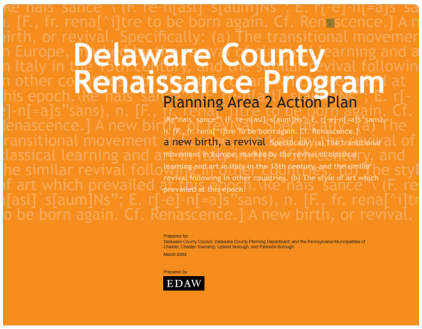


Title: The City of Chester Vision 2020 Climate Adaptation Planning Elements

Date: June 2014

Prepared by: Chester Hazards and Climate Project Team

Summary: This 2-year vision plan was born out of 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," and seeks to understand the City's climate vulnerabilities, prioritize and plan community resiliency efforts, and engage government leaders and the public on the need for investing in resiliency

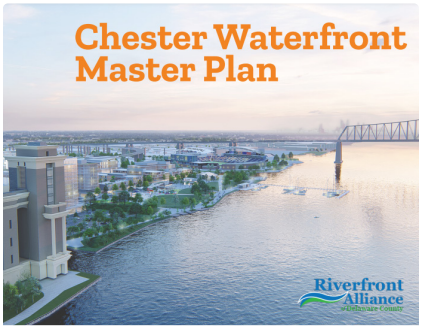


Title: Delaware County Renaissance Program: Planning Area 2 Action Plan

Date: March 2003

Prepared by: EDAW

Summary: The Action Plan for Planning Area 2, which includes Chester, identifies several assets including the area's proximity to Philadelphia and access to I-95, waterfront amenities, and open space resources (upland of Chester). The plan identified priority areas for mixed-use development along Chester's waterfront and creating greenway corridors along Chester Creek and 2nd Street. It also targeted Crozier Park and the corridor between Incinerator Road and Kerlin Street as a potential pilot project site for a flood abatement program.



Title: Chester Waterfront Master Plan

Date: 2020

Prepared by: Riverfront Alliance

Summary: The Master Plan outlined a framework for the transformation of the Delaware Riverfront, detailing a market analysis supported by a private development program alongside necessary public investments in infrastructure needed for both a near-term and long-term vision. Vision elements prioritize connectivity, waterfront activation, sustainability, successful development, and enhancing Chester's image..



Title: City of Chester Green Stormwater Infrastructure Plan

Date: 2017

Prepared by: Delaware Valley Regional Planning Commission (DVRPC)

Summary: The plan outlines a framework for expanding green stormwater infrastructure projects in Chester to deal with flooding and runoff, using Veterans Memorial Park as one example. It builds on the City of Chester Vision 2020 Climate Adaptation Planning Elements plan.

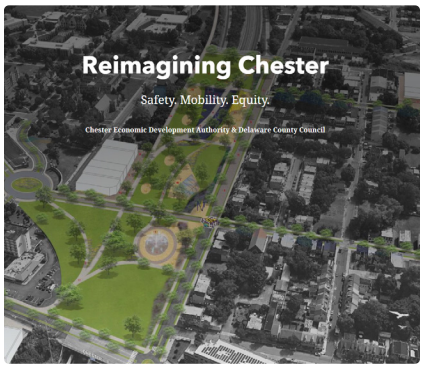


Title: Resilience through Recreation

Date: 2018

Prepared by: Viridian Landscape Studio, Ann Toole Recreation, Natural Lands, Pennsylvania Environmental Council

Summary: Resilience through Recreation is the City of Chester's plan to revitalize its public parks and recreation system, connect communities with safe places to walk and bicycle, and make its riverfront a recreational destination.

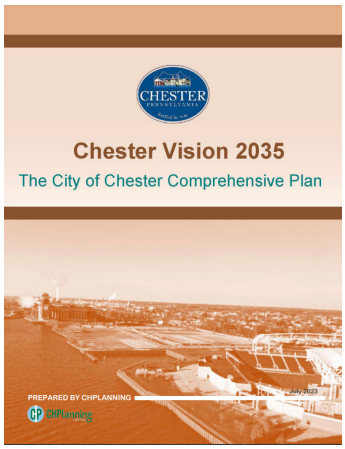


Title: Reimagining Chester Study

Date: 2022

Prepared by: ALTA Planning

Summary: Reimagining Chester is a $6.5 million request for a federal RAISE grant from the Chester Economic Development Authority to support a comprehensive planning study in Chester. The study seeks to unify isolated planning efforts across Chester and result in a community-based action plan, alongside the design of priority projects. To date, the Delaware County Council has committed $50,000 to the initiative. The initiative was not successful in receiving funding in the first application.



Title: Chester Vision 2035 Comprehensive Plan

Date: 2022

Prepared by: CHPlanning

Summary: Acting as Chester's comprehensive plan, Chester Vision 2035 is an update to the City's 2012 plan. Relevant goals include increased investment in mixed-use development and expansion of public spaces, expanding floodplain management regulations, implementing green stormwater infrastructure programs, and advocating for a community-led strategy plan addressing climate and disaster resiliency planning. The plan identifies Deshong Park as a space for community programming and trail connections and recommends enhancing trails at the waterfront while adding additional programming, like an environmental education center.

EASTWICK

In recent years, Eastwick has had a lot of attention from various city, state, and federal agencies. Various plans and studies have been published, highlighting Eastwick's unique vulnerability to flooding and recommendations for flood mitigation efforts. The U.S. Army Corps of Engineers's flood risk management feasibility study is leading to the implementation of a levee around the Clearview Landfill.



Title: The Lower Schuylkill Master Plan

Date: May 2013

Prepared by: Philadelphia Industrial Development Corporation (PIDC)

Summary: The master plan envisioned the Lower Schuylkill as an industrial hub by defining three distinct campuses: an Innovation District, a Logistics Hub, and an Energy Corridor. It also proposed new transit connections to the rest of the city alongside other gateways, public amenities, and green infrastructure.

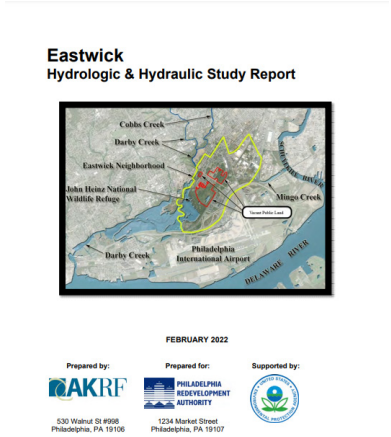


Title: Lower Eastwick Public Land Strategy: Planning for an Inclusive and Resilient Future in Eastwick

Date: March 2019

Prepared by: Interface Studio

Summary: This vision plan and land use study focuses on future uses for three sites in Eastwick, including the former George W. Pepper School and vacant land along 84th Street and Lindbergh Boulevard. Throughout the process, public engagement and market analyses shaped the outcome of the plan, which included a proposal of a mix of commercial, industrial, low-density residential, and green infrastructure development.

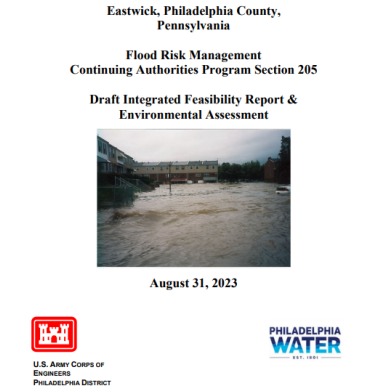


Title: Eastwick Hydrologic and Hydraulic Study Report

Date: February 2022

Prepared by: AKRF

Summary: In coordination with the Lower Eastwick Public Land Strategy, this study evaluates recommended uses of around 185 acres of vacant land in Eastwick with the development of an Hydrologic and Hydraulic model that incorporates climate change and sea level rise.



Title: Eastwick Flood Risk Management Feasibility Study

Date: August 2023

Prepared by: U.S. Army Corps of Engineers (USACE), Philadelphia District

Summary: The U.S. Army Corps of Engineers prepared a feasibility report and environmental report identifying various flood risk management solutions for Eastwick. The report recommends a construction of a 15-feet-high and 1,370-feet-long levee along Cobbs Creek within the Eastwick Regional Park and Clearview Landfill.



Title: Eastwick Trails Feasibility Study

Date: 2015

Prepared by: Campbell Thomas & Company

Summary: This feasibility study focuses on the portion of the East Coast Greenway that runs through Eastwick and looks to connect the John Heinz National Wildlife Refuge to other regional assets while making Eastwick more walkable. It is a part of a larger regional strategy to develop a 750 mile network of major trails to provide bicycle and pedestrian access to the Delaware Valley's recreational assets.

GRAYS FERRY

There has been less focused planning on Grays Ferry to date than in the other focus communities. Larger city-wide plans have included Grays Ferry in their analyses and recommendations. However, as larger change comes to the neighborhood (like the development of the Bellwether District on the former PES Refinery site), the area needs more focused and coordinated planning for land use, open space, and housing and economic development.

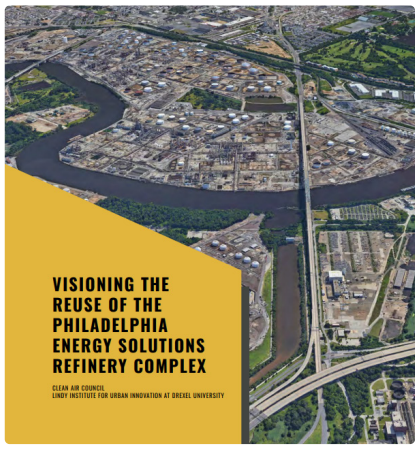


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Title: Visioning the Reuse of the Philadelphia Energy Solutions Refinery Complex

Date: 2020

Prepared by: Clean Air Council, Lindy Institute

Summary: This report outlines plans for how the closed Refinery site can be repurposed and used for green spaces, community facilities, and commercial development. The history of pollution and the need for environmental justice measures is highlighted, as are recommendations to mitigate future flood risk at the site.



Title: Grays Ferry Avenue Healthy Corridor National Study

Date: December 2017

Prepared by: Urban Land Institute (ULI)

Summary: Recommendations include transportation and infrastructure improvements for increased access and public health. The study also included increasing green space and tree canopy as well as strategies for redevelopment of vacant land in the area.

Visioning Nature-Based Solutions and Public Access at the Former PES Refinery Site



Figure 177. Rendering of Schuylkill River Trail at North Yards, Source: OLIN/Clean Air Council, 2020

Short-Term: River Trail and Access

» Nearby residents want river access, and they made it clear that while long-term planning is needed, they are tired of waiting for change. This conceptual rendering imagines an extension of an existing river trail through the North Yards, the portion of the former PES Refinery site closest to residential neighborhoods. An elevated berm offers flood protection inland of a thickened riparian edge. A constructed wetland provides stormwater treatment separated from contaminated soil and groundwater. The proposed landscape requires no changes the plans of the site's current owner, HRP Group (formerly Hilco), and could be implemented in five years.



Figure 176. Rendering of Girard Point with the warehouses reconfigured to make room for public access, wetlands, and flood storage. Source: OLIN/Clean Air Council, 2020

Long-Term: Room for the River and \Restoration

» Girard Point is the largest and lowest-lying sector of the former Refinery site, once part of the vast freshwater tidal marshes at the confluence of the Schuylkill and Delaware Rivers. HRP Group plans to raise the entire site by five feet, above projected flood levels, and fill it with a logistics center. This strategy leaves no room for ecology or the public, and could worsen flooding in adjacent low-lying neighborhoods. We proposed a middle ground that interlaces warehouses with a tidal wetland restoration providing flood storage, habitat, and a wild river landscape for visitors.