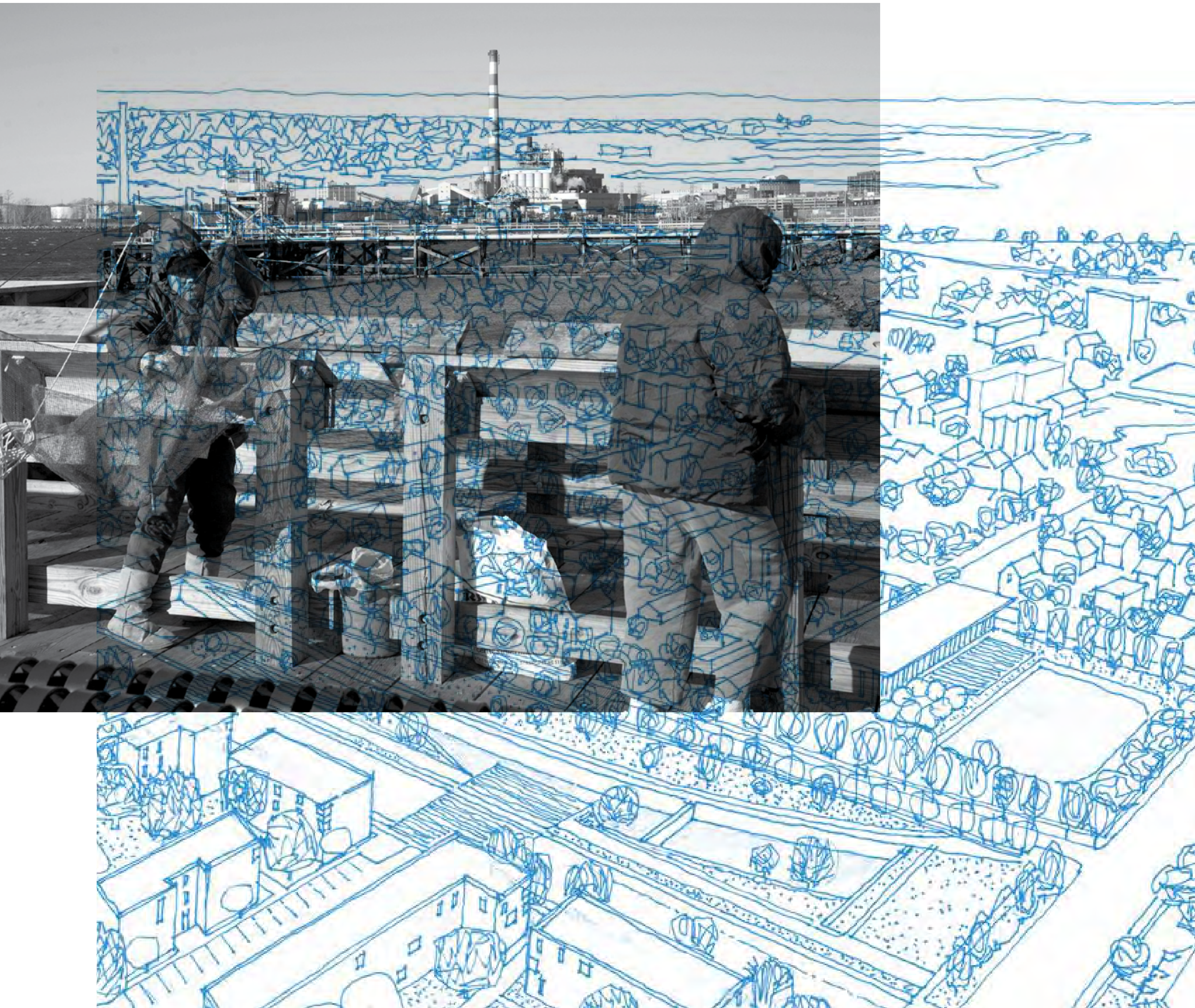
28 FEBRUARY 2018
DESIGN STRATEGIES REPORT

Resilient Bridgeport



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Chronic Flooding in the South End
Water in Iranistan Avenue, a primary roadway in the focus area, after a rainstorm in August 2016.
Image credit: Diego Celis

January 18, 2015
The Seasides
Image credit: Marcella Kovac

A Letter from the State of Connecticut

A shock often paralyzes, momentarily, when it hits the system; but when that initial reaction dissipates, the acute crisis can lead to focus and an ultimate strengthening of the system that was temporarily weakened. Superstorm Sandy created an impact in Bridgeport, and in large and small communities across the region, uncovering underlying chronic stresses that had been allowed to become seemingly inevitable characteristics of our society, and also shed light on assets that may have been left to stagnate without cultivation. Bolstering inherent strengths to alleviate chronic stresses so that communities can emerge from the immediate impact of a shock stronger than they were prior, and even better suited to reach their goals, is the realization of Resilience. With funding from the Federal Department of Housing and Urban Development's Rebuild by Design competition, a new approach to post-disaster recovery **emphasizing a holistic approach to community resilience**, some of the greatest global designers partnered with Connecticut and its most populous city to ground these theories in a community, comprised of real infrastructure, buildings, businesses, institutions, ecosystems and - most importantly - people.

This funding allowed the state and its consultants to engage local stakeholders through a robust participatory process that produced this blueprint for green and grey infrastructure that **support recovery from the shock, confront the stresses that constrain potential, and highlight and develop those local attributes** that will underpin resilience. The residents, business owners, and institutional representatives who have spent evenings and weekends engaging with their neighbors to guide the consultant team toward this strategy and, in doing so, strengthened their community network are Resilient Bridgeport. The city departments, state agencies, contractors, developers, institutions, and neighborhood organizations that will implement this strategy and, in doing so, strengthen their capacity to achieve existing and new objectives are Resilient Bridgeport.

This document outlines the strategy to achieve resilience in Bridgeport and similar communities. It is a physical object, imbued with agency to support local stakeholders acting out their roles within a Resilient Bridgeport: a manifestation of both memory and desire, lighting the path already charted collectively by participants to date and for enabling its course to be corrected and advanced as new participants continue to become engaged. This document is also a mirror for other communities in Connecticut and beyond who may see a piece of themselves in the **challenges and opportunities** presented here and a blueprint for how they too can foster their own flavor of resilience that best prepares their community to achieve its goals regardless of the shocks and stresses that they may face.

During this planning process for Resilient Bridgeport, Connecticut was **awarded significant additional financial support to construct the top priority infrastructure projects identified in this strategy, and to scale up resilience in the state through the creation of statewide policy and a Resilience Roadmap** developed by the State Agencies Fostering Resilience (SAFR) Council and a coastal resilience plan - Connecticut Connections - for Fairfield and New Haven Counties.

Through a **robust and engaging planning and decision-making process**, each community's unique natural features, infrastructure and built environment, and human capital will present a strategy for resilience that shares ingredients with Bridgeport's but is uniquely of that place. Connecticut's coast is grounded in a geology that presents high ground ridge lines that run parallel to its rivers and perpendicular to Long Island Sound. Its linear infrastructure spine running perpendicular to those ridges - typified by the Northeast Corridor/New Haven Line - connects its communities to one another and to resource centers beyond the state's borders. Its communities - made up of individuals, businesses, and institutions - provide the talent and capacity to support the area's evolution. They have a **strong historic connection to the water**, to the Sound and the rivers that shape our state.

This document presents a strategy that builds on the particular manifestation of these assets within the City of Bridgeport in a way that limits the potential impact of the acute shock of a coastal storm event, but in doing so, simultaneously addresses the underperforming tax base, disconnected employment opportunities, and concentrated poverty that stress the City's and its communities' capacity to emerge from that and other shocks stronger than before. The process that led to this strategy is one that will guide future work across Connecticut, through Connecticut Connections and the SAFR Council. **Resilient Bridgeport will be the first of many and a precursor to a Resilient Connecticut** that will better prepare our state and its communities for the known and unknown challenges that we will face in the foreseeable future and beyond.

David Kooris
Director, Rebuild by Design and National Disaster Resilience
State of Connecticut, Department of Housing

Design Team

Led by Waggonner & Ball Architecture/Environment, the design team brings together architects, landscape architects, urban designers, engineers, and ecologists to provide an integrated approach to the development of a resilience strategy for Bridgeport.

Waggonner & Ball Architecture / Environment is a design and planning practice based in New Orleans, close to the Mississippi River and the Gulf of Mexico. Waggonner & Ball designs environments and transformational strategies, from civic buildings to innovative district and regional plans across the United States. **Arcadis** is a global engineering and design consultancy that provides expertise in hydraulic modeling, ecology, economic analysis, civil engineering, and infrastructure design, with an office in New York City. **Reed Hilderbrand** is a landscape architecture firm with an office in New Haven, that provides expertise in design that connects people to place, through culture and natural systems. The **Yale Urban Design Workshop** is a community design center based at the Yale University School of Architecture, in New Haven, that provides urban design and community engagement expertise. **Dorgan Architecture and Planning**, based in Storrs, Connecticut, together with Bridgeport Neighborhood Trust and Donald Watson, lead the team's community engagement efforts.

WAGGONNER & BALL

ARCADIS

REED HILDERBRAND

YUDW
Yale Urban Design Workshop

CONNECTICUT
Department of Housing

ALL IMAGES IN THIS REPORT ARE CREDITED TO THE RESILIENT BRIDGEPORT TEAM LED BY WAGGONNER & BALL ARCHITECTURE/ENVIRONMENT, UNLESS OTHERWISE NOTED.

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Why Bridgeport?

Downtown, Core of the City
The rich layering of historic and contemporary architecture, along with attractive and well used public spaces, is a major asset, and shows the potential for more vibrant community areas in the future

Evolution of Bridgeport

History of Innovation
Since its founding, Bridgeport has been a place of invention and the vanguard of industry, home to local companies that changed manufacturing, including Howe sewing machines (top)[1], Sikorsky helicopters (middle), and Buckminster Fuller's Dymaxion Car (above).[2]

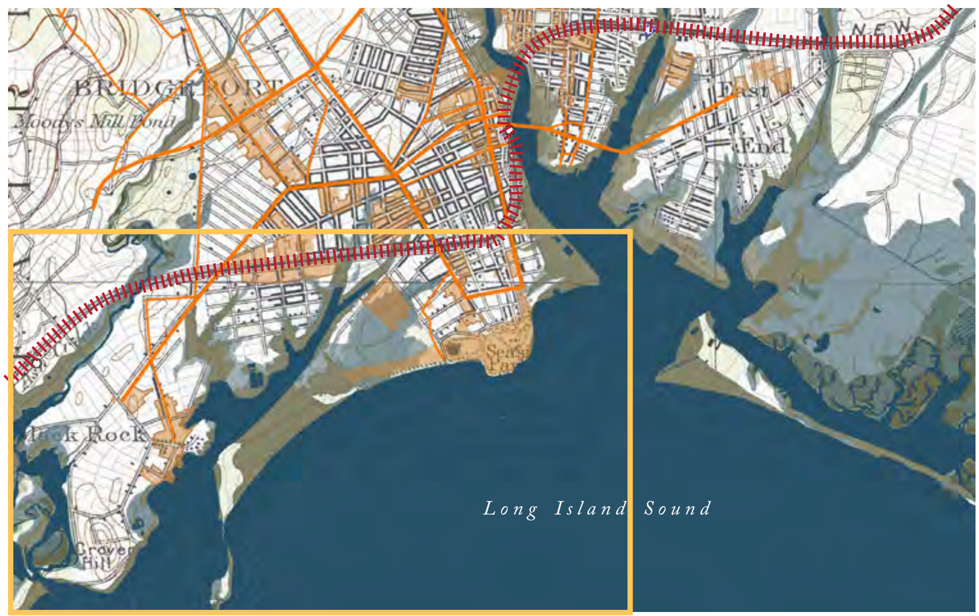
Bridgeport is a coastal city built on peninsulas. A significant amount of development in the 20th century was constructed on filled streams and marshes. These low-lying regions are now susceptible to flooding. Today, the city's infrastructure is aging, its ecosystem is damaged, and the economy is transitioning, as in other small and medium-sized industrial cities in the region.

Between 1850 and 1920, Bridgeport quickly grew from a town of 7,500 people to a bustling city of 145,000, becoming the fifth largest city in New England. **Innovation catalyzed the initial growth of Bridgeport** and created a prosperous place for well over a century. Manufacturing of new inventions such as sewing machines, ammunition, and helicopters attracted more investment and residents. This continued through World War II, when regional energy production also emerged as an industry.

At the same time, development placed increasing real estate pressure on Bridgeport's natural landscape. Areas, such as the marshes along the east side of the South End, were filled in, coastal edges were hardened, and natural watercourses were modified, increasing the volume and velocity of surface runoff. Over time, larger footprints of impervious surfaces – such as buildings, parking lots, and roadways – has **amplified flooding** caused by regularly occurring storms. Parts of the South End and Black Rock Harbor were built on fill and often not elevated to the level of existing adjacent land. As a result, these low lying areas are prone to flooding. Development, particularly around Iranistan Avenue, including Marina Village, Seaside Village, and areas west, are at risk as seas rise.

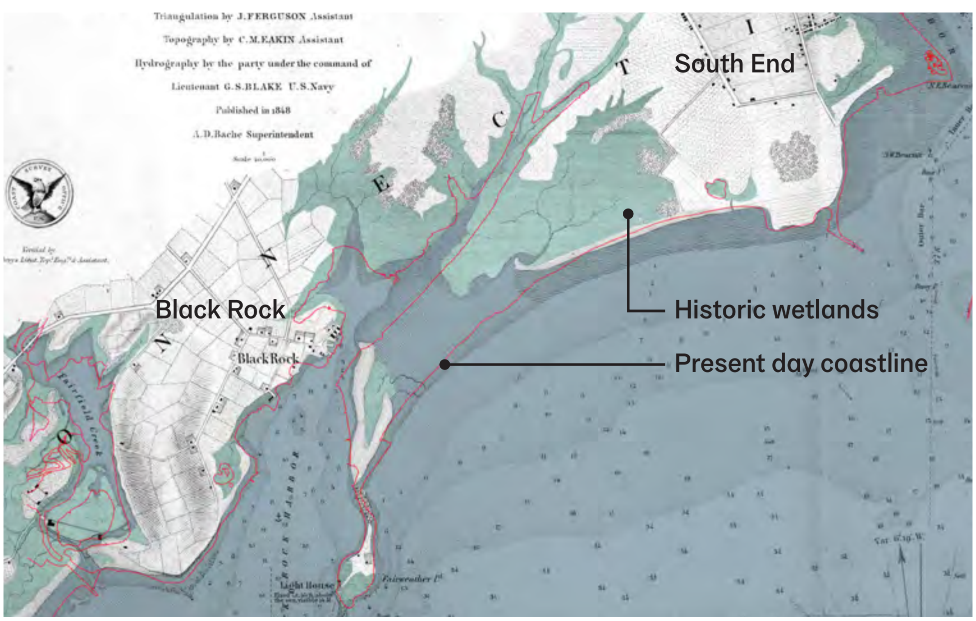
Resilience – the ability to withstand ongoing chronic stresses, such as repetitive flooding, as well as specific shock events like a disaster, and then adapt and thrive – is critical to the successful future of Bridgeport, coastal Connecticut, and communities around Long Island Sound. After decades of declining investment, along with pollution from a combined sewer system, Bridgeport has an opportunity to **chart a course to a thriving, resilient future**, through upgraded infrastructure, restored ecosystems, and new investment. While the city's economy has largely deindustrialized, existing historic buildings with strong architectural character are gradually seeing reuse. This identity can be reclaimed in a new economy, such as the emerging local sustainable energy industry, to make Bridgeport a leader in resilient design.

Regional Connections: Edge of the New York Metropolitan Area
Bridgeport is part of the Northeast Corridor, and is a key point between New York (60 miles) and Boston (150 miles). In Connecticut, the major pattern of development is along the water's edge; 62% of the state's population of 3.57 million lives in coastal counties. Bridgeport is Connecticut's most populous city with 146,700 residents. Much of the region's critical infrastructure – electricity generation, wastewater treatment, and rail and road transportation corridors – lie within the coastal floodplain and is at risk due to rising sea levels.



Historic City: Water and Higher Ground
Bridgeport developed on the edge of a peninsula at the juncture of the Pequonnock River and Long Island Sound. Major transportation corridors, shown in orange, developed running north from the shore along high ridges and along waterfronts. The downtown area, with direct access to Bridgeport Harbor, grew first. The construction of the railroad connecting the harbor to the hinterland in the 1840s allowed Bridgeport to become a major industrial city. Factories and mills developed on the waterfront, and then along the rail lines, with workers' housing to follow.

- Water, 1700s-1893
- Wetlands, 1848-1893
- Bridgeport Historic Districts
- Roads, 1700s



Historic Coastline: Manipulated Over Time
The coastline of Bridgeport has been continuously modified since the area was first inhabited and urbanized in the 1840s. Economic pressures on real estate from industrial and commercial interests resulted in a process of landfilling, both along water edges (the east side of the South End) and in former shallow marsh areas (the west side of the South End). Throughout the city, waterways and wetlands gradually transformed into urban landscapes, in a way that destroyed this important natural buffer to storms. Impervious surfaces in upland areas then generated higher volumes of stormwater runoff. Filling in lowland areas, where former wetlands are shown in green, has produced areas that are prone to routine flooding.

Catalyst for Change: Superstorm Sandy

In 2012, Sandy exposed widespread systemic deficiencies throughout the region and in Bridgeport, and has become the driving force for reshaping architecture, infrastructure, and public spaces.

Sandy hit Bridgeport just one year after Hurricane Irene and the Halloween nor'easter pummeled Connecticut and the East Coast in 2011. The timing of multiple devastating storms within a year was Bridgeport's catalyst for change. Sandy caused $38 million worth of damage to buildings and contents within the project area. The aftermath and immediate recovery forced the city to evaluate and reassess its current weaknesses, particularly economic vulnerability within the community.

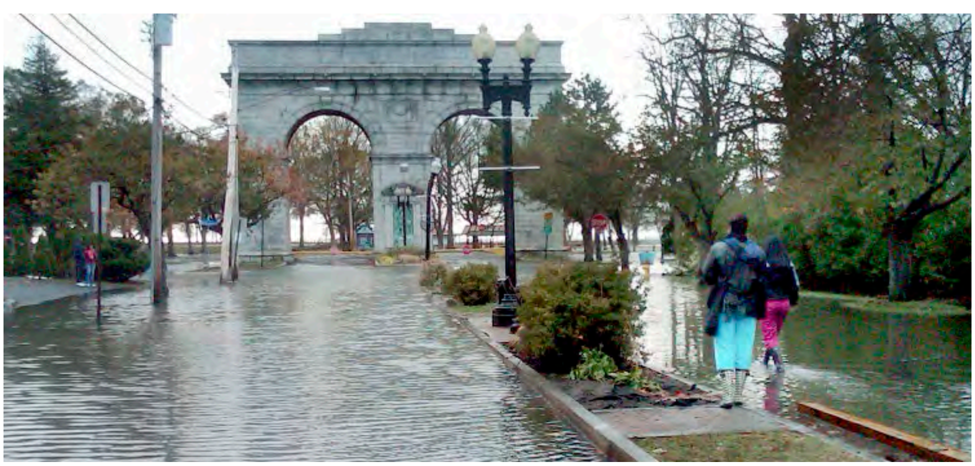
Damage from flooding was primarily concentrated in the low lying parts of the South End and other areas along the coastline. Wind damage also occurred near the coast and slightly inland, where fallen trees downed power lines which cut off power to large portions of neighborhoods. Fortunately, the storm caused relatively limited displacement of residents and businesses.

It did not take a single storm on the scale of Hurricane Katrina in New Orleans, but instead multiple smaller events have **exposed ongoing vulnerabilities** in the city. Sandy, along with Irene and the Halloween nor'easter, highlighted widespread aging and degradation of critical infrastructure, including drainage, utilities, and transportation. These systems could have fared far worse, as New York City and coastal New Jersey experienced after Sandy.

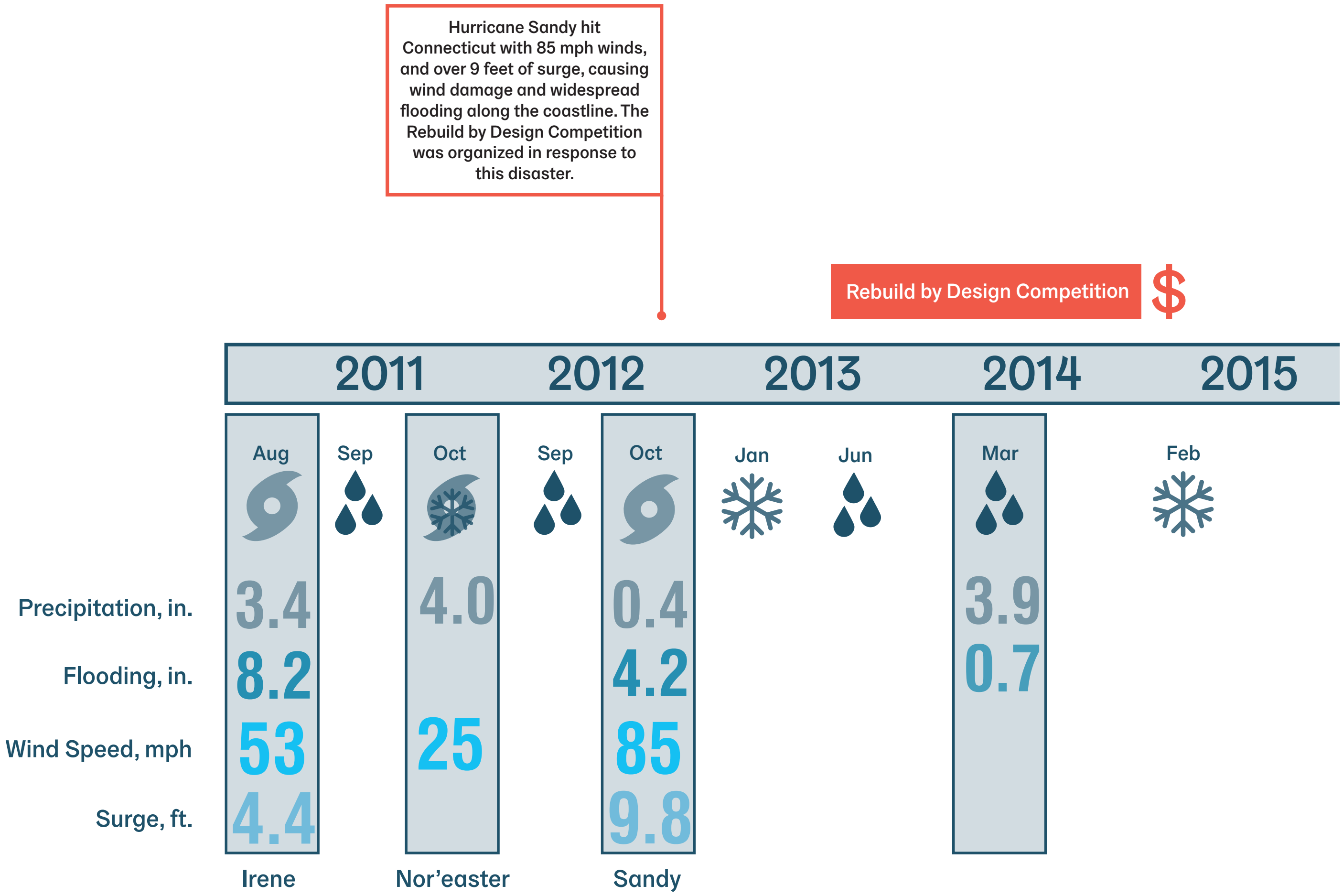
Bridgeport was poised to pivot after the storm. The city was open to a resilient approach and had been part of the national conversation prior to Sandy. Across City agencies and with broad community support, Bridgeport already had a willingness for a resilience agenda. The B Green 2020 plan, adopted in 2010, outlines a ten year vision for the city to develop a new type of economy that is based on a range of projects and initiatives to **increase sustainability**. BGreen 2020 also prioritizes resilience, health, quality of life, and economic opportunity as the core of the plan. This innovative effort was subsequently updated after Sandy in 2013, and emphasizes the urgency for Bridgeport to adapt to the effects of climate change and remake itself to become a model city.

Sandy Hits Bridgeport
Above: Waves from the storm surge in Long Island Sound crash ashore at the edge of Seaside Park.
Image credit: Jessica Hill, AP

Damage in the South End
Left: Fallen tree and flooding in Seaside Village in the South End.
Image credit: Diego Celis



Flooding Outside of Seaside Park
Left: Historic main entrance at the foot of Park Avenue is flooded, along with several blocks of the roadway itself.
Image credit: John Christoffersen, AP



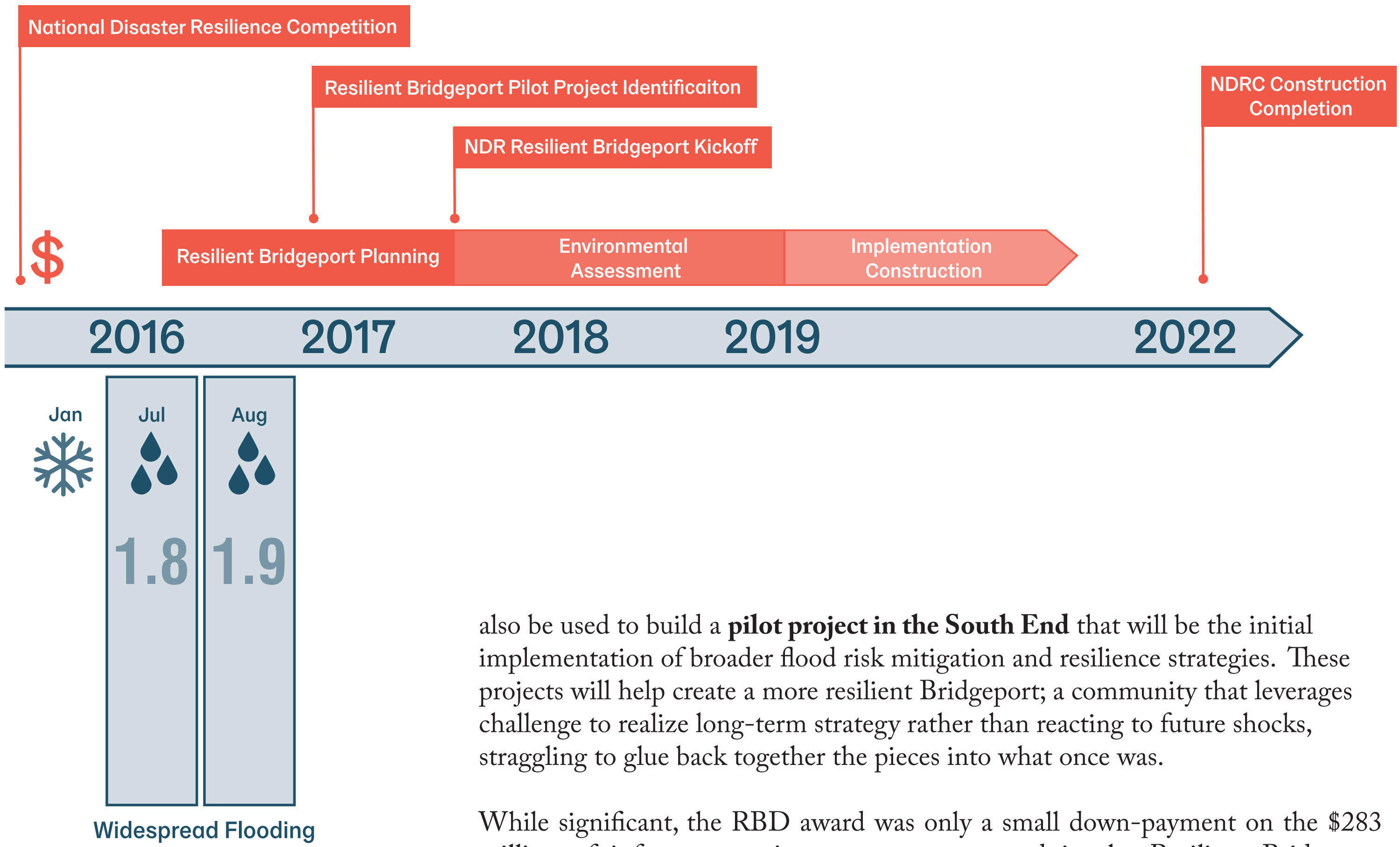
Response for Resilience: Competition to Design

Rebuild By Design provided a structure for knowledge-sharing, visioning, and integrating planning processes with an eye towards answering the question of what a 21st century city needs to look like. This effort requires new ideas, ways of working, and learning from other regions.

Resilience is the ability of a community to prepare for and get back on track following an acute shock, such as major storms, overcoming chronic stresses in the process, such as poverty.

In 2014, the U.S. Department of Housing and Urban Development (HUD) selected the City of Bridgeport and the multidisciplinary design team led by Waggonner & Ball to prepare an integrated resilience framework for the city through the federal Rebuild By Design (RBD) Competition. This effort intended to produce **innovative design strategies that could be practically applied** to help Bridgeport become more resilient in the face of future disaster, made more likely by climate change. Similarly, following Hurricane Katrina, Waggonner & Ball led the Dutch Dialogues, a cross-disciplinary effort to reimagine New Orleans as a city that embraces water.

HUD awarded the State of Connecticut $10,000,000 in 2015 for the Bridgeport RBD team to continue developing a plan for reducing flood risk and improving resilience for the South End and Black Rock Harbor areas. The funding will



Timeline of Resilience

CLIMATE CHANGE, SEA LEVEL RISE, AND INCREASING STORM INTENSITY WILL LIKELY EXACERBATE THE FREQUENCY AND FORCE OF THE WEATHER EVENTS LIKE THOSE SEEN THIS LAST DECADE. LARGER SURGE AND RAINFALL EVENTS WILL CAUSE GREATER DAMAGE TO PROPERTY AND COULD IN THE FUTURE MAKE REBUILDING COST PROHIBITIVE.

also be used to build a **pilot project in the South End** that will be the initial implementation of broader flood risk mitigation and resilience strategies. These projects will help create a more resilient Bridgeport; a community that leverages challenge to realize long-term strategy rather than reacting to future shocks, straggling to glue back together the pieces into what once was.

While significant, the RBD award was only a small down-payment on the $283 million of infrastructure improvements proposed in the Resilient Bridgeport application for the South End, Downtown, and Black Rock Harbor. Together, these investments were designed to create social, economic, environmental, and resilience benefits valuing far greater than that investment amount. Investments in hard infrastructure and natural systems would fuel the next generation of growth in the city, laying the foundation for further private investment providing jobs and tax base in accordance with a strategy that increases neighborhood resilience and prosperity with each investment. With a concept in place, Connecticut was well positioned to compete in the national competition modeled after RBD, the National Disaster Resilience (NDR) competition. Open to over sixty state and local governments, NDR urged communities large and small to build strategies and identify infrastructure investments like those that had been formulated for Bridgeport. In its application, Connecticut generalized the Bridgeport approach for applicability along the entire coast, highlighted unfunded Bridgeport projects unfunded through RBD, and identified the first round of improvement to reposition New Haven for success. The State was awarded an additional $54.3 million; Connecticut was one of 13 awardees through NDR in 2016. Of that award, $42.5 million will be used for additional Bridgeport projects in the city's South End identified in this strategy document, and the remainder will be used to advance resilience policy and planning along the Connecticut coast and statewide.

This document is meant to **guide the ongoing process of resilience** planning. This document captures key ideas and processes, and is less of a record than a call to action and engagement. This document strives to aid in **leveraging additional investment and interest.** Continued community participation is needed in planning and implementation efforts. Just as sea level rise projections will change, ongoing dialogue, monitoring, data collection, learning, planning, and design – constant adaptation – is necessary to contend with the environmental challenges of today.

Existing Assets in the South End, View towards Fairfield
The drone photo above indicates key places and stakeholders

Response for Resilience: Community Engagement

Working Together in the South End

The South End of Bridgeport is home to a wide range of stakeholders including residents, preservationists, the University of Bridgeport, local and regional industries, and recreational organizations. Resilient Bridgeport has become a **large scale conversation**, enabling different groups to come together and discuss larger issues of resilience and healthy growth within the South End.

The team met with both public and private stakeholders to negotiate different issues surrounding the pilot project and resilience strategies. This open dialogue around issues of land use and ownership, easements, infrastructure maintenance, preservation, and adaptation has encouraged cooperative planning with many stakeholders. Facilitating this ongoing discussion provides opportunities for mutually beneficial planning efforts, increasing the value of this and other public investments.

Creating Opportunity

Bridgeport's recent grants –RBD and NDR funding – and concentrated interest provide a critical chance for the innovative adaptation of a coastal industrial city to become an example for other cities throughout the region. Grants have created **opportunities to leverage funding** within the city, and will help **catalyze several major redevelopment sites**. Within this process, the team will continue to explore partnerships in the community and the region to expand the impact of the original funding. This planning effort has collected data and created decision-making tools, such as an enhanced stormwater model, that can aid the City of Bridgeport in future projects.

Creative Engagement

Engagement throughout the RBD competition and Resilient Bridgeport processes has shown that residents, businesses, institutions, agencies, and entities at both regional and national levels are **eager to see progress**. The Design team hosted over ten workshops that required active participation in the design and project selection process.

Existing Assets in the South End, View towards Stratford
The drone photo above indicates key places and stakeholders

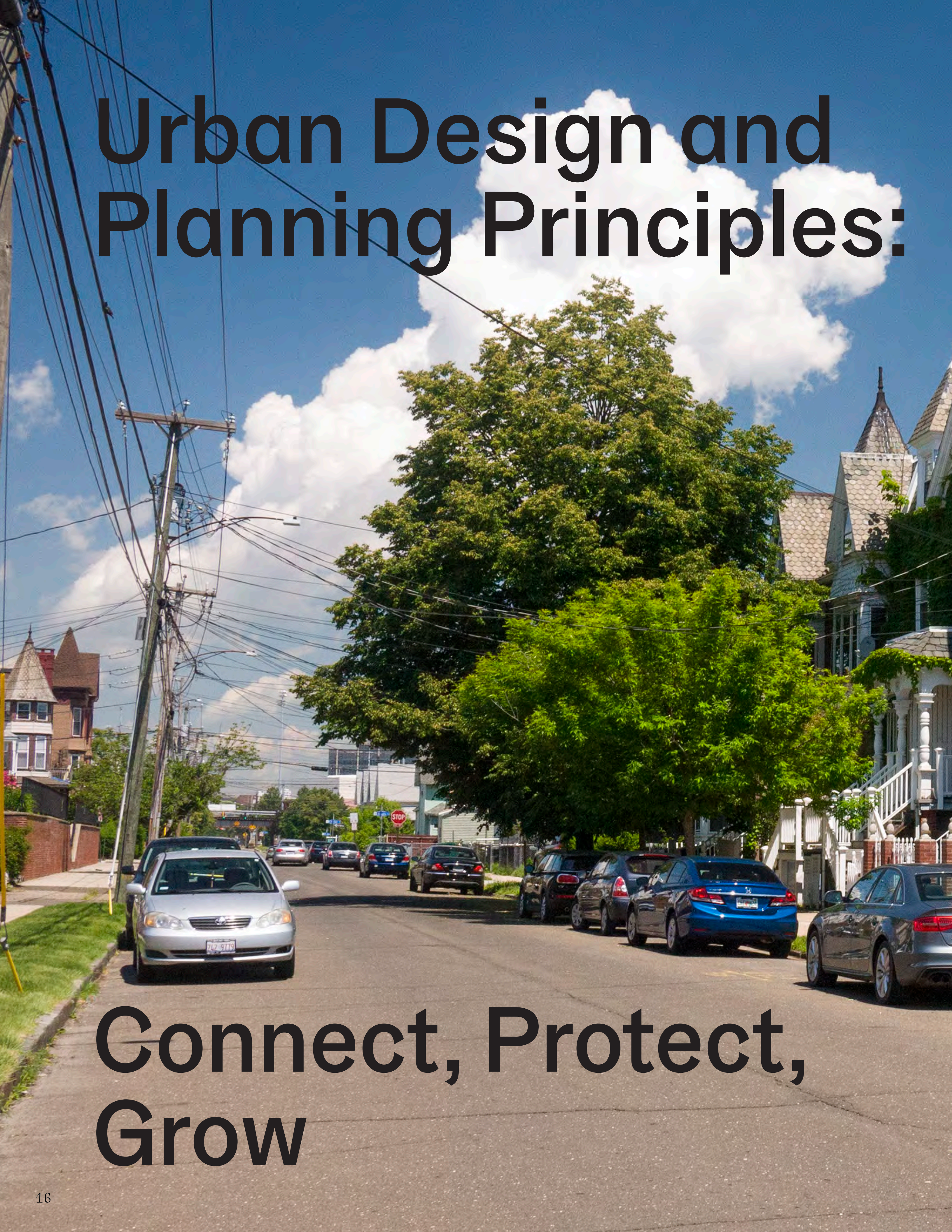
Resilient Bridgeport also sought out partnerships with local organizations for lectures, events, and potential projects. These organizations included the National Trust for Historic Preservation, Union of Concerned Scientists, Groundwork Bridgeport, Housatonic Museum of Art, The Nature Conservancy, and others.

Community Resources

A design center at 7 Middle Street in downtown Bridgeport, initially conceived of in RBD, represents a process that focuses on learning, connecting stakeholders, and **creating civic dialogue towards a shared vision**. Along with a Design Conditions Atlas, broadsheets, website, and social media, the Resilient Bridgeport design space at "7 Middle" shows the promise of making ideas and design visible and accessible – critical to implementation of current and future work. Visibly located at the corner of Middle Street and John Street, 7 Middle is also one block away from the regional multi modal transit center, and is easily accessible by public bus. The insight and enthusiasm of the community has been vital to the design process.

Learning, Connecting, and Working
At right, a walking tour of the South End and a workshop at the design center at 7 Middle with community members.

Urban Design and Planning Principles:



Connect, Protect, Grow

Existing Examples
Many parts of the project area were designed or built to successfully create character, value, and a sense of place by following logical urban design principles, such as these historic rowhouses on Broad St. in the South End.

Layered and Integrated Planning

Integrated resilient planning requires a deeper understanding of how different layered systems interact. Soils and water are the basis for planning and designing infrastructural networks, which help to shape the urban fabric and human activity. Policies and human activities change the shape of the land and the flow of water and nutrients across the landscape. These interactions are visible throughout Bridgeport, coastal Connecticut, and the New England coast. Prior decisions regarding these systems both support and constrain future action.

Image credit: Andrew Sternad, Yale Urban Ecology & Design Lab

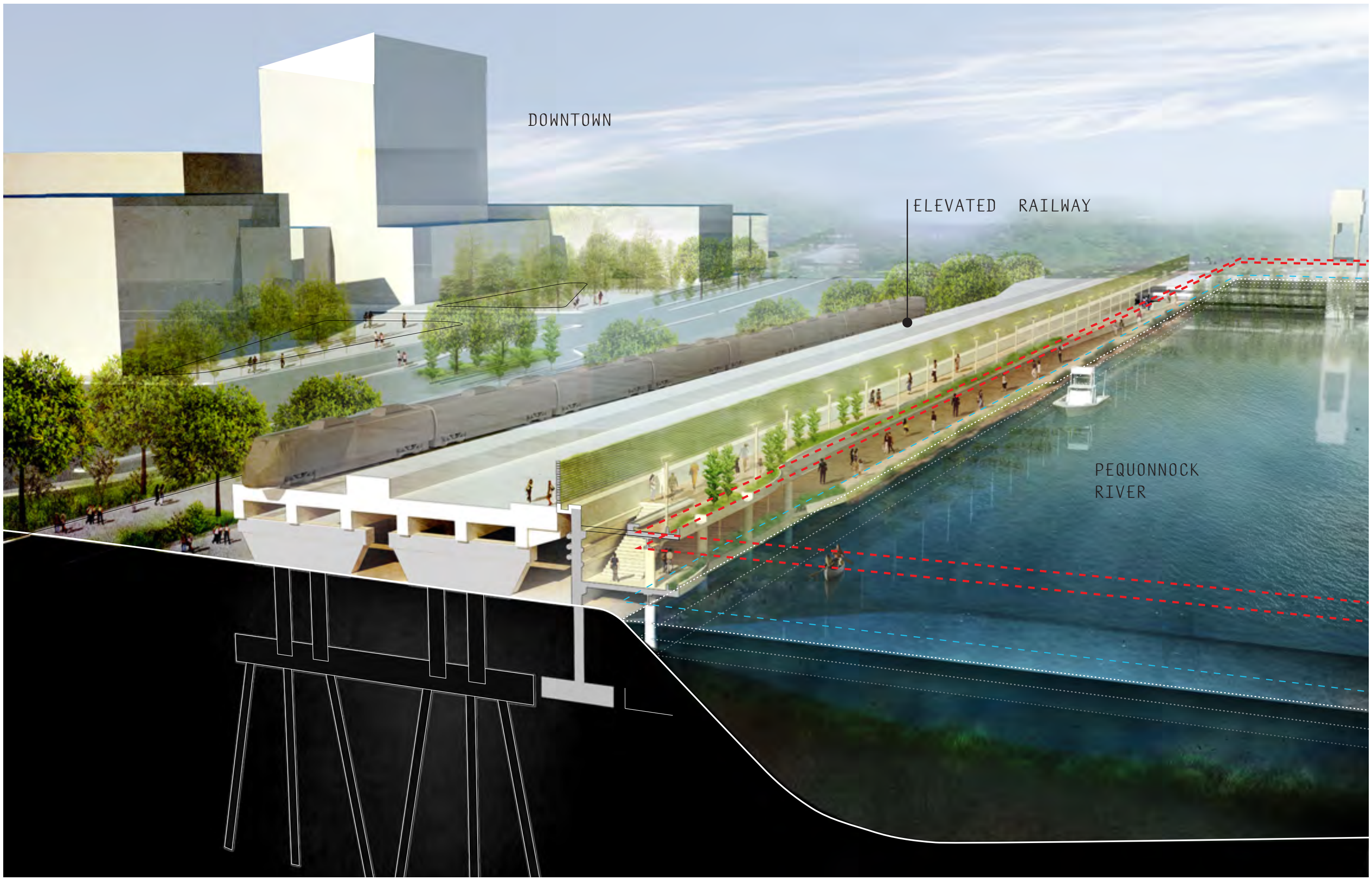
Connect, Adapt, Grow

Achieving resilience requires identifying strategies that provide multiple positive effects beyond a single intent – benefits in the short and long-term, at the local and regional scale, and across ecological, economic, and social sectors.

Resilient design requires an understanding of both natural and man-made infrastructure systems and how they interact with one another. The natural context often spans political boundaries and encompasses soils, topography, risk of extreme events, microclimates, and conditions that are inherent to inhabiting the coastline compared to occupying high ground further inland. The legacy of past investments and decisions forms the infrastructure context and includes rail lines, highways, roads, land uses, brownfields, and conditions that are inherent to a built environment with long history. In each place, local/regional and natural/built environments combine to form a unique context for resilience. The principles found on the following pages are designed to be specific to Bridgeport, but generalizable at least across Connecticut, New England, and the Northeast.

In this section, the principles of urban design are organized in four categories: waterways and waterfronts, public spaces, streets, and buildings and sites. These four principles of urban design are central: waterways and waterfronts, public spaces, streets, and buildings and sites. These principles served as the criteria for selecting a pilot project in Bridgeport and represent **core elements of future projects** in the city, with the goal of replicating them throughout coastal Connecticut and New England. As broad themes, they contain specific strategies for how to "connect, protect, grow" — three main ideas that are critical to the success of Bridgeport and the larger coast. This report intends to encourage the development of work that can be **replicated across the region,** leading the way into a more resilient future.

Resilience enables communities to adapt these systems - both natural and man-made - to improve their ability to withstand a disruption more effectively. Resilience also enables them to build new relationships, launch new initiatives, and seize new opportunities - opening up new future paths than those that previously existed. This is the resilience dividend. [3]



Connecting, Protecting, and Growing Along the Edge

The transit corridor running through Downtown could be replaced or augmented to provide public access along the entire riverfront and storm surge reduction while continuing to support inter-city and inter-state mobility.

Connect:

- SEEING, UNDERSTANDING, AND USING WATERWAYS AND WATERFRONTS AS VITAL PARTS OF THE CITY AND ITS PUBLIC REALM
- USING CORRIDORS AND TRANSPORTATION NETWORKS TO REESTABLISH PEOPLES' ABILITY TO ACCESS WATERWAYS AND WATERFRONTS, LINK DIVERSE NEIGHBORHOODS TO ONE ANOTHER, AND PROVIDE EGRESS DURING STORM EVENTS EXTENDING AND EXPANDING NATURAL HABITATS AND ECOLOGICAL ZONES TO STITCH TOGETHER AN ENHANCED NETWORK OF BIOLOGICAL DIVERSITY

Adapt:

- ESTABLISHING REDUCE FLOOD RISK FROM RISING SEAS AND INCREASING STORM FREQUENCY AND INTENSITY
- ENCOURAGING ADAPTATION ALONG THE COAST
- RESTORING AND MANAGING HABITATS INCLUDING FRAGMENTED COASTAL ECOSYSTEMS, HISTORIC LANDSCAPES, AND NEIGHBORHOOD FABRIC

Grow:

- LEVERAGING INVESTMENT IN INFRASTRUCTURE AND “UNLOCKING" DEVELOPMENT POTENTIAL
- BUILDING IDENTITY OF CITY AS A PLACE AND INNOVATION

Waterfronts as Public Spaces
Direct experience of the water's edge ensures that the natural and historic context informs design for a resilient future.
Image credit: Cameron Blaylock

Waterways and Waterfronts

Access to water has shaped the development of Bridgeport since the city was founded. Waterways are a **community resource**, serving as a connection to the Pequonnock River and out to Long Island Sound. Local water bodies provide shipping, recreation, transportation, aquaculture, education, and research. While vulnerable to future rising seas, Bridgeport has the opportunity to adapt and innovate.

Water is the greatest natural resource to sustain life, by producing energy, food, habitat, and circulation. Waterfront communities should see waterways as a part of their **cultural and ecological heritage, and future** – as public spaces to be adapted through conservation efforts that improve water quality, water flow, biodiversity, and resilience of landscapes.

Bridgeport waterways have the opportunity to grow through:

- Biodiversity: habitat restoration
- Transportation on and to the water
- Economy of new clean industries: aquaculture, shipping, and waterfront development

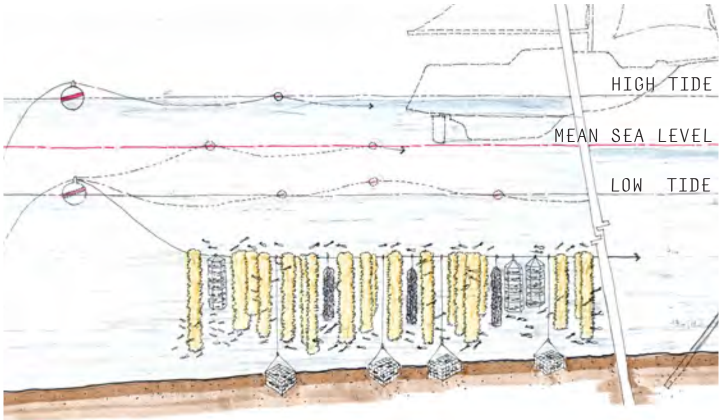



Image credit: Boston Globe

Growing in the Water
Top: proposed vertical ocean farming with kelp and mollusks.
Above: mussel harvesting in Long Island Sound.

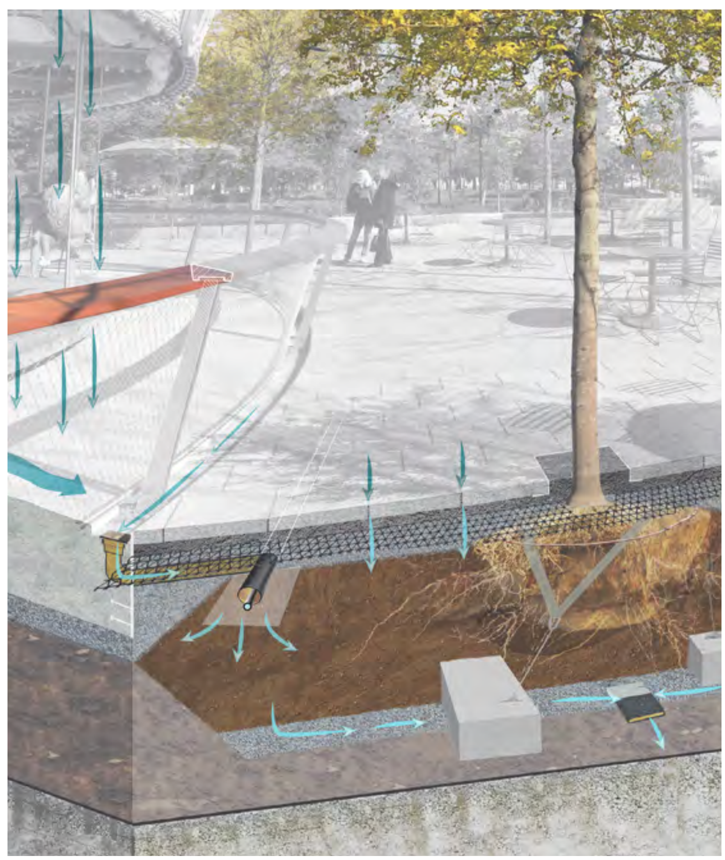
Public Spaces

The South End is home to Seaside Park — a large historic park that is a regional attraction with miles of frontage along Long Island Sound, designed by Frederick Law Olmsted in the 1860s. The process of **creating more multifunctional public spaces** can engage and connect the community through the design, as well as the ongoing operations and maintenance of the park.

Public spaces can serve additional functions of:

- Reducing chronic flood risk in the neighborhood by storing stormwater
- Creating additional habitat for local plants and animals
- Communicating the history of a place's environment, cultural heritage, and people

New public spaces within Bridgeport will create a network that strengthen the historic identity as "Park City," creating destinations in the city to draw people together. These open spaces can also form a **new type of resilience network**, by temporarily storing stormwater or as a site for emergency services and egress.



Resilient Systems in Public Spaces
Green infrastructure, such as a tree well that collects, slows, and infiltrates stormwater, can be integrated into parks and plazas.

Multifunctional Streets and Sites
The annual Fairfield County Juneteenth African-American/Caribbean Parade transforms Main Street into a space for spectacle.

Streets

Streets are the connective tissue that link neighborhoods and the city. They both dictate the routes of circulation, and are also the **conduit for utilities and water systems**. Bridgeport's streets need to be reconsidered to anticipate flows, from streamlining underground utilities, to providing places for additional water storage and delay capacity, as well as enabling safe evacuation during storm events. Streets should adapt to accommodate **multiple modes of transportation,** from bicycles and pedestrians, and anticipate other systems such as bus rapid transit (BRT) and self driving vehicles.

Streets can also serve as one of the primary overland water conveyance networks, and visibly demonstrate a new relationship to water. By anticipating storm surge and water flowing both in and out, streets could **function as flood risk reduction** infrastructure, such as a raised infrastructure corridor that doubles as flood defense. The image at above right shows Wordin Avenue as this type of street.

Each street is a **public investment that enables and guides new development** of buildings and sites. Streets can set the stage for new investment in key places, such as raised roads near potential redevelopment parcels.

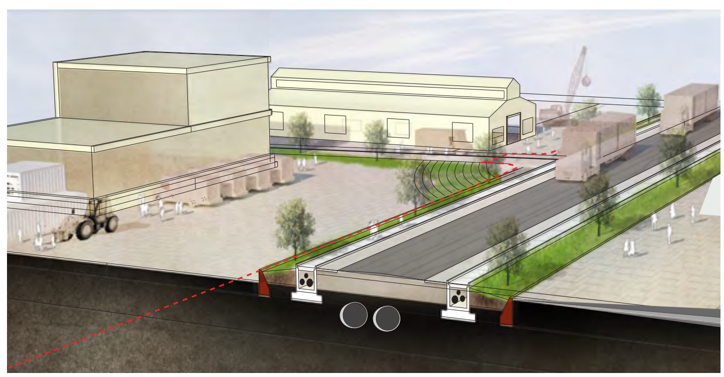


Image credit: unabridged architecture

Multifunctional Street Design
Making roadways more resilient would layer benefits of improving utilities, transportation, and flood risk reduction.

Buildings and Sites

Each building, block, street, or site should be considered in its larger context: the neighborhood, city, or watershed. As one system within the city, **buildings should adapt to be more resilient** by minimizing stormwater runoff and reducing consumption of power and water, while maintaining the character and scale of the neighborhood. Homes within the floodplain should be elevated for flood risk reduction, and upgrade building systems to be operable even when compromised, such as a backup power supply.

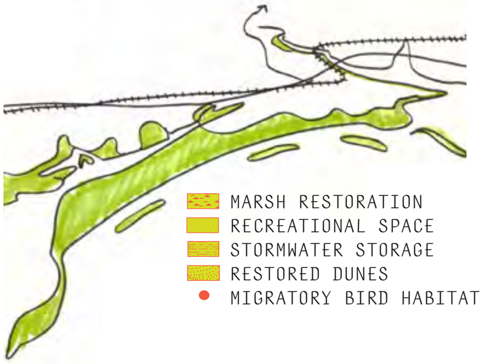
Historic building stock should be renovated or adapted for reuse, to reduce the life cycle cost of existing buildings by avoiding the demolition and disposal of valuable materials. Reusing existing buildings would also preserve the historic architecture that **communicates a neighborhood's identity.** New policy measures, such as the adoption of maritime architectural design guides or incentives through tax programs, can also help encourage growth and promote consistent development. **Self-sufficient growth of the tax base** within Bridgeport is critical to implement infrastructure programs and maintain existing systems. Reusing and adapting existing buildings, along with resilient development on vacant land would encourage further investment and revitalize neighborhoods.

Image credit: unabridged architecture

Building Adaptation, New and Old
Architecture can be elevated, reused, and catalyze development.

Resilience Design Strategies

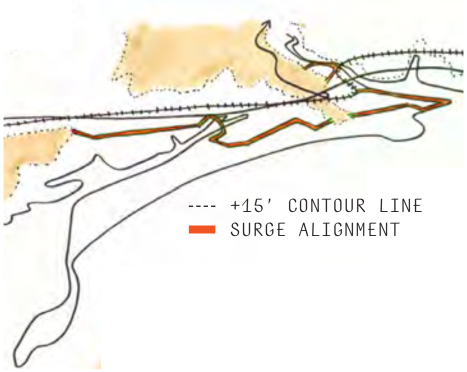
Fayerweather Island
Bridgeport's local example of marsh habitat, off the coast of Seaside Park.



Restore the Edge: Strengthen and Provide Access to the Coast

Preserves historic Seaside park and enhances its ability to buffer the adjacent neighborhood from wave energy; restores ecological habitats on and offshore; leverages waterfront for economic productivity; creates new spaces for a balanced approach to the water's edge.

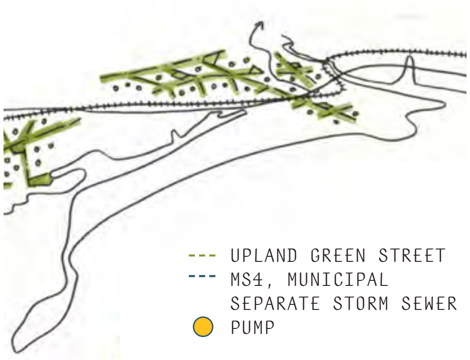
RESTORE THE EDGE GENERATES THE MOST ENVIRONMENTAL BENEFITS.



Adapt to Rising Seas: Provide Surge Reduction

Integrates flood risk reduction infrastructure into the neighborhood fabric providing co-benefits for connectivity, redevelopment, and ecological restoration, while decreasing flood risk from Long Island Sound and Cedar Creek.

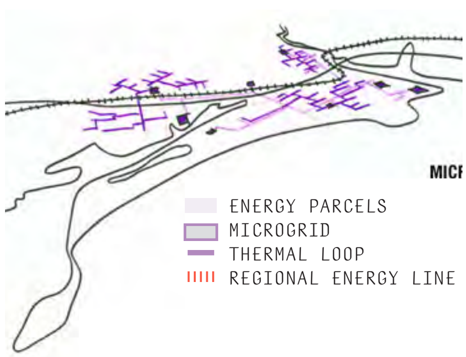
ADAPT TO RISING SEAS AVOIDS THE MOST ECONOMIC LOSSES



Delay and Convey Stormwater: Enhance Stormwater Capture and Discharge

Addresses chronic flooding from normal to heavy rainfall events, and reduces contributing stormwater volume to Bridgeport's combined sewer system, potentially separating systems where possible.

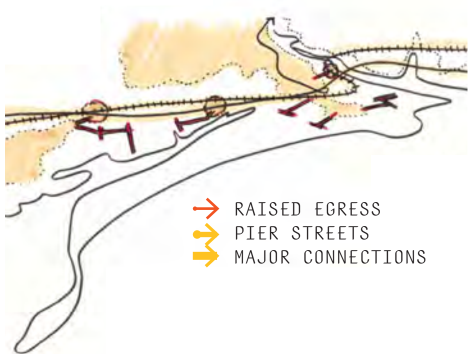
DELAY AND CONVEY GENERATES THE MOST WATER QUALITY BENEFITS



Make Energy Locally: Create Distributed Utility Networks

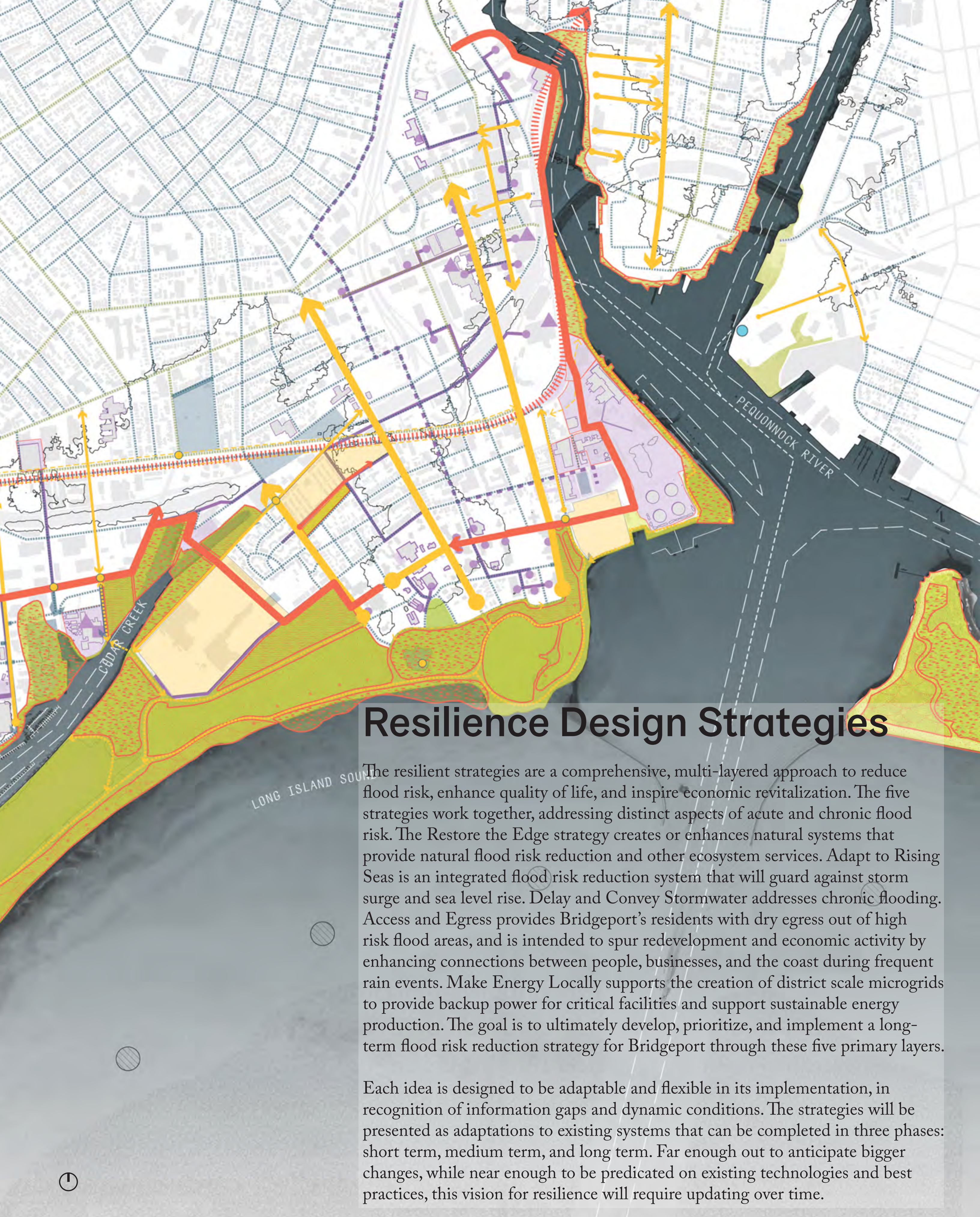
Supports the creation of neighborhood-scale microgrids and district heating/cooling to provide backup power for critical facilities; support renewable and low-carbon energy production; leverage regional energy assets for local benefit.

MAKE ENERGY LOCAL AVOIDS THE MOST DISRUPTION AND REDUCED THE MOST EMISSIONS



Access & Egress : Transportation and Development

Provides residents with dry egress out of high risk flood areas, with the intent of spurring development and economic activity by enhancing connections between people, businesses, and the coast.



Resilience Design Strategies

The resilient strategies are a comprehensive, multi-layered approach to reduce flood risk, enhance quality of life, and inspire economic revitalization. The five strategies work together, addressing distinct aspects of acute and chronic flood risk. The Restore the Edge strategy creates or enhances natural systems that provide natural flood risk reduction and other ecosystem services. Adapt to Rising Seas is an integrated flood risk reduction system that will guard against storm surge and sea level rise. Delay and Convey Stormwater addresses chronic flooding. Access and Egress provides Bridgeport's residents with dry egress out of high risk flood areas, and is intended to spur redevelopment and economic activity by enhancing connections between people, businesses, and the coast during frequent rain events. Make Energy Locally supports the creation of district scale microgrids to provide backup power for critical facilities and support sustainable energy production. The goal is to ultimately develop, prioritize, and implement a long-term flood risk reduction strategy for Bridgeport through these five primary layers.

Each idea is designed to be adaptable and flexible in its implementation, in recognition of information gaps and dynamic conditions. The strategies will be presented as adaptations to existing systems that can be completed in three phases: short term, medium term, and long term. Far enough out to anticipate bigger changes, while near enough to be predicated on existing technologies and best practices, this vision for resilience will require updating over time.

Restore the Edge

Preserves historic Seaside Park and enhances its ability to buffer the adjacent neighborhood from wave energy; restores ecological habitats on and offshore; leverages waterfront for economic productivity; creates new spaces for a balanced approach to the water's edge.

Bridgeport's historic identity is closely linked to its coastline on Long Island Sound, one of the most important estuaries in the country. Early settlers were reliant upon both farming and fishing, and the city rapidly grew in the mid-19th century because of the shipbuilding and whaling industries. The naturally deep ports continued to support urban growth as the city developed into a thriving industrial center. Unfortunately, Bridgeport's growth came at a cost. Natural habitats, such as wetlands, beaches, dunes, and low-lying coastal woodlands that historically characterized the shoreline were damaged. While Long Island Sound still provides recreational, commercial, and ecological services to the Bridgeport community, there is great **opportunity to restore native shoreline habitats** by layering coastal resilience and enhancing existing ecological and socio-economic services.

Restoring this "green edge" aims to rebuild native habitats that once dominated Long Island Sound shoreline, while also addressing **stormwater management, chronic flooding, coastal resilience, and pollution**. Restoring Bridgeport's shoreline would provide multilayered benefits:

- Enhanced coastal resilience specifically accounting for sea level rise, surge reduction, and drainage
- Improved sediment and water quality, reducing long term management costs
- Decreased chronic flooding
- Remediated soil contamination in brownfields
- Enhanced ecological habitat services to increase species diversity
- Enhanced commercial, recreational, and educational opportunities

These benefits and each of the following sections are discussed in more detail in the Benefits Report.

Coastal Resilience

This project is an opportunity to blend "green" measures, such as a living shoreline, and wetland restoration, with the traditional grey measures, like bulkheads, floodwalls, and rip-rap. Shorelines that have been primarily hardened by industrial development can become more naturalized. Blending strategies through a holistic approach provides a **comprehensive storm surge reduction system incorporating native shoreline habitats** that can evolve with sea level rise. These habitats **attenuate wave action,** aiding in buffering areas from storm surge. Green strategies can also improve poor water quality, chronic flooding, pollution, and ecological habitats degraded as a result of industrial development and hardened shorelines.

Pollution and Brownfields

Brownfields are vacant parcels of formerly industrial land with soil contamination. They provide opportunities to restore historic coastal wetlands while bringing benefits to the Bridgeport community. The approach is to remediate potential site contamination and excavate to suitable elevation for restoring wetlands Excavated fill could be used on site to **restore open space** and/or coastal forest, or shrubland. Excavated materials may be required to be capped.

Ecological Habitat

Bridgeport's shoreline was historically dominated by coastal and freshwater wetlands, beaches, dunes, and low-lying coastal woodlands. This **mosaic of native plant communities** was critical to supporting diverse terrestrial and aquatic ecosystems. Over time, urban development significantly degraded critical ecological services of Long Island Sound ecosystem. The Connecticut coastline was a major resource for migratory birds, and functioned as a refueling stop during their journey; the majority of migratory birds now avoid Bridgeport's shoreline. Science has demonstrated that the restoration of native habitats will attract species that were historically displaced. Restoring native shoreline habitats will attract larger numbers and a **greater diversity of bird species**, and could make Bridgeport a regional attraction for birdwatchers.

Natural Salt Marsh
Existing habitat on Fayerweather Island off the coast of Seaside Park.

Recovered Park Space
Brownfield sites around Seaside Park are being reclaimed by nature.

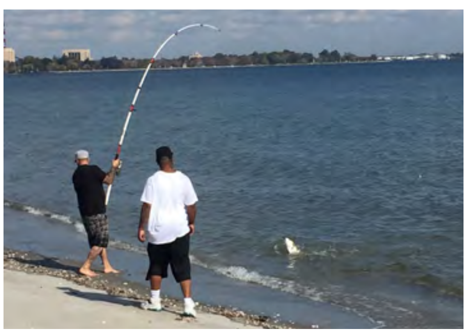
Key Benefits

BY RESTORING THE COASTAL EDGE WITH A VARIED LANDSCAPE OF HABITATS, RECREATIONAL OPPORTUNITIES, AND ECO-TECHNOLOGY INDUSTRIES, POSSIBLE BENEFITS INCLUDE:

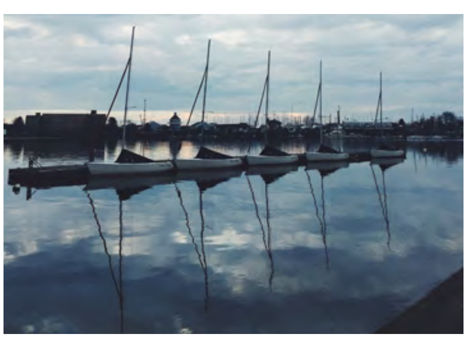
1. $8.8 MILLION IN ANNUAL ECOSYSTEM SERVICE BENEFITS FROM 270 ACRES
2. ATTENUATED WAVE ACTION, HELPING TO BUFFER STORE SURGE
3. CREATION AND ENHANCEMENT OF EXISTING HABITATS FOR FISH, MIGRATORY BIRDS, AND OTHER WILDLIFE OF COMMERCIAL AND RECREATIONAL IMPORTANCE
4. REMEDIATED EXISTING BROWNFIELD SITES
5. BOLSTERED RECREATIONAL OPPORTUNITIES
6. NEW AQUATIC ECONOMIC OPPORTUNITIES SUCH AS OCEAN FARMING
7. IMPROVED AIR & WATER QUALITY THROUGHOUT THE CITY
8. 39 JOBS CREATED FOR EVERY $1 MILLION INVESTED IN RESTORATION WORK
9. LESSENED EFFECTS OF URBAN RUNOFF ON RIVERS, LAKES, AND COASTAL WATERS
10. INCREASED COMMUNITY INVOLVEMENT IN STEWARDING NATIVE HABITATS

Seaside Park Beach
June 11, 2014
The Seasides
Image credit: Marcella Kovac

Emerging Center for Aquaculture
This vocational school in Black Rock Harbor focuses on aquaculture and water industries.
Image credit: Shelley Cryan



Resourece: Recreational Fishing
Many residents fish off of Fayerweather island in Seaside Park.



Resource: Recreational Boating
April 17, 2015
The Seasides
Image credit: Marcella Kovac

Commerce, Recreation, and Education

Bridgeport had a thriving oyster industry through the 19th century, with historic maps showing the intense harvesting in Long Island Sound immediately offshore from the city. Over time, the local industry suffered from overfishing, pollution, and heavy boat traffic. The restoration of green shorelines, and potentially oyster reefs, could improve water quality and restore native habitat structure and diversity. Restoring these native habitats within existing parks, such as Seaside Park, could **create educational opportunities** through partnerships with schools and local organizations.

Waters Edge Resources

Coastal shorelines are complex ecosystems that include a diverse range of habitats, both aquatic and terrestrial, each directly related to its proximity to water. Restoring this ecological diversity along the shoreline is **critical to sustaining important flora and fauna populations** native to the Connecticut coast. There is a vital connection between land and aquatic ecosystems; actions on land can directly affect aquatic communities. Over time, the entire food chain within Bridgeport's coastal ecosystem was destroyed. Four species in particular represent the great diversity and resilience of the Connecticut shorelines: oysters, bluefish, horseshoe crab, and red knot. These species, their ecosystem benefits, and the opportunities they could create for Bridgeport, are further discussed in the Ecology Report.

Offshore Resources

Just offshore in Bridgeport is a wealth of economic opportunity. One of those opportunities is **aquaculture**, specifically vertical ocean farming featuring kelp. Vertical farms are large submerged structures create habitat for kelp, oysters, mussels, and scallops. Kelp can grow up to three quarters of an inch an day and in addition to being sold for food, biofuel, and pharmaceuticals can uptake significant amounts of dissolved nitrogen from the water column aiding the significant nitrogen pollution problem in Long Island Sound. After being harvested, kelp is taken to shore and processed. This could create a use for some of the abandoned industrial sites along Cedar Creek. Several companies have created a booming business around kelp farming due to relatively low entry capital needed and the uptake in demand for kelp products. These industries and the expanded habitats could enable **eco-tourism** driving development of ferry services or charter boats.

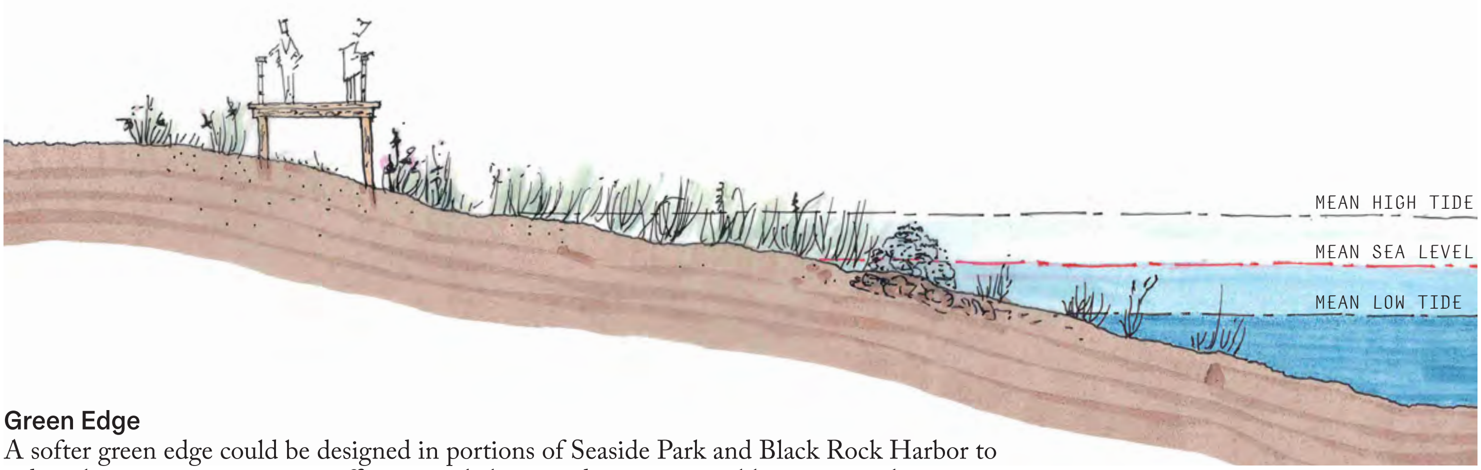
"...multiple sustainable commercial uses for kelp, including organic liquid fertilizer and biofuel; and... solar refrigeration systems for transport and storage."
- Bren Smith, GreenWave

Symbiotic Water Quality and Habitat

Menhaden are a species of fish that have historically been used for fish oil, but now are serving to aid in cleaning Cedar Creek. These fish feed on the water from the waste water treatment plant outfall, helping to clean the water further. Here they can be seen schooling around the water outflow.

Offshore Resource: Kelp Farming

One potential water industry for Bridgeport is kelp farming. Growing, harvesting, and processing kelp would create jobs, lower the pH of Long Island Sound, and create more offshore habitat. Bren Smith, shown at left, is GreenWave Executive Director and owner of Thimble Island Ocean Farm in Connecticut, which has pioneered restorative seaweed farming in Long Island Sound. Image Credit: CBS NEWS



Green Edge

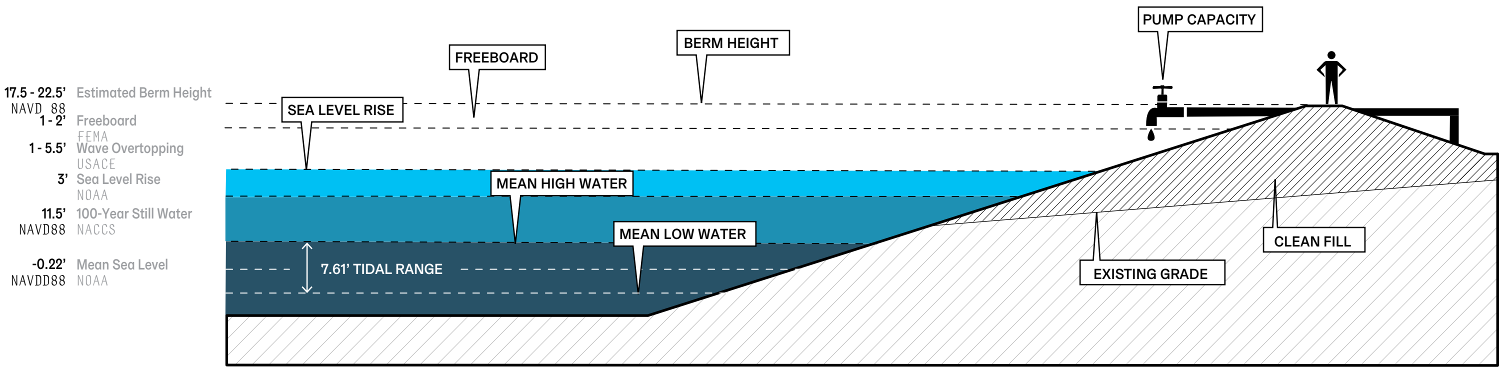
A softer green edge could be designed in portions of Seaside Park and Black Rock Harbor to aid in cleaning stormwater runoff, creating habitat, and increasing public access to the water.

Adapt to Rising Seas

Integrates flood risk reduction infrastructure into the neighborhood fabric providing co-benefits for connectivity, redevelopment, and ecological restoration, while decreasing flood risk from Long Island Sound and Cedar Creek.

Resting on the north shore of the Sound, Bridgeport, like many other places along the coast, is exposed to hazards such as large storm events accompanied by high winds, waves, and surges. Such storms can result in flooding from high water levels in the Sound, cause erosion, and inflict damage to structures and communities. Bridgeport has found ways to manage and address storm risks under current conditions. However, climate change has the potential to dramatically increase coastal hazards in Connecticut and by extension, coastal risk to cities along all coastlines.

The most direct risk to the city comes from storm surge and high water levels. With climate change, **sea levels are expected to rise** in the Sound, so even higher frequency storm events, such as a moderate tropical storm or a nor'easter, can become a threat to coastal communities. As water levels rise, higher waves are bound to follow. Areas that already experience wave action will be subject to more severe wave erosion and damage because larger water depths will allow larger waves to reach the shore. In unadapted areas, higher water levels will spread inland, allowing waves to reach structures that were previously above the flood level, thus subjecting these structures to wave impacts, erosion, and other damage. Not only will the flood plain begin to expand but the frequency at which it floods will increase as well.



Designing for Future Water Levels
The diagram above illustrates the various regulatory surge elevation requirements considered when designing the height of a surge reduction structure.

Design Considerations

In order to mitigate the risk that community residents, property, and infrastructure are exposed to during storm events, a **variety of flood risk reduction alignments were evaluated**, see alternatives on previous page. The measures that can comprise an alignment are depicted and discussed on the following pages. Ultimately, there is no perfect solution; instead, the selection of alignment and measures is based upon site specific conditions, such as property ownership, the space available to construct flood risk reduction measures, soil conditions, drainage, and utility crossings. Similarly, measures can be selected to incorporate secondary benefits, such as ecological enhancements or pedestrian and bicycle paths.

Another determining factor in flood risk reduction measures and alignment locations is the design height of the measure. The design elevation is based upon the FEMA 100-year stillwater elevation, as well as wave action, which is how waves interact with the measure. Wave action is impacted by a variety of factors, such as the slope of a risk reduction measure (e.g., a floodwall versus a levee) and the materials used (e.g., plantings versus concrete). In addition, to ensure that the risk reduction measures perform as intended for their design life, sea level rise is anticipated in the design height. Given that many flood risk reduction measures can last between 50 and 70 years, a conservative **estimate of 3-4 feet** was included in calculations. This sea level rise prediction is consistent with current policy on sea level rise planning in Connecticut.

Lastly, costs and benefits should be considered, and a cost-benefit analysis is a useful tool to compare potential projects to one another. One major cost factor in the implementation of a surge alignment is the stormwater infrastructure needed on the inside of the alignment. The following spread assigns general cost ranges to each of the surge reduction alignment options so that a relative comparison can be made when comparing overall investment and assessing that cost against projected benefits. Additional information on alignment design can be found in the Design Elevation Criteria Report.

Key Benefits

BY INTEGRATING THE SURGE REDUCTION ALIGNMENT WITH THE EXISTING LANDSCAPE AND LAND USES, THE ALIGNMENT COULD:

1. GENERATE $10 MILLION IN ANNUAL BENEFITS
2. REDUCE THREAT OF STORM SURGE FROM SEA LEVEL RISE
3. DECREASE DAMAGES FROM ACUTE STORM EVENTS, SUCH AS HURRICANES IRENE AND SANDY
4. INCREASE RECREATIONAL AND EDUCATIONAL OPPORTUNITIES AND ACCESS
5. IMPROVE AIR & WATER QUALITY THROUGHOUT THE CITY
6. ATTENUATE WAVE ACTION FOR INLAND VEGETATION AND HABITATS THROUGH BUFFERING ZONES
7. REDUCE BUSINESS LOSS AND INTERRUPTION DURING STORM EVENTS

Surge Reduction Typologies

Reducing surge from coastal storms made more frequent, intense, and far-reaching by climate change and Sea Level Rise can take on many different forms: a more traditional grey approach, a multifunctional space, or be layered with green space for wave attenuation.

Floodwall

$4,300 – $9,500 per linear foot

Floodwalls are surge reduction structures useful when space is limited or land area is too valuable to forfeit. These are typically used in dense or industrial areas. Floodwalls can incorporate educational information, public art, amenities such as benches and bus stops, or wayfinding signs can be attached to them to mitigate their impact in dense areas.

Bulkhead

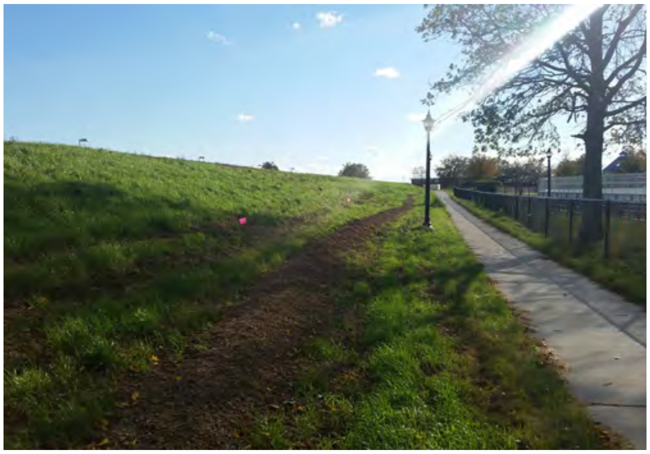
$3,500 – $10,000 per linear foot

There are many examples of bulkhead edges along Bridgeport's harbor and Cedar Creek. These sheet piles are driven into the earth and can be backfilled to create higher land. While traditional bulkheads typically impact the aquatic habitat, eco-friendly materials, such as reef blocks and recycled materials, can lessen the negative impact to the local ecosystem.

Promenade

$8,000 – $12,000 per linear foot

Promenade surge structures create public space and access to the water while blocking storm surge. The tiered steps allow visitors to interact with the tidal shoreline. Cost drivers consider height requirements and the amount of wave action. Implementation can be difficult as it may require a large footprint to achieve desirable public space, and clear access points.



Levee

$1,100 – $2,500 per linear foot

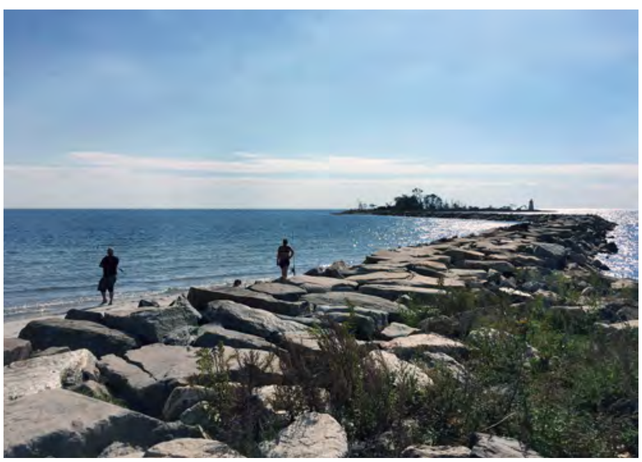
Levees, or earthen berms, are widely used in coastal and riverine areas to maintain the shoreline edge. Levees can be armored with stone or planted with grass species. They are cost-effective measures if earthen fill material and large swaths of contiguous land are available. Cost consideration are contingent on berm footprint and corresponding height. Levees are a passive flood risk reduction measure, requiring minimal operation and maintenance, such as mowing.

Living Shoreline

$900 – $7,000 per linear foot

Living shorelines are coastal edges that incorporate a combination of reefs, breakwaters, maritime or coastal forests, shrub communities, and fresh and tidal wetlands to reduce wave action and erosion while also providing resilience and habitat restoration benefits. Living shorelines generally involve a long, gentle slope from the subtidal zone (i.e., below mean low tide) into the maritime and coastal forest zone. In order to provide flood risk reduction, living shorelines must incorporate a structural intervention into the design. The maintenance cost for living shorelines can vary as designs are site specific.

Image credit: Meredith Guinness



Breakwater

$3,000 – $4,000 per linear foot

The existing breakwaters in Seaside Park aid in protecting the mouth of the Pequonnock River and Black Rock Harbor. These structures could be expanded and elevated to account for sea level rise. Additionally, breakwaters could be placed in front of Seaside Park to dissipate wave energy as it approaches the shoreline. Major cost drivers and implementation issues for breakwater structures include the height of the structure, from where the rock material is acquired, and permitting.

Surge Barrier

$50 – 160 million each

A surge barrier is an in-water structure composed of floodgates and marine floodwalls. Surge barriers are designed to permit normal maritime and boating operations in non-storm conditions; however, in advance of a severe storm event, the barrier can close, in an effort to limit flooding impacts in areas on the inside of the barrier. Surge barriers are often costly to construct and require significant permitting and approvals to be implemented. This photo shows a local example of a barrier in Stamford, CT.

Image credit: Army Corps of Engineers

Delay and Convey Stormwater

Addresses chronic flooding from normal to heavy rainfall events, and reduces contributing stormwater volume to Bridgeport's combined sewer system, potentially separating systems where possible.

Green Infrastructure Region
The green shaded areas shows where green infrastructure would be most effective in terms of infiltration based on elevation and soil type.

Managing stormwater in a city is a complex task. In Bridgeport, with a total area of 16 square miles, **one inch of rain citywide generates approximately 337 million gallons, or 511 Olympic swimming pools, of stormwater.** While some of the stormwater gets absorbed back into the soil, much of the city is developed or paved with surfaces that do not allow rainwater to infiltrate into the ground, and located on a high water table, resulting in the majority of stormwater runoff entering into the city's sewer system. This places a tremendous amount of stress on the system, which is often a combined sewer at some of the lowest-lying and therefore most flood prone neighborhoods. When the volume of water trying to enter the sewer system exceeds the capacity of the current infrastructure, flooding frequently occurs with raw, dilute sewage, backing up into city streets.

This type of sewer system, as well as the challenges that result from it, are not unique. **Combined sewer systems** are remnants of the country's early infrastructure and are typically found in older cities, such as New York City and Chicago. Fewer problems arise from this type of system on dry weather days, meaning the combined flows are treated at a wastewater treatment plant (WWTP) prior to its release to a nearby waterbody. On wet weather days, however, the addition of stormwater can overwhelmes the system.

Flooding in the South End
A small rain storm can cause overflow of the combined sewer system into the streets. Courtesy of Diego Celis

Combined Sewer Separation
Areas outlined in red are those that are next slated for separation, eliminating the combined sewer and adding stormwater sewer to the existing pipes in those neighborhoods.

In an effort to prevent combined sewer flows from backing up into streets, homes and buildings, the volume of flow that exceeds the WWTP capacity is diverted and discharged - untreated - through outfalls, into a local waterbody. This is called a combined sewer overflow (CSO) event. In Bridgeport, a rain event as small as 0.4-inches of precipitation may trigger a CSO event, **releasing hazardous substances** such as coliform bacteria, organic matter, and floatables into surrounding water bodies on a frequent basis. For more information reference the Ecology Report.

Over the last few decades, cities such as Philadelphia, have looked for ways to remedy the effects caused by urbanization and development, as well as the impact on combined sewer systems. Moreover, cities are also acknowledging the potential threats to their stormwater infrastructure posed by climate change, such as rising sea levels and more intense rainfall events.

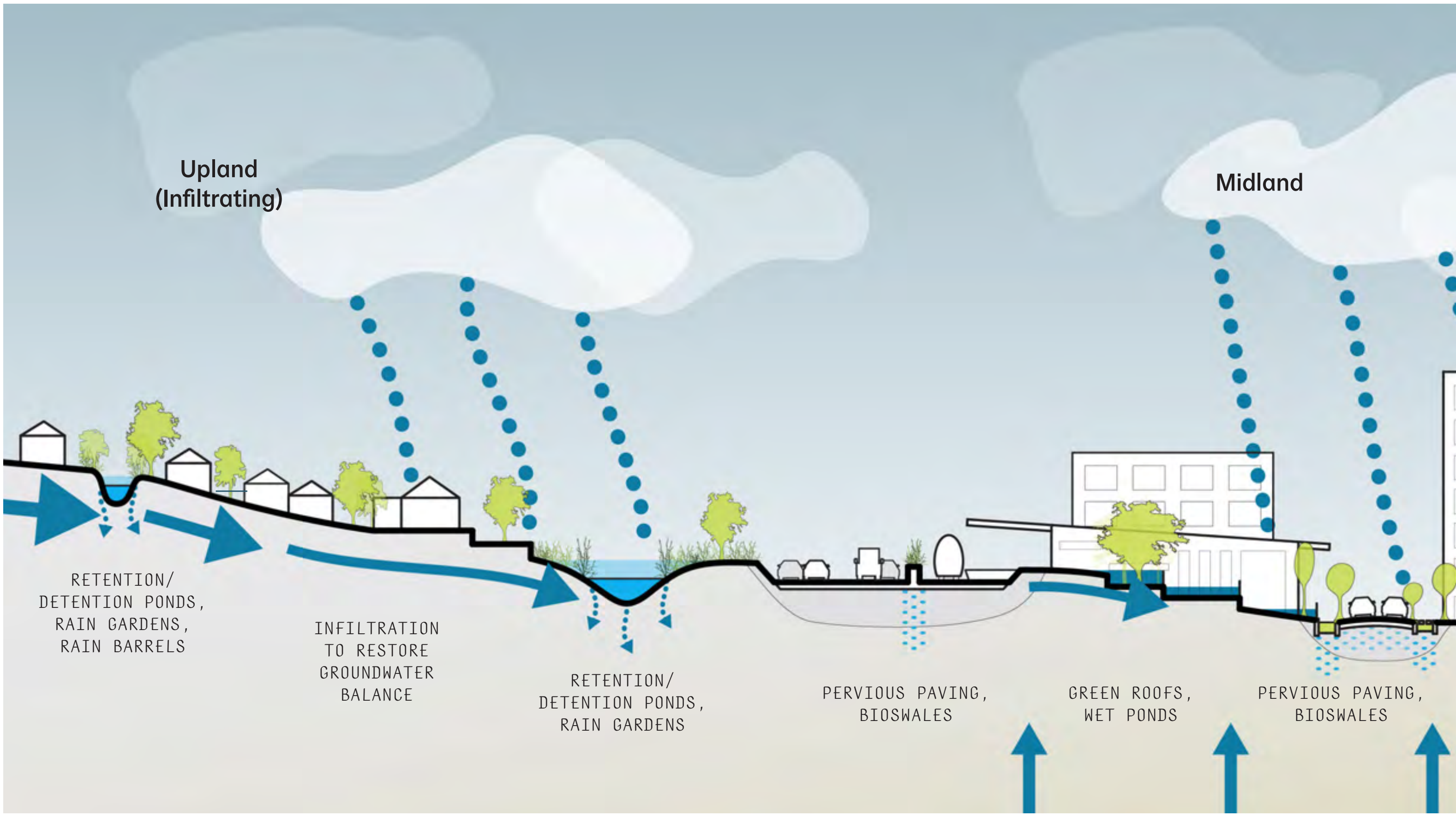
The city has begun to implement several small scale pilot green infrastructure projects on streets and in public spaces in CSO areas but needs to be scaled up dramatically, as is being done in Kansas City, Missouri, to achieve the benefits described in the following spreads.

For more information on Bridgeport's stormwater system see the Stormwater Appendix.

Key Benefits

BY INTEGRATING GREEN INFRASTRUCTURE WITH A SEPARATED SEWER SYSTEM, BRIDGEPORT MAY EXPECT THE FOLLOWING POSSIBLE BENEFITS:

1. DECREASED FREQUENCY & INTENSITY OF CHRONIC FLOODING IN LOW LYING COASTAL NEIGHBORHOODS
2. $10.3 MILLION OF POLLUTION AND DAMAGE FROM COMBINED SEWER OVERFLOW (CSO) PREVENTED ANNUALLY
3. 26 ACRES OF GREEN AREA CREATED OR ENHANCED THROUGH GREEN INFRASTRUCTURE
4. 5,710 BENEFITING RESIDENTS
5. IMPROVED AIR & WATER QUALITY THROUGHOUT THE CITY
6. REDUCED HUMAN HEALTH RISKS RELATED TO CSO OVERFLOW
7. REDUCED URBAN RUNOFF THROUGH GREEN INFRASTRUCTURE INFILTRATION

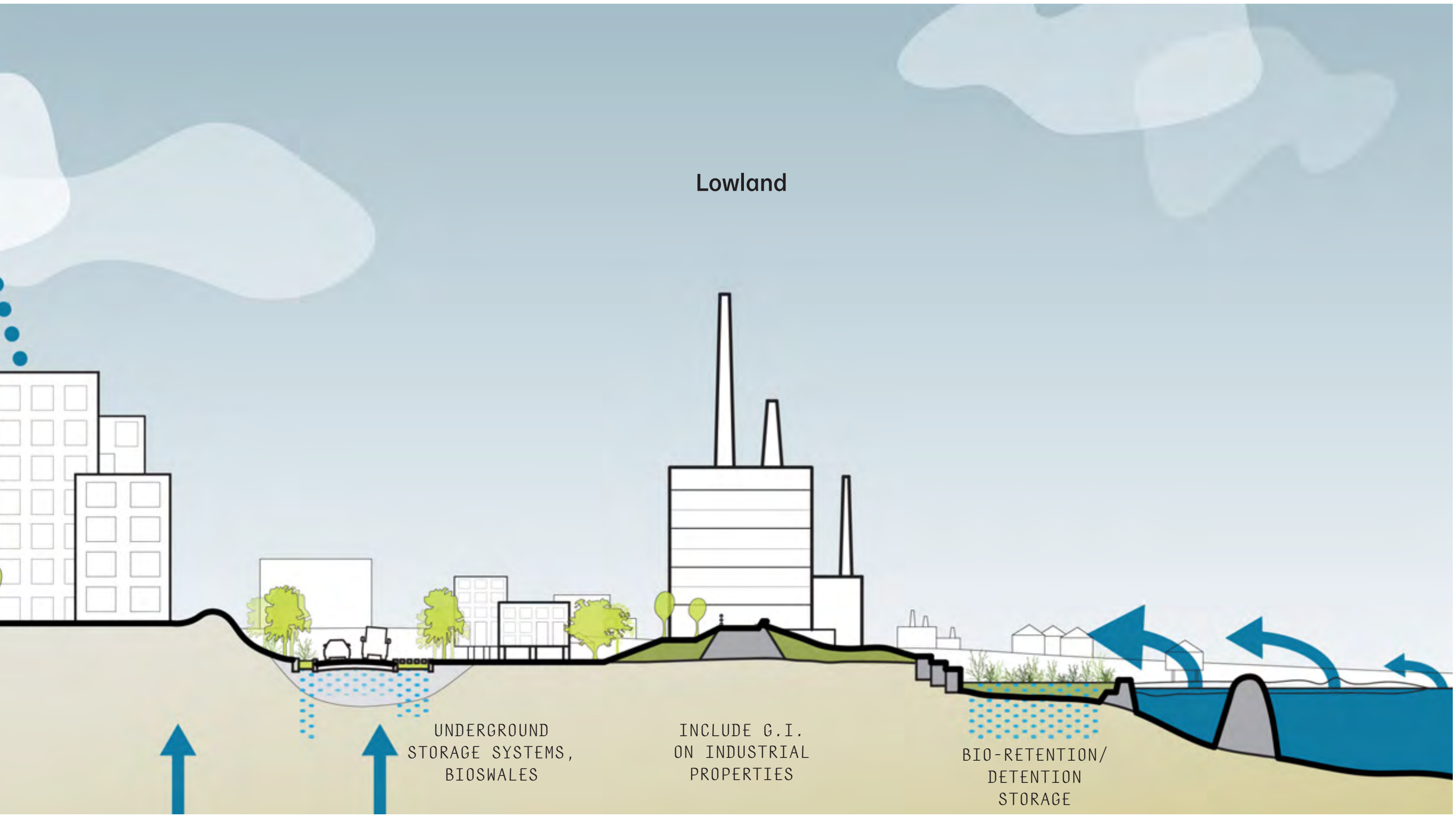


Benefits of Green Infrastructure

At the heart of many of the city's strategies is a robust green infrastructure (GI) program, including bioswales, green roofs, and retention/detention basins. GI provides many benefits beyond **improving stormwater management**, such as environmental, **economic**, and **social benefits**. For example, retention of stormwater minimizes the operating costs of a WWTP, trees and vegetation improve air quality by filtering and removing pollutants from vehicles, and green spaces serve additional functions as park spaces, adding community amenities. Green infrastructure can be organized into three main categories: **subsurface conveyance, surface conveyance, and storage.** Specific strategies in each of these groups could be applicable, depending on goals, available land, existing infrastructure, cost, operations and maintenance, visibility, and effectiveness. Each type of GI should be carefully evaluated to fulfill the aspiration and best outcome.

While GI installations provide many community benefits, they are typically better suited to handle the rainfall volume from small rain events. In addition, they usually require a significant amount of space to be effective, which can be a sizable limitation for a city and a barrier to implementation. Lastly, maintenance is a critical consideration; GI installations need to be **routinely maintained for peak performance**. As a result, green infrastructure is recommended to complement grey infrastructure improvements as well as **policy** that helps manage runoff from new development.

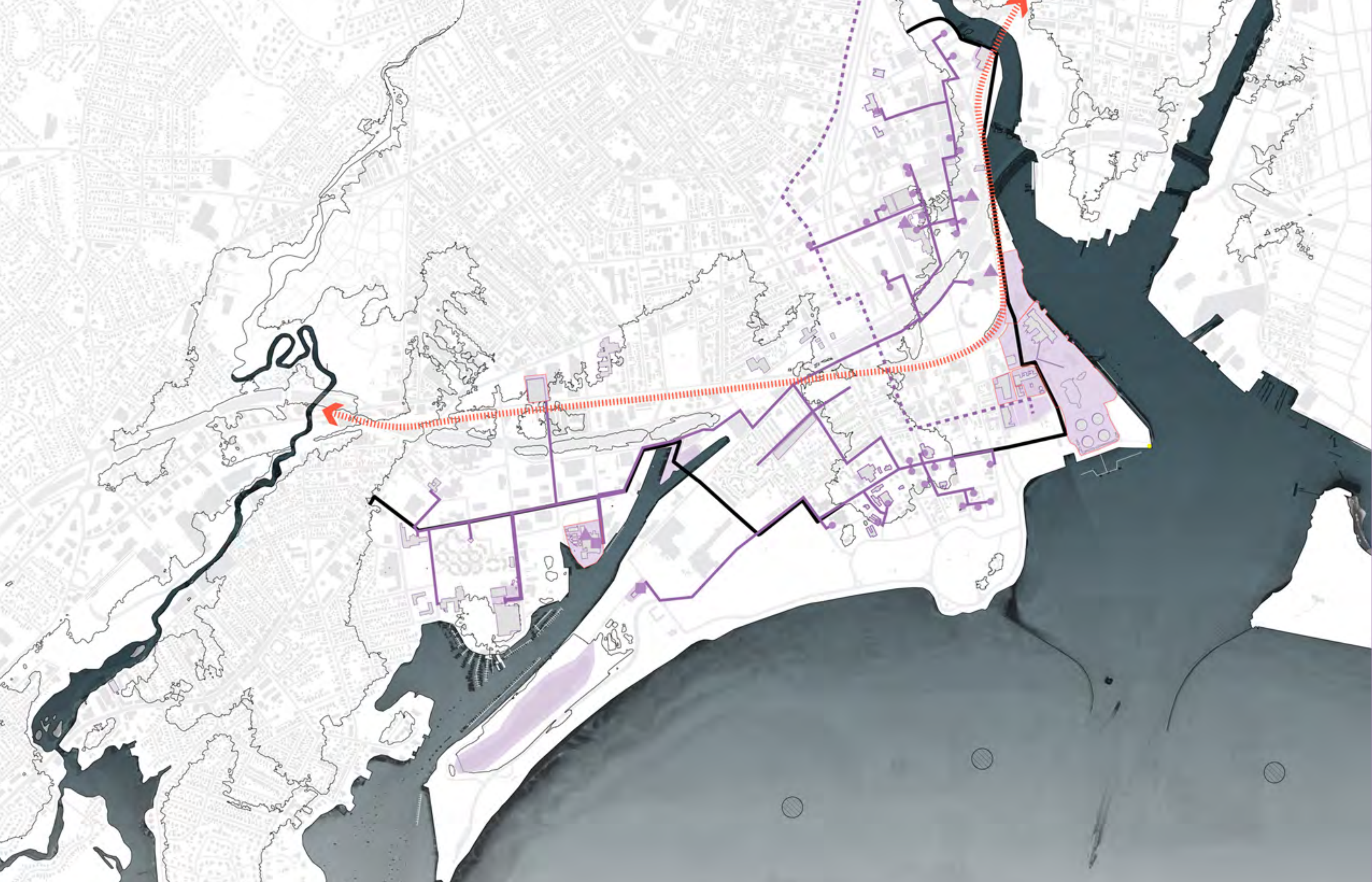
Many of these types of green infrastructure can be implemented at modest priced **individual site scales**, via rain barrels or a rain gardens.



Paths and Water
Top left: Designed by team member Reed Hilderbrand, planted swales surround boardwalks within the parking lot at the Parrish Art Museum.

Seaside Village Rain Garden
Top Right: Designed by team member Alex Felson, the neighborhood scale rain garden helps mitigate street flooding.

Green Streets
Left: Curb cuts, bioswales, and rain gardens together as a complete street system. Image credit: Kevin Robert Perry

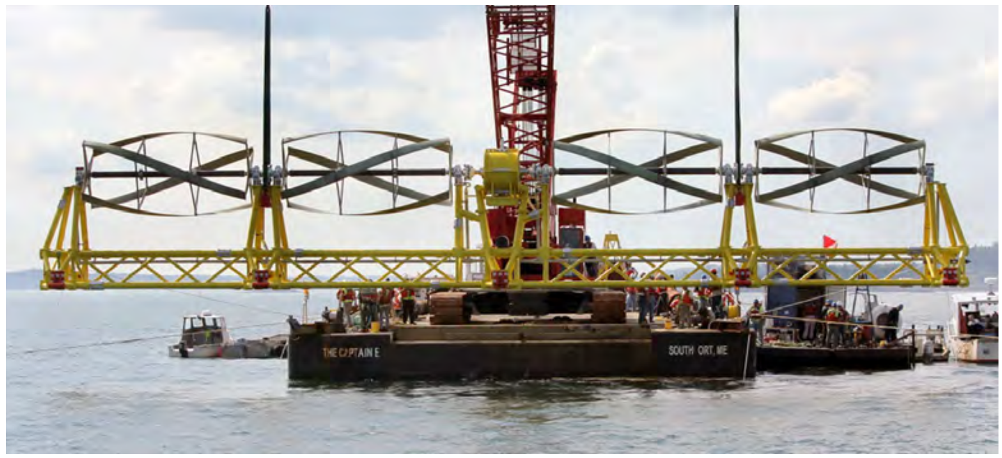


Make Energy Locally

Supports the creation of neighborhood-scale microgrids and district heating/cooling to provide backup power for critical facilities; support renewable and low-carbon energy production; leverage regional energy assets for local benefit.

In the 1940s and 1950s, Bridgeport's South End became a major center for the production and distribution of electric power, providing critical energy infrastructure for the region. Today, the neighborhood hosts several existing energy producing centers, including the massive PSEG campus along the eastern shoreline, as well as newly installed renewable power generation in the form of a fuel cell plant at State Street and Railroad Avenue and a photovoltaic field on the former landfill site in Seaside Park. Bridgeport is also home to two **energy microgrids**, which is a local utility system with the controlled capability to disconnect from the traditional grid and operate autonomously, potentially useful during a storm event. [4] Additional microgrids could be established to support critical facilities and storm shelters in locations with a power supply when the main grid is down.

With several energy producers in Bridgeport, creating additional microgrids for energy security and emergency access lighting in storm events is a logical addition to the resilience strategies. Another system emerging in Bridgeport is the waste heat recovery system, or thermal loop. Spearheaded locally by Nupower LLC, **thermal loops** will be installed incrementally at institutions around the city.



New Leader in Renewable Energy
Top left: On the former landfill in Seaside Park, Green Energy Park contains 9,000 photovoltaic panels and a fuel cell. Photo credit: United Illuminating

Left: PSEG will convert their coal fired plant, shown here with its iconic red and white smokestack, to natural gas. The new plant will produce 485 MW per year.

Top right: Bridgeport Fuel Cell plant, which opened in 2013, remains the largest of its kind in North America. [5]

Right: A tidal energy generator, shown off the coast of Maine, could be deployed in many places across coastal Connecticut, unlike wind powered turbines, tidal generators avoid harm to migratory birds.[6]

Bottom, right: Parcel scale energy production can increase energy security; homes with solar panels, like these in Bridgeport, can operate off the grid during storm events. [7]

Long term **clean renewable energy** strategies for Bridgeport include tidal and solar power. Tidal energy collectors also have the capacity to be integrated with storm surge barriers, breakwaters, or small mobile units. The waters off the coast of Seaside Park could be a productive site of clean, renewable energy. Despite Bridgeport's sometimes cloudy weather, installation of solar panels is growing throughout the region. Incentive programs could help make solar power affordable for lower income residents as well. Energy security for individual properties is critical for this resilience strategy.

With the primary benefit of providing **affordable and redundant sources of energy**, a local eco-industry focused on innovation would also generate substantial revenue and create many new jobs for residents. From designers and researchers, to the manufacturers, installers, and maintenance crews of renewable energy systems, microgrids, and thermal loops, Bridgeport could incubate this emerging regional movement and become a national leader in resilient energy production.

Key Benefits

AS BRIDGEPORT CONTINUES TO BE A LEADING REGIONAL ENERGY PRODUCER, THE CITY COULD EXPECT THE FOLLOWING BENEFITS FROM IMPLEMENTING RESILIENT ENERGY STRATEGIES:

1. REDUCED PERSONAL AND BUSINESS LOSSES THROUGH THE IMPLEMENTATION OF MICRO-GRIDS
2. REGIONAL POWER PRODUCTION MAINTAINED AS A MAJOR INDUSTRY
3. LOWERED TOTAL POLLUTANT EMISSIONS THROUGH RENEWABLE ENERGY SOURCES
4. NEW JOBS AND REVENUE CREATED
5. OPPORTUNITIES TO BECOME NATIONAL LEADERS IN SUSTAINABLE ENERGY PRODUCTION
6. INCREASED WATER QUALITY BY ELIMINATING POLLUTION THROUGH CLEAN ENERGY PRODUCTION

Access & Egress

Provides residents with dry egress out of high risk flood areas, with the intent of spurring development and economic activity by enhancing connections between people, businesses, and the coast.

Access and egress to and from properties are the primary concerns for low lying areas during storm events. **Raising critical connections** to and from vulnerable neighborhoods allows for safe evacuation and emergency access to flooded areas during and after storm events.

Providing **dry egress** to neighborhoods is a concern for both safety and redevelopment. Critical facilities, for which even a slight increase in flooding is too great a threat, are required to provide dry egress in order to be redeveloped. Such is the case with the Marina Village site. Raised connection corridors, or spines, can spur redevelopment in coastal areas, while still promoting architectural adaptation to rising seas.

Raised corridors can be paired with a wayfinding program, such as signage and lighting, to provide clear directions during evacuations and better **connections through the neighborhood** year round. Signage and lighting can denote important sites such as shelters or educational information such as historic flooding heights. Better connections, raised or otherwise, can catalyze redevelopment in critical nodes around Bridgeport. The integration of built infrastructure and environment could transform the Black Rock industrial area

Layered Streets as Public Spaces
Designed by Resilient Bridgeport team member Reed Hilderbrand, the Boston Public Library's layered street creates safe and pleasant pedestrian and vehicular circulation.

Industrial Traffic
Truck traffic should be separated from residential areas in the neighborhood.

Access for Bicycles
The Resilient Bridgeport Design Team led a student bike ride through the watershed.

into a district of green technology and reuse of waste energy and materials. Streets can be designed to **separate industrial and residential traffic**, as well as integrate stormwater management practices, increasing safety and creating a renewed sense of neighborhood identity.

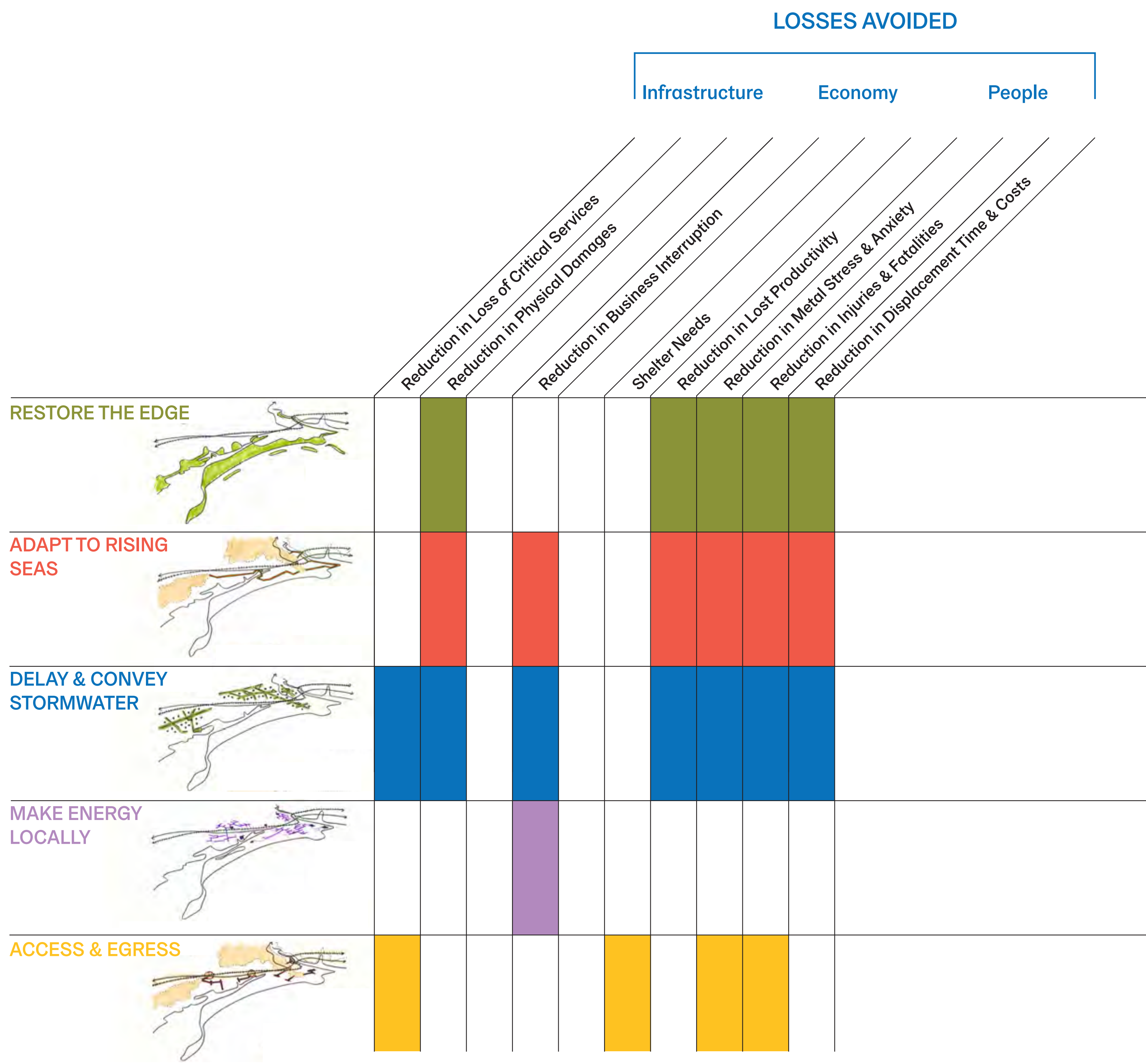
Bridgeport has a major opportunity to improve access and egress — both in the city and the region — through **public transportation**. The **regional train station** is located just one block from the **city bus depot and ferry terminal**. Despite this existing multi-modal hub, transit-oriented development in the downtown is limited, and pedestrians from the station have limited connections to surrounding neighborhoods. By expanding the bus service and bike lanes throughout the city, neighborhoods can be better linked, which could also encourage greater redevelopment at critical intersections. By linking districts to I-95 and downtown, more destinations can be created, attracting both residents and visitors off of the highways and into the city. Designing to amplify multi-modal transit systems also encourages residents to walk and bike more to benefit their overall health and reduce fossil fuel use. When evacuation is necessary, public transit such as the ferry could quickly bring a large number of people to safety at a designated location, both keeping them together and effectively concentrating recovery resources.

One of the goals of this strategy is to create a framework **to catalyze redevelopment**. This is a critical step in growing the tax base for Bridgeport, and generating future revenue to fund city infrastructure and programs. In the relatively small study area, dozens of large open sites could be developed, and dozens more existing buildings, many of them historic, could be redeveloped. This strategic revitalization could result in a total investment from tens to hundreds of millions of dollars in a formerly neglected area.

Key Benefits

THROUGH THE IMPLEMENTATION OF A NETWORK OF RAISED EGRESS CORRIDORS AND/OR MULTI-FUNCTIONAL PUBLIC SPACES, BRIDGEPORT COULD EXPECT:

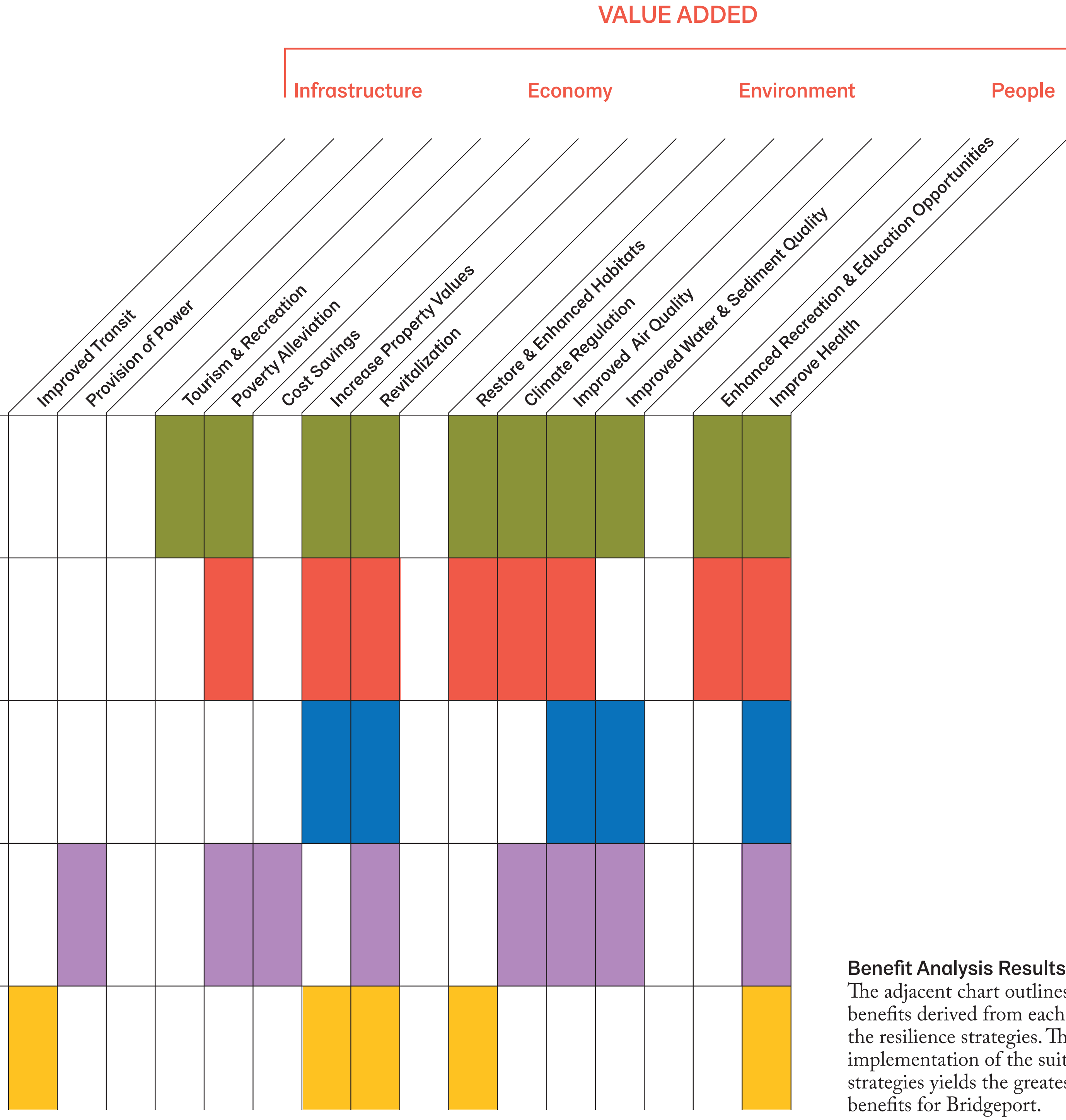
1. 3,632 BENEFITING RESIDENTS
2. IMPROVED EGRESS ROUTES THROUGH STREET RAISING AND WAYFINDING
3. INCREASED CONNECTIVITY THROUGHOUT THE CITY AND TO THE COAST
4. BETTER ACCESS TO AMENITIES VIA PUBLIC TRANSIT
5. IMPROVED QUALITY OF LIFE FOR RESIDENTS VIA MULTI-FUNCTIONAL STREETS
6. NEW OUTDOOR RECREATIONAL OPPORTUNITIES WITH SPACES FOR WALKING AND BIKING
7. INCREASED ACCESSIBILITY AND CONVENIENCE VIA NEW MODES OF TRANSPORTATION
8. INCREASED JOB OPPORTUNITIES THROUGH NEW TRANSPORTATION ROUTES
9. IMPROVED EVACUATION VIA PUBLIC TRANSIT, SUCH AS THE FERRY



Resilience Strategies Benefits

The five resilience strategies work in harmony to address various aspects of resilience. The strategies create a comprehensive approach to reduce flood risk from both chronic and acute event to achieve a more resilient Bridgeport.

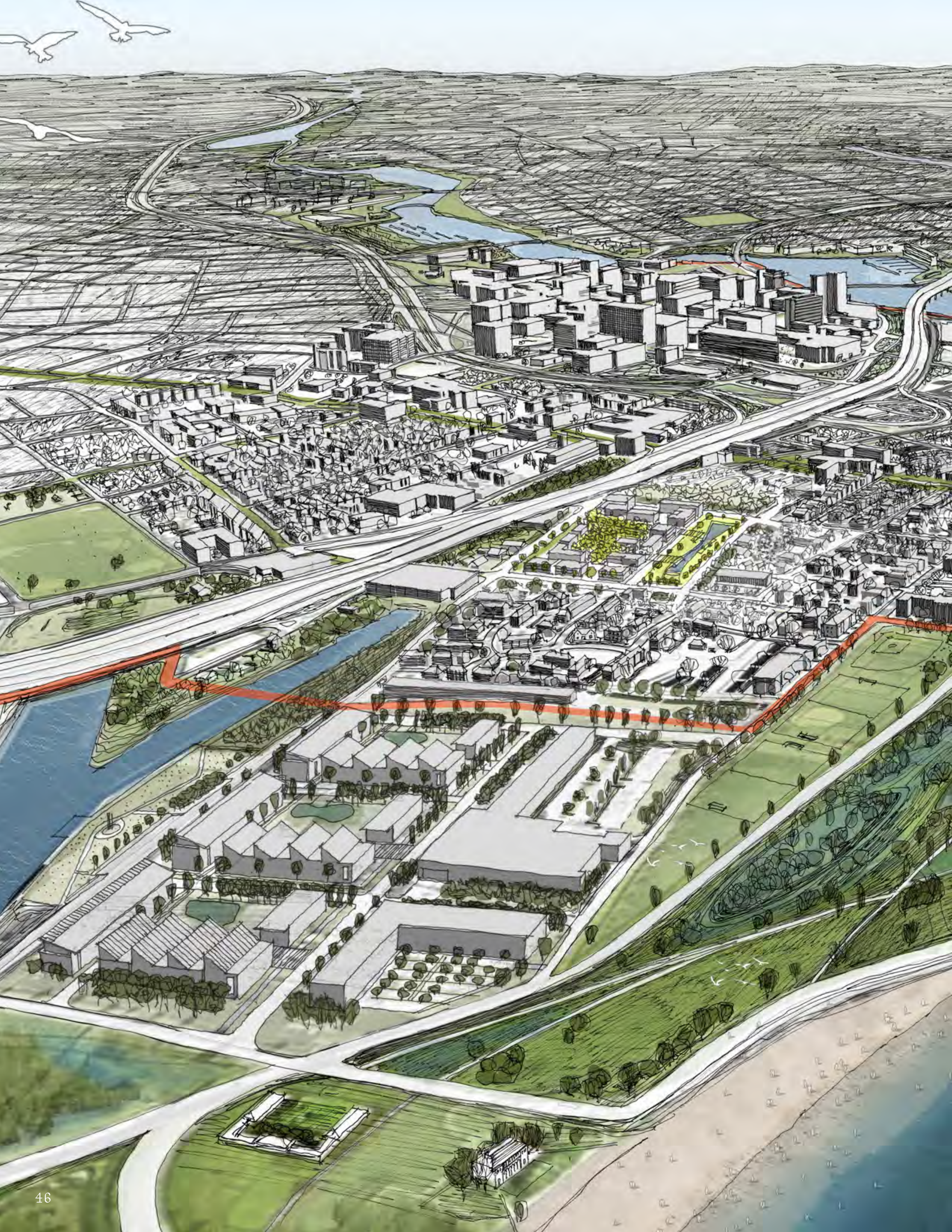
A benefit analysis was preformed to help inform sound decision making related to public infrastructure investment by identifying strategic areas for investment that maximize return on investment. Thus, a benefit analysis was completed to inform



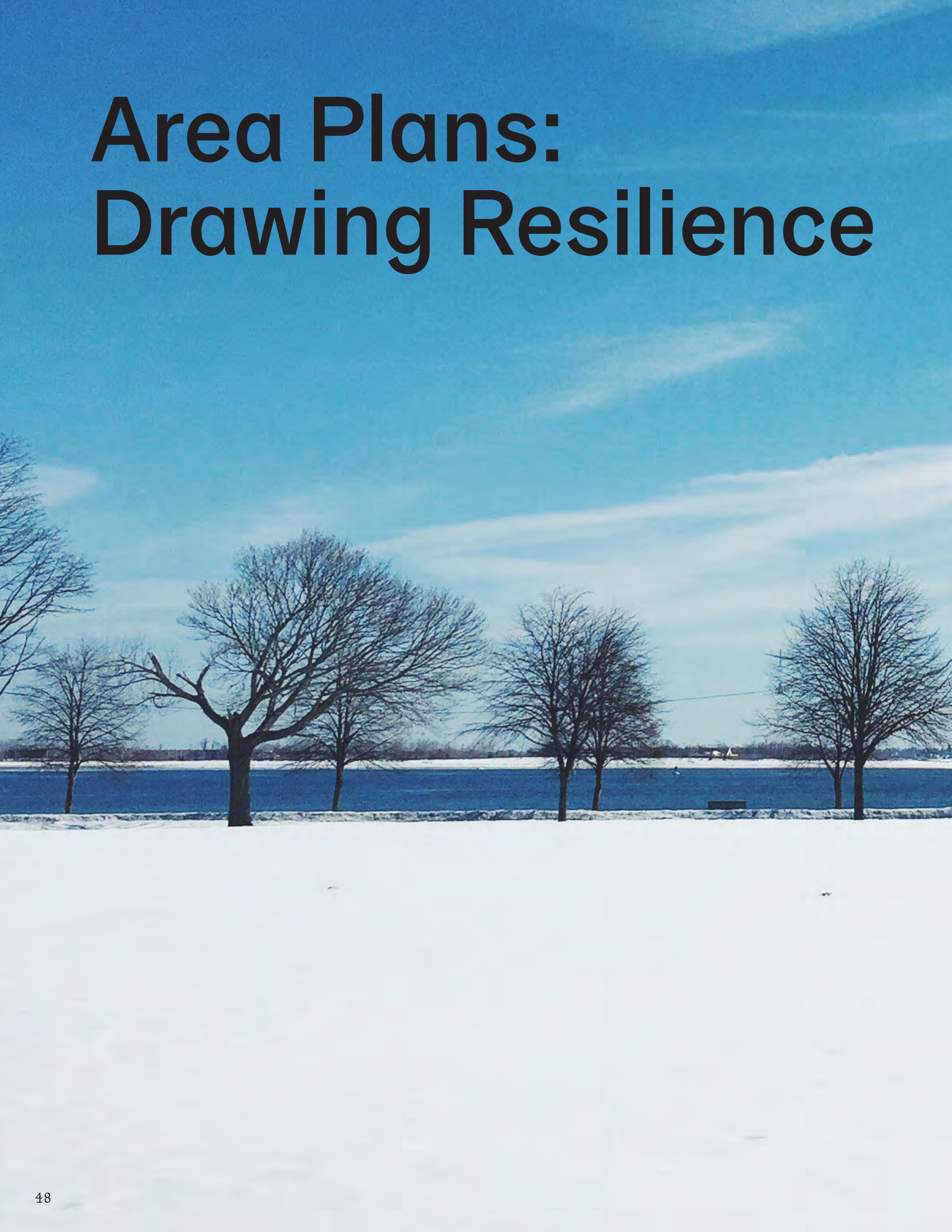
Benefit Analysis Results
The adjacent chart outlines the benefits derived from each of the resilience strategies. The implementation of the suite of strategies yields the greatest benefits for Bridgeport.

resilient design strategies development, justify the implementation of the resilient strategies, and inform the Rebuild by Design pilot project. Benefits are categorized as value added and losses avoided to help clarify the intent of the investment. The magnitude of each benefit is measured based on the number of people, structures, and businesses benefiting and the area of new or enhanced natural space created.

The strategies within Delay and Convey Stormwater produced the most annual benefits, at $10 million. Similarly, $8.8 million in environmental benefits were associated with Restore the Edge. Even though Adapt to Rising Seas annual benefits are the least between the three scenarios, the built, social, and economic system of the South End benefit greatly. For additional information benefit analysis reference the Benefits Report.



Area Plans: Drawing Resilience



Seaside Park
February 28, 2015
The Seasides
Image credit: Marcella Kovac

Area Plans: Drawing Resilience

The drawings in this section illustrate the potential impact of the projects funded through RBD and NDR, as well as future investments to evolve Bridgeport's neighborhoods, infrastructure, and waterfront to a more resilient future.

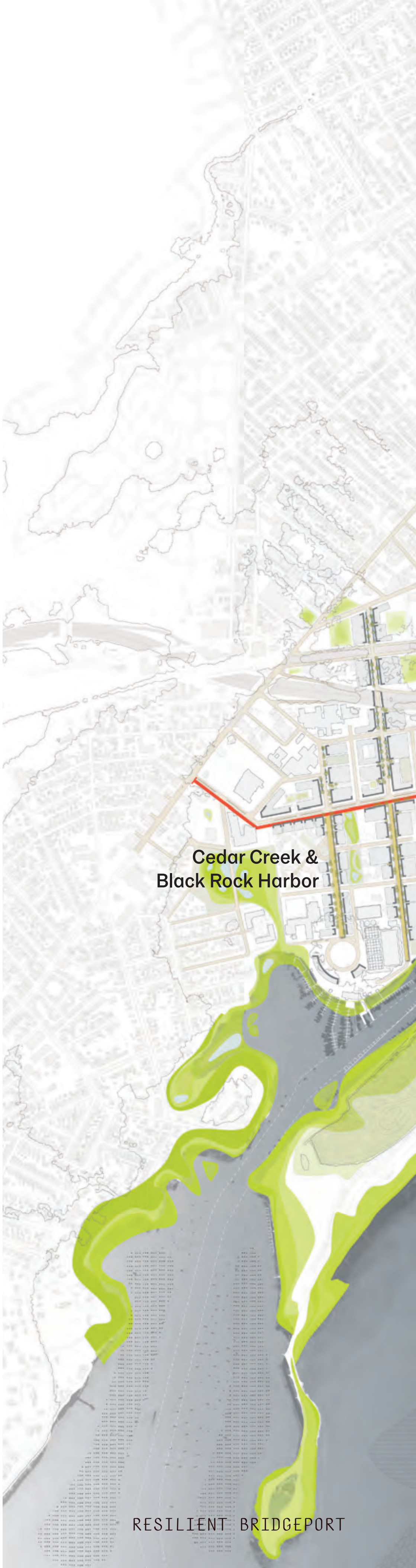
The goal of the urban design framework, laid out in these area plans, is to guide Bridgeport to reconnect the citizens of its diverse neighborhoods to each other, to the water, and to economic opportunity. This framework is intended to be an **open-ended interpretation** and to outline how Bridgeport might **meet the challenges and opportunities of future development.** All suggested development is meant to support the overall strengthening of the physical, social, and economic fabric of the city.

This section includes plans for five areas within the greater study area explored in this report. Seaside Park became the initial focus area because of its historic character, its key role in the identity of the city and the neighborhood, and its unique approach to ecologically responsible coastal adaptation. The four additional areas illustrated in these plans extend outward from the Park along the adjacent ridgelines and waterways.

To the Park's immediate north and west, the South End: West of Park explores the neighborhood developed on the western slope of the Park Avenue ridgeline including the former waterways and wetlands filled for industrial and residential development in the late 19th and early 20th Centuries. As a logical extension of that area, the next section focuses on Cedar Creek and Black Rock Harbor, home to the City's growing renewable energy resources and green industry as well as waterfront and on-water recreation. As a shared drainage area for portions of three distinct neighborhoods – Black Rock, the West End, and the South End – this area presents a unique opportunity to link together multiple commercial and residential constituencies in a common strategy for flood risk reduction and water management.

To the Park's immediate north and east, the South End: East of Park looks at one of the City's oldest settled areas located on the eastern slope of the Park Avenue ridgeline including the low-lying corridors linking Long Island Sound to Downtown and the heavy industrial power generation area along Bridgeport Harbor built on urban fill. Extending logically from that area, Downtown + East Side explores the head of Bridgeport Harbor and the lowest section of the Pequonnock River feeding into it. With shared vulnerability at the confluence of the river and the Sound, these areas require a coordinated flood risk reduction and water management strategy. Similarly, proximity to the rail station and the primary corridors leading out from that multi-modal facility demand a coordinated economic development and placemaking strategy for these areas as well.

For more information on costs associated with specific project components described on the following area plans, see the Focus Areas Conceptual Cost Outline.




East Side
Downtown
East of Park
West of Park
Seaside Park

"Zoning map of the city seems reversed. We need public areas along the water, and industry should move inland." - Comment from a community member

Olmsted Vaux & Viele Plan
The original plan for Seaside Park included three major entrances connecting the park to downtown.

Key Projects

1. MIRROR LAKE: OUTFALL RESTORATION AND NATURALIZATION OF WATER'S EDGE
BENEFITS: INCREASED STORMWATER STORAGE, WATER QUALITY, AND HABITAT
IMPLEMENTATION: A PRIORITY PROJECT FOR SEASIDE PARK

2. RAISED BALL FIELDS:
BENEFITS: IMPROVED PUBLIC HEALTH, COMMUNITY ENGAGEMENT, STORMWATER STORAGE, AND WAVE ACTION ATTENUATION
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS, BUT SHOULD BE CONSIDERED WHEN PLANNING THE SOUTH END BERM

3. HISTORIC PARK PRESERVATION: TRANSITION PLANTS TO WITHSTAND SEA LEVEL RISE, STORMWATER, AND SALINITY
BENEFITS: PRESERVED COMMUNITY HISTORY, ENHANCED PUBLIC SPACE
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS

4. ADAPTING SEASIDE PARK: GENERAL RESILIENT DESIGN IMPROVEMENTS THROUGHOUT PARK
BENEFITS: INCREASED HABITAT, WAVE ATTENUATION, INCREASED WATER QUALITY
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS

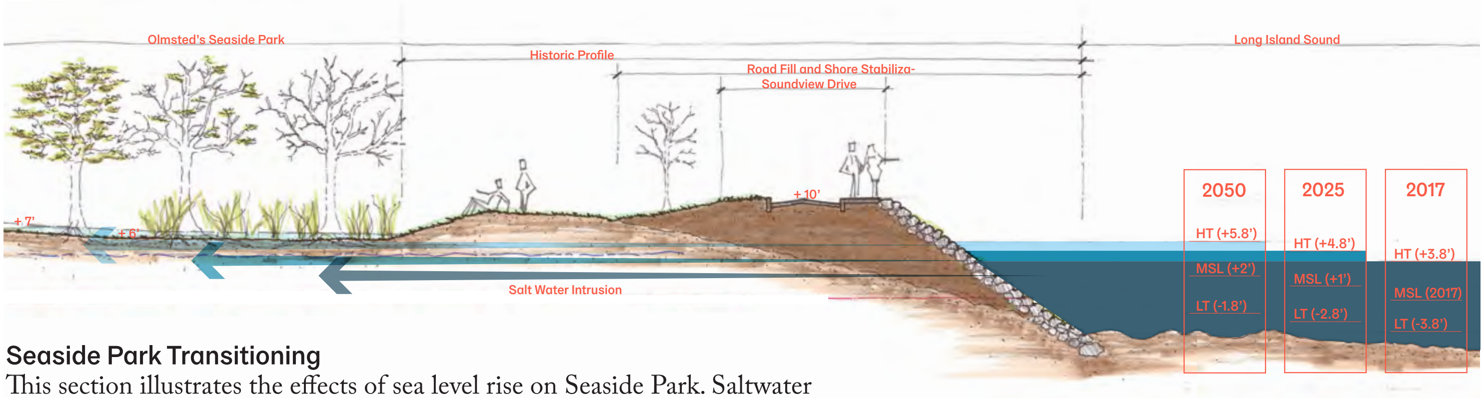
FOR MORE INFORMATION ON THESE COMPONENTS SEE FOCUS AREA ON PAGE 64.

Seaside Park

Originally designed by famed landscape architect Fredrick L. Olmsted, this large park is one of Bridgeport's greatest assets, and can adapt to rising seas by acting as a natural green buffer for the city.

Implemented by P. T. Barnum in the mid 19th century, Seaside Park was the first public land in the city to border the sea, and is still one of the largest public waterfronts in Connecticut. The park serves many functions including **recreational use, wildlife habitat, and decreasing storm surge effects**. The Park's ability to continue to provide these benefits will be compromised by sea level rise if changes are not made. This future vision of Seaside Park seeks to address sea level rise while enhancing these uses: redesigning Mirror Lake for better habitat areas to **increase migratory bird activity and marine life**, regrading existing recreational fields to remain drier during rainstorms and providing a buffer, reducing the impact of storm surge.

With the **park acting as a buffer** to the city, the green edge allows for the engineered surge reduction to be further from the coast. This provides many benefits, including lower cost of construction as height and berm width are reduced. Parts of the landscape would remain manicured, but to increase habitat and decrease maintenance costs, parts of the park would be planted with native salt tolerant plant species. Eventually, surge reduction, recreational use, and transitional planting concepts are planned to extend out from Seaside Park and form a more extensive green edge along all of Bridgeport's coastline.



Seaside Park Transitioning

This section illustrates the effects of sea level rise on Seaside Park. Saltwater infiltration of groundwater will impact plants in the park; this diagram indicates the need to begin transitioning to salt tolerant species.

Rock Chapel Marine

Far Left: This waterfront park in Chelsea, MA is shared by an active industrial salt company. Designers, community members, city agencies, and industry worked together to improve habitat, remediate pollution, and maximize recreational space.
Image credit: Landing Studio

Kosciuszko Park

Left: In nearby Stamford, Kosciuszko Park has several ball fields, walking paths, playgrounds, and a large swath of naturalized landscape, showing how manicured areas can blend into more naturalized habitats.

Key Projects

1 RAISING WORDIN AVENUE: BETWEEN FAIRFIELD AVE AND PINE ST
BENEFITS: SURGE REDUCTION, DRY EGRESS, UNLOCKS DEVELOPMENT POTENTIAL NORTH OF WORDIN AVE
IMPLEMENTATION: RECOMMENDED FIRST RESILIENCE PROJECT IN BLACK ROCK HARBOR
ALTERNATIVE SURGE ALIGNMENTS: SHOWN ON THE PLAN IN DASHED LINES

ALTERNATIVE SURGE ALIGNMENTS: SHOWN ON THE PLAN IN DASHED LINES.
2A THE SOLID LINE, REQUIRES ARCHITECTURAL ADAPTATION OUTSIDE OF THE LINE
2B REDUCES FLOOD RISK AT THE SIKORSKY SITE FOR FUTURE REDEVELOPMENT
2C CREATES A TRUCK ROUTE OVER WATER, AND MAXIMIZES DEVELOPABLE SPACE
NO ACTION ALTERNATIVE: WILL RELINQUISH SPACE TO SEASIDE PARK AND REQUIRE ADAPTATION OF BUILDINGS, INFRASTRUCTURE AND LANDSCAPE

2 PIER STREETS: RAISED UNPROTECTED STREETS TO EXTEND SOUTH FROM WORDIN AVE
BENEFITS: ALLOW NEW DEVELOPMENT OF WATERFRONT AND ECO-TECH INDUSTRIES
IMPLEMENTATION: TO OCCUR AFTER RAISING WORDIN AVE, WILL CHANGE ADJACENT BUILDING TYPOLOGIES

3 COASTAL EDGE IMPROVEMENTS: INCLUDES CONVERSION OF BROWNFIELD SITES TO WETLANDS
BENEFITS: BROWNFIELD REMEDIATION, IMPROVED STORMWATER QUALITY, WAVE ATTENUATION, CREATION OF PUBLIC SPACE, AIR AND WATER IMPROVEMENTS, CREATION OF HABITAT, IMPROVED PUBLIC HEALTH, AND RECREATIONAL OPPORTUNITIES
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS

4 PEDESTRIAN BRIDGE: CONNECTS ACROSS BLACK ROCK HARBOR TO SEASIDE PARK
BENEFITS: CONNECTS NEIGHBORHOODS TO THE PARK, PRIORITIZES CEDAR CREEK AS AN ASSET
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS

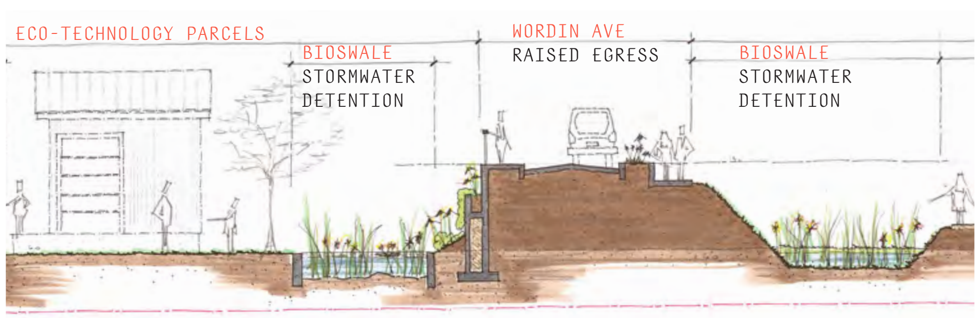
5 INLAND STORMWATER STORAGE: THE DAMMED HEAD OF CEDAR CREEK COULD BE DRAINED FOR ADDITIONAL STORMWATER STORAGE CAPACITY
BENEFITS: REDUCED CHRONIC FLOODING, INCREASED PUBLIC SPACE AND HABITAT
IMPLEMENTATION: THIS STRUCTURE WOULD BE BUILT IN CONNECTION TO THE SOUTH END BERM CONNECTING TO RAISED WORDIN AVE; THIS PROJECT IS DEPENDENT ON SOUTH END BERM CONNECTING TO RAISED WORDIN AVE

Cedar Creek & Black Rock Harbor

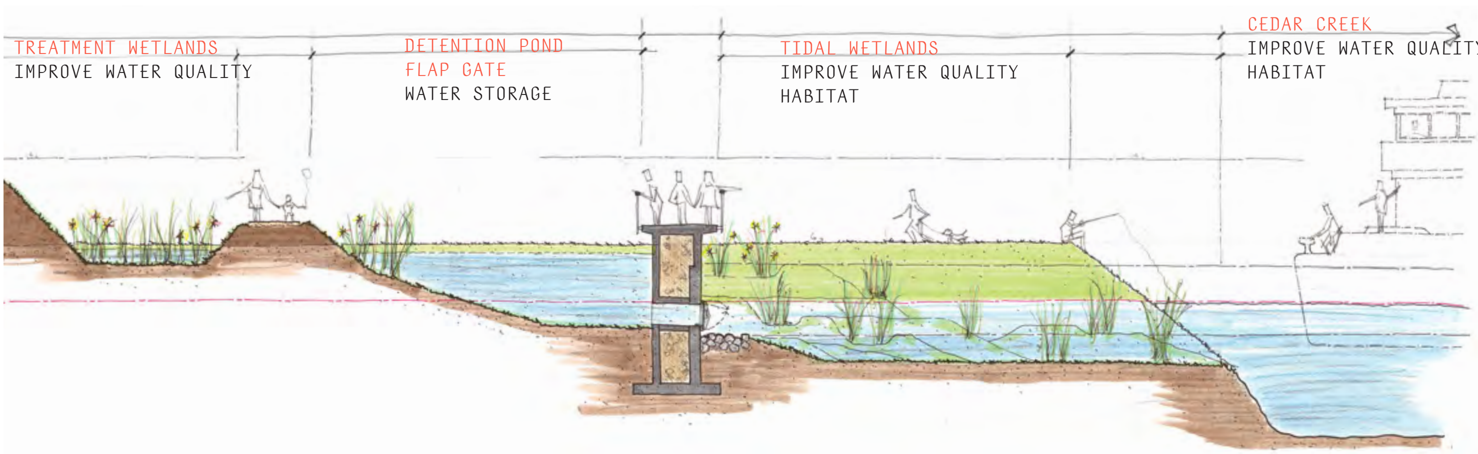
Future planning for coastal risk reduction and stormwater management in this area will be integrated with the strategies and framework developed in the South End.

Cedar Creek and Black Rock Harbor comprise one natural system but include multiple distinct and disconnected neighborhoods and commercial districts. Access between these areas is limited for both vehicles and pedestrians by the waterways and large regional transportation corridors. At the head of Cedar Creek, the residential neighborhood in the South End: West of Park tapers off into an industrial cul-de-sac dominated by the former Sikorsky facility. In the heart of Black Rock Harbor, the **Eco-Technology Park** is emerging from a long-standing industrial district now focusing on sustainable and renewable energy and green businesses.

The plans illustrate the extension of **a raised Wordin Avenue**, which would reduce flood risk for development and infrastructure to the north, and create a series of **pier-like raised corridors** to the south. This would allow dry access and egress to critical facilities and future development in the Eco-Technology Park. Naturalization of the shoreline along Cedar Creek and Black Rock Harbor will enable a new network of public open spaces along the reclaimed waterfront, connecting both sides of the creek. Additional **connections are envisioned across Cedar Creek**, linking the area to Seaside Park and to the current Sikorsky site, which could then be more intensively developed as part of the Eco-Technology Park to create new jobs for the South End.




RAILROAD
ECO-TECHNOLOGY PARK
I-95
FAIRFIELD AVE
PINE ST
WORDIN AVE
SIKORSKY SITE
SEASIDE PARK
BLACK ROCK HARBOR
1
2
2A
2B
2C
3
4
5


TREATMENT WETLANDS
IMPROVE WATER QUALITY
DETENTION POND
FLAP GATE
WATER STORAGE
TIDAL WETLANDS
IMPROVE WATER QUALITY
HABITAT
CEDAR CREEK
IMPROVE WATER QUALITY
HABITAT

South End: West of Park

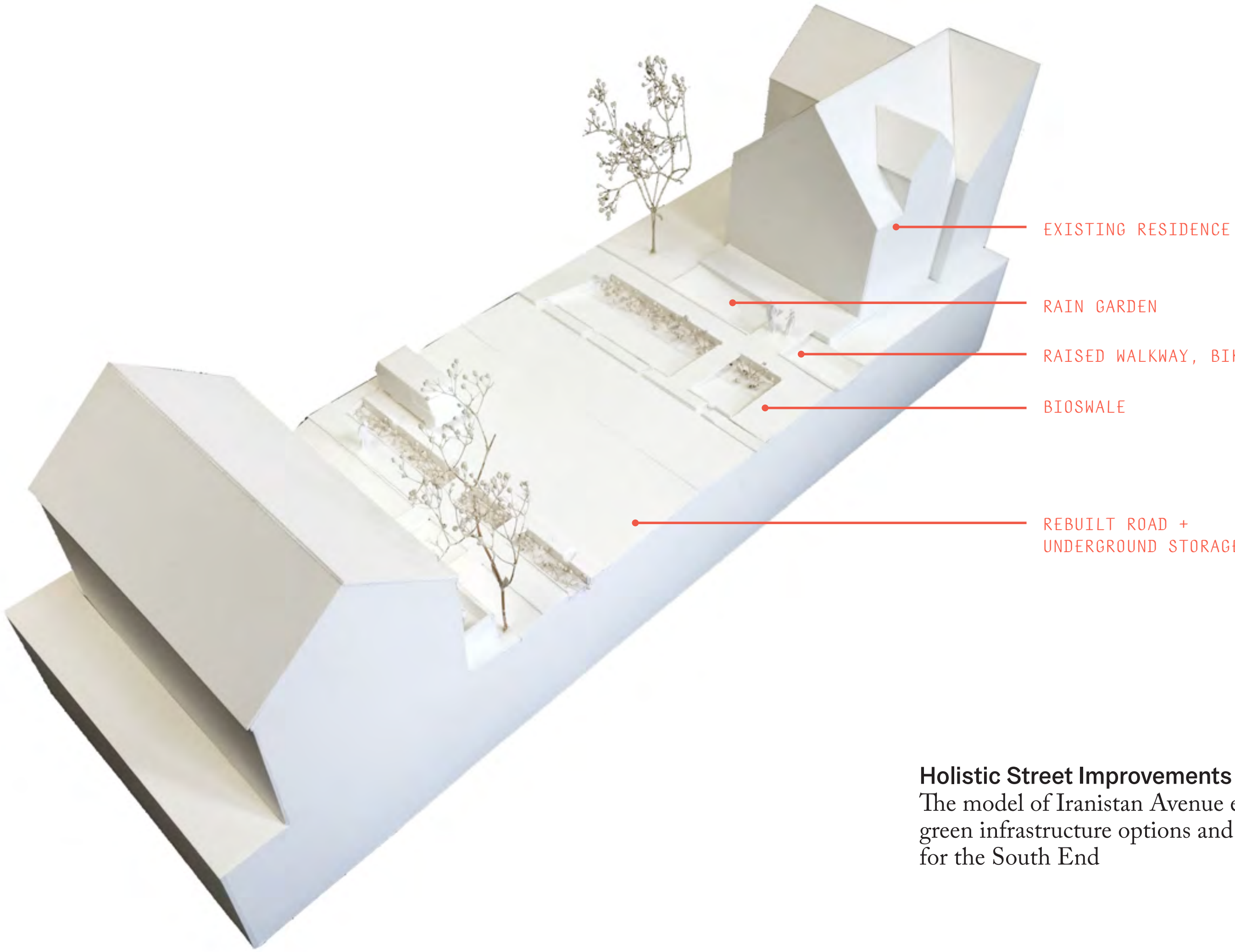
The neighborhood west of Park Avenue is host to the Rebuild By Design pilot project, demonstrating the benefits that can result from prioritizing critical stormwater management interventions.

Key Projects

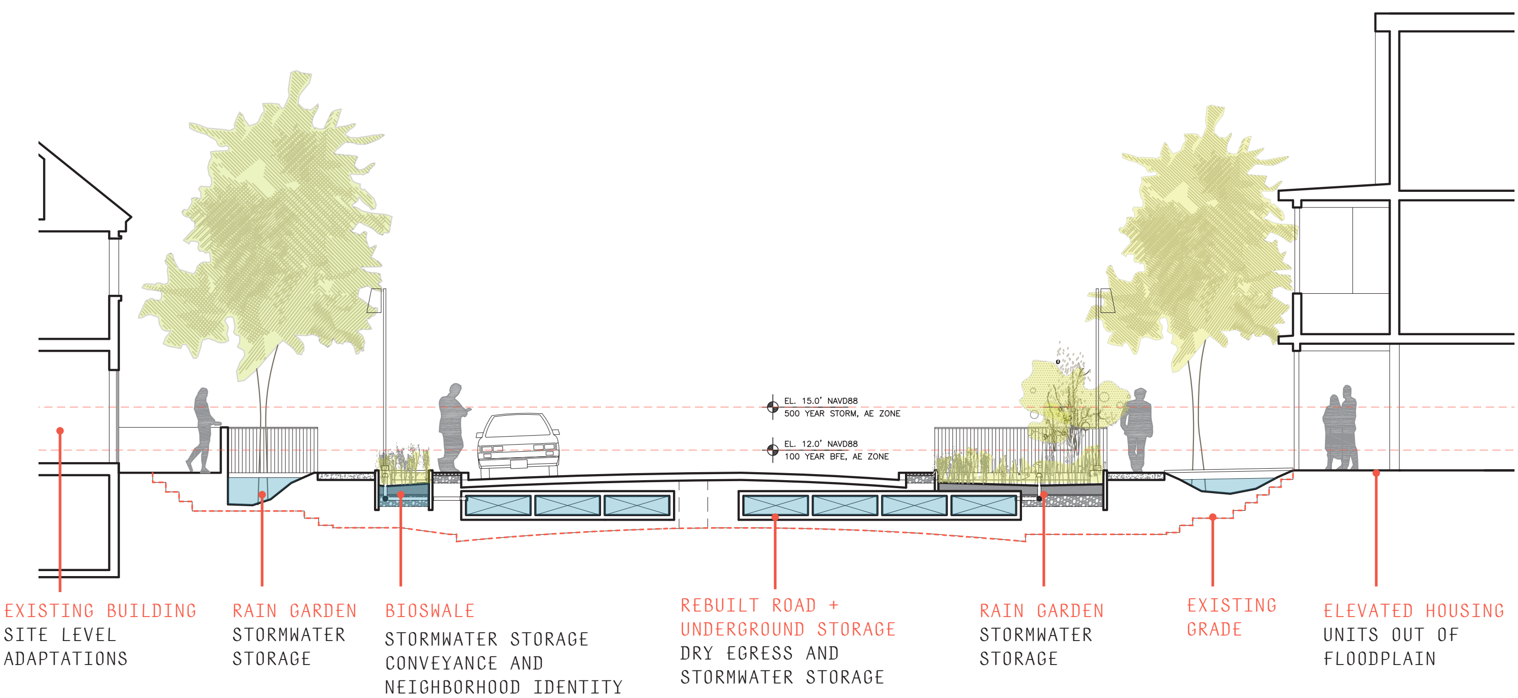
1. RBD PILOT PROJECT: INCLUDES AN APPROXIMATELY 2.5 ACRE STORMWATER PARK AND A NEW RAISED DRY EGRESS STREET, JOHNSON ST. EXTENSION
BENEFITS: DRY EGRESS, DECREASED CHRONIC AND ACUTE FLOODING, PUBLIC AMENITY
IMPLEMENTATION: CONSTRUCTION PLANNED TO COMMENCE IN SPRING 2019

2. SOUTH END BERM: CONSTRUCTED THROUGH SEASIDE PARK AND BEYOND, TIES INTO HIGHER GROUND ALONG PARK AVE
BENEFITS: FLOOD RISK REDUCTION, PUBLIC SPACE
IMPLEMENTATION: MAY BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS

The area west of Park Avenue includes the future redevelopment of Marina Village, along with Seaside Village and the University of Bridgeport, and is extremely low-lying in comparison to the surrounding area. As a result, this part of the South End is **vulnerable to flooding** from coastal storm events that bring high tides. Additionally, the local combined sewer system floods during ordinary rainfall events, as the current drainage system has inadequate capacity to accommodate stormwater runoff, and the system has insufficient slope to bring the water to outfalls in Cedar Creek by gravity. The area has a high water table; the current neighborhood was historic tidal wetlands, which were filled in to create more dry land. This makes storing water beneath the surface, through infiltrating green infrastructure like rain gardens, difficult to implement. This area plan shows street improvements, a **separated stormwater system** that includes a **stormwater park**, **South End Berm,** and the **proposed pilot project**. The largest move in the near term for this area is the separation of combined stormwater sewers and creation of the MS4, Municipal Separate Storm Sewer System. This basic system — the pump, force main, and stormwater park — creates the capacity to expand the separated stormwater network as funds become available. For more information on these components see **Focus Area on page 64**.



Holistic Street Improvements
The model of Iranistan Avenue explores green infrastructure options and dry egress for the South End



Integrated Services
Potential future section of Iranistan Ave examines additional ways to store stormwater.

South End: East of Park

Key Projects

1. RAISE UNIVERSITY AVE: PROVIDE EGRESS ROUTE TO HIGH GROUND AT PARK AVE
   BENEFITS: EGRESS, DECREASED CHRONIC AND ACUTE FLOODING, NEW PUBLIC AMENITY
   IMPLEMENTATION: WOULD BE BUILT IN CONNECTION TO THE SOUTH END EAST ALIGNMENT

2. BLUE/GREEN CORRIDOR: NETWORK OF GREEN AND BLUE STREETS ALONG BROAD AND MAIN STREETS
   BENEFITS: DECREASED CHRONIC AND ACUTE FLOODING, STORMWATER STORAGE BEHIND SURGE ALIGNMENT IN ACUTE EVENTS
   IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS

3. SOUTH END EAST ALIGNMENT: SURGE ALIGNMENT THAT TIES INTO HIGH GROUND
   BENEFITS: SURGE REDUCTION, PUBLIC SPACE CREATION, AND ACCESS TO WATER
   IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS; HEAVILY DEPENDENT ON FUNDING AND EASEMENTS
   ALTERNATIVE SURGE ALIGNMENTS: SHOWN ON THE PLAN IN DASHED LINES

A network of blue-green streets and spaces that manage stormwater, as well as a system of flood risk reduction to be planned and implemented by the NDR project.

The east side of the South End is a complex area that includes major regional energy facilities and infrastructure, along with older industrial buildings, historic residences, churches, and a large part of the University of Bridgeport. The plans illustrated here envision the evolution of a **network of blue-green streets** and spaces that manage stormwater, as well as **a system of flood risk reduction** to be planned and implemented with NDR funding.

This new system of flood risk reduction and water management would unlock the considerable development potential of this area, including the eastern edge of the University of Bridgeport, the 60 Main Street site, and a range of sites along Main Street and Broad Street, along with historic properties. The 60 Main development site could be filled and integrated into the perimeter alignment or a flood wall could be used to bisect the site, causing the development to include architectural adaptation to avoid flooding.

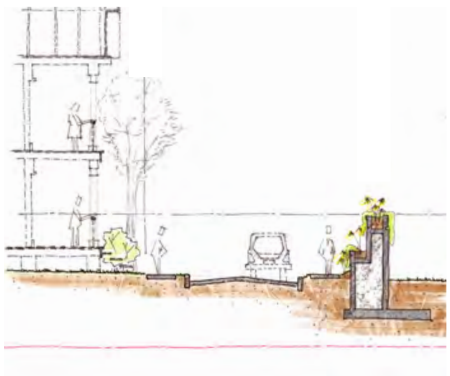
A primary development goal for this area is to reconnect the South End with Downtown Bridgeport and the multi-modal transit station. By emphasizing improvements along Broad and Main streets, the South End can be better integrated with downtown and the regional transportation corridor.

Surge Alignment Comparison

Moving forward, the NDR design team will advance up to three **alternative surge reduction alignments**, and from these select the preferred alignment and design to 30%. The team will compare three alternatives including community affects, design quality, integration into surrounding context, connectivity to Seaside Park, and the ability to develop neighboring parcels.

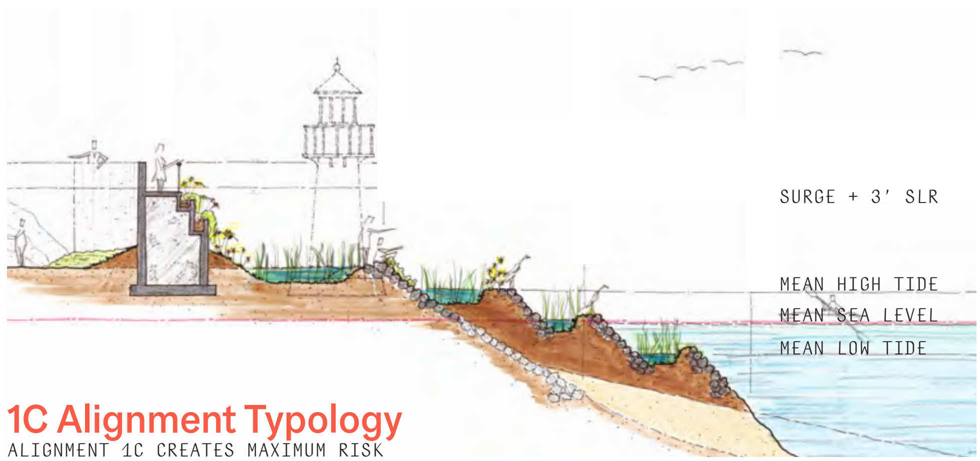
Each alignment will also be quantitatively evaluated to assess the impacts of flood risk reduction concepts — storm surge, wave action, and inundation extents — on surrounding areas to chart performance.

Each alignment will be **integrated into the surrounding context**. Alignment design will extend to adjacent properties, incorporating roadway and park connections, while also considering land use characteristics, program, larger community connectivity, and economic, social and cultural goals prioritized by the east South End community.



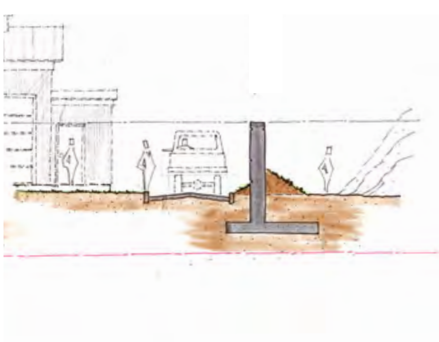
1A Alignment Typology

THIS TYPOLOGY, SHOWN IN THE PLAN IN DASHED LINES,IS PULLED BACK FROM THE WATER'S EDGE, ON HIGHER LAND, ENABLING A SHORTER WALL,WHICH STILL REACHES THE MINIMUM DESIGN ELEVATION, BUT RESULTING IN THE MOST SIGNIFICANT IMPACT ON THE SURROUNDING NEIGHBORHOOD FABRIC AND CHARACTER.



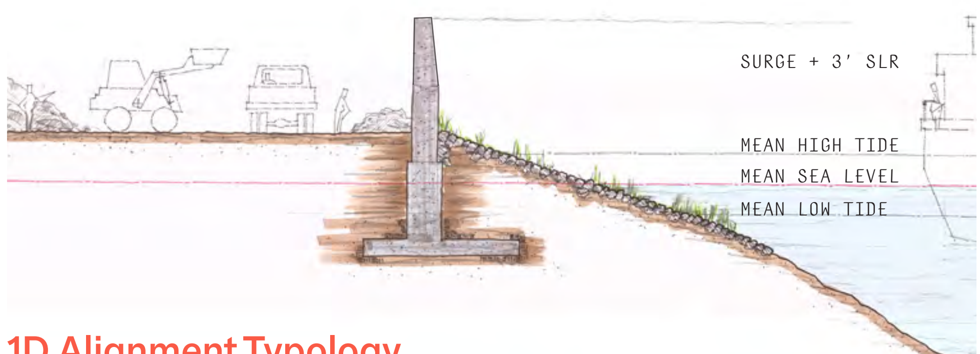
1C Alignment Typology

ALIGNMENT 1C CREATES MAXIMUM RISK REDUCTION FOR EXISTING INVESTMENTS AND REQUIRES A STRONG PUBLIC-PRIVATE PARTNERSHIP WITH PSEG. ALIGNMENT 1C COULD CONSIST OF A FLOODWALL, OR THE PSEG SITE CAN BE RAISED OR FILLED AS A PLATFORM, INTO WHICH THE REST OF THE ALIGNMENT WOULD TIE.



1B Alignment Typology

ALIGNMENT 1B REDUCES RISK TO PUBLIC UTILITIES WHILE LEAVING PSEG TO IMPLEMENT THEIR OWN PLAN IN THE FUTURE. THIS ALIGNMENT SEEKS TO BALANCE PUBLIC INVESTMENT TO REDUCE RISK FOR PRIVATE COMPANIES.



1D Alignment Typology

AN EDGE ALIGNMENT WOULD REQUIRE THE MOST COOPERATION WITH LOCAL LAND OWNERS. 1D WOULD REQUIRE INDUSTRIAL ADAPTATION ALONG THE WATER. ALIGNMENT 1D REDUCES FLOOD RISK FOR THE MOST PROPERTY AND RESOURCES, BUT ALTERS WATERFRONT ACCESS.

Downtown & East Side

The visible core of Bridgeport's Downtown is enhanced with a wave of redevelopment and by investment in multi-modal transportation, along with improvements to its key asset, the Pequonnock River.

The compact downtown is a concentration of varied land use: businesses, financial institutions, federal, state, and local government offices, Housatonic Community College, cultural facilities, historic architecture, and, recently, new residential redevelopment. However, it remains circumscribed by elevated highways, **cut off** from its potentially attractive and valuable waterfront. Downtown is vulnerable to flooding along its low-lying eastern edge, where it should be bridging to new development on Steel Point, as well as to the East Side and East End neighborhoods.

The plans for the eastern edge illustrate raised streets and sites linking into and **extending the system of flood risk reduction** begun by NDR along the east side of the South End. Illustrated measures would also provide future dry egress and spur new development along the Pequonnock waterfront, not only in the historic downtown, but eventually through new resilient development along elevated pier streets on the eastern shore of the Pequonnock combined with evolutionary naturalization of parts of that shoreline.

Over time, this should have the dramatic effect of expanding the downtown, its sphere of influence and economic energy. The Pequonnock and the harbor could become a **new center for Downtown and the region** that celebrates the symbiotic and resilient relationship of land and water; the productive relationship of a resilient Bridgeport to the River, the harbor and to Long Island Sound.

Riverfront Development
As the perimeter surge alignment wraps downtown, development possibilities can be leveraged.

New and Restored Access
Improved circulation routes to and from downtown can improve regional transportation and increase redevelopment.

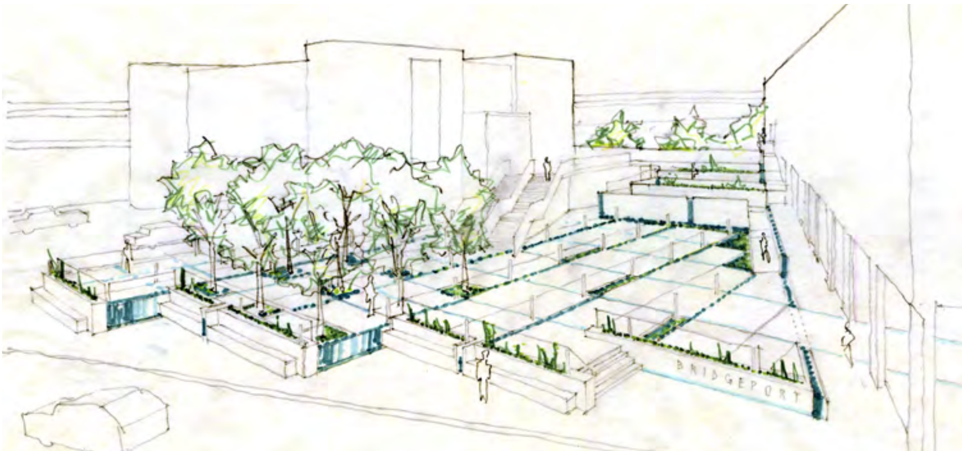
Key Projects

1. DOWNTOWN PLAZA: BLUE/GREEN INFRASTRUCTURE INCORPORATED INTO TRANSPORTATION PLAZA
BENEFITS: INCREASED ACCESS AND EGRESS BY TRAIN, INCREASED STORMWATER MANAGEMENT AWARENESS THROUGH VISIBLE COLLECTION, AND IMPROVED PUBLIC SPACE
IMPLEMENTATION: IN CONJUNCTION WITH THE TRAIN STATION RENOVATION, A PRIORITY PROJECT FOR THE CITY

2. DOWNTOWN SURGE ALIGNMENT: RIVERFRONT SURGE ALIGNMENT THAT TIES INTO HIGH GROUND
BENEFITS: SURGE REDUCTION, DECREASED ACUTE FLOODING, INCREASED REDEVELOPMENT POSSIBILITIES
IMPLEMENTATION: A LARGE INVESTMENT PROJECT; CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS

3. WATER STREET: CONVERT TO A BLUE/GREEN STREET THAT EVENTUALLY WILL SERVE ONLY AS STORMWATER MANAGEMENT
BENEFITS: INCREASED STORMWATER STORAGE, DECREASED ACUTE FLOODING DOWNTOWN
IMPLEMENTATION: SHOULD HAPPEN IN THE ABSENCE OF A SURGE REDUCTION STRUCTURE

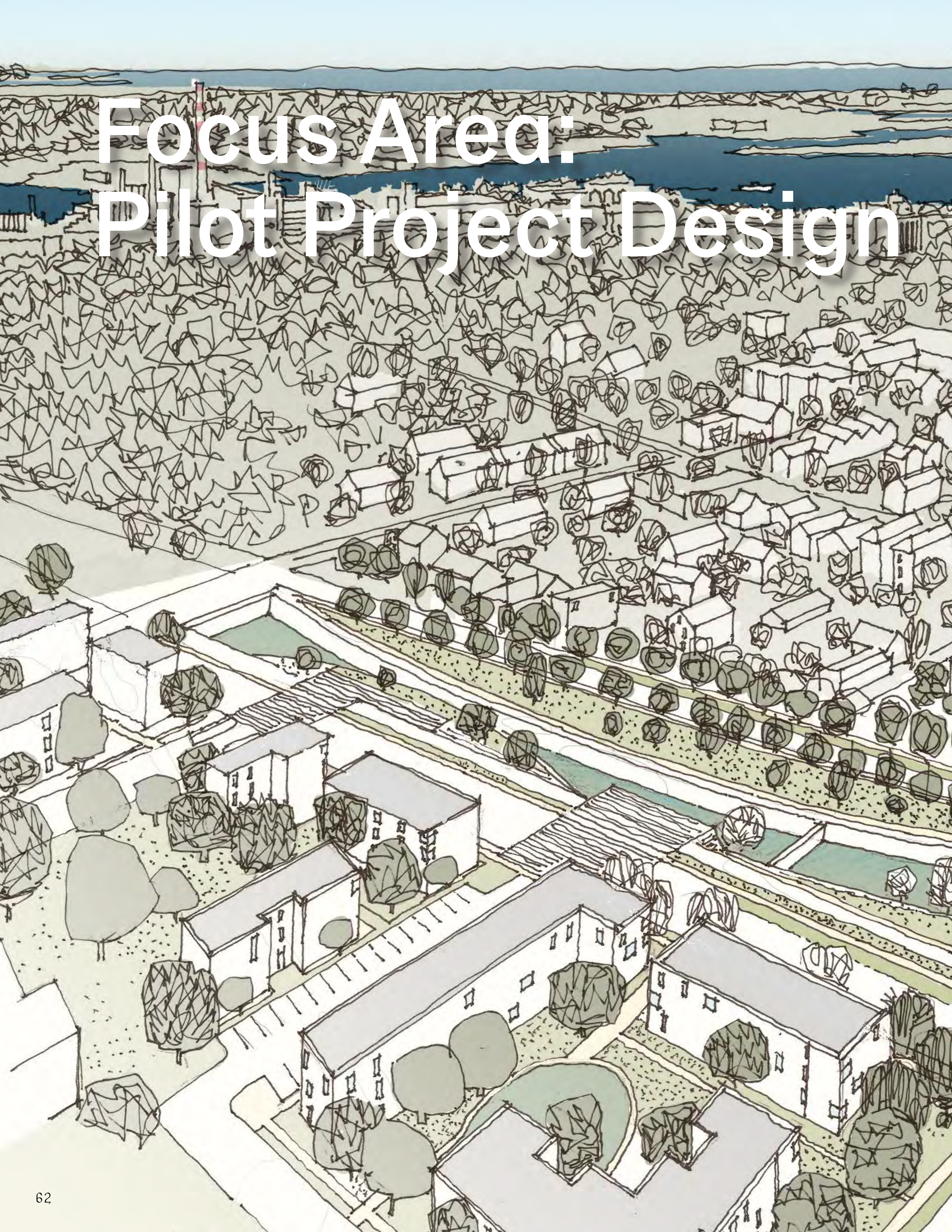
4. PIER STREETS: RAISED STREETS EXTENDING INTO THE MARSH ON THE EAST SIDE OF THE PEQUONNOCK RIVER
BENEFITS: INCREASED ACCESS AND EGRESS TO COASTAL AREAS, INCREASED WATERFRONT REDEVELOPMENT POTENTIAL
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS TO REPLACE EXISTING RACE TRACK STRUCTURE



Downtown Plaza

A new raised plaza connecting the train station, in the background, to Downtown along John Street. The plaza is elevated above the floodplain, creating an enhanced place of arrival and highlighting the use of public space as a water management feature, combining hardscape and landscape.

Focus Area: Pilot Project Design



Transforming the South End

The Resilient Bridgeport pilot project specifically aims to facilitate the redevelopment of Marina Village by reducing the flood rick to those parcels in both acute and chronic flooding event.

Components

1 UPLAND DETENTION THROUGH GREEN AND SUBSURFACE STORMWATER STORAGE SITES
BENEFITS: DECREASED CHRONIC FLOODING ON STREETS AND IN LOW COASTAL AREAS
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENT OF OTHER PROJECTS

2 RAISED EGRESS
BENEFITS: ACCESS DURING NORMAL RAINFALL EVENTS, EVACUATION ROUTES DURING LARGER EVENTS, AND FOR EMERGENCY RESPONDERS INTO THE NEIGHBORHOOD DURING FLOODING
IMPLEMENTATION: MUST BE PAIRED WITH STORMWATER SYSTEM IMPROVEMENTS

3 STORMWATER PARK THE INITIAL COMPONENT OF A SEPARATED STORMWATER SYSTEM (MS4)
BENEFITS: IMPROVED WATER QUALITY, NEW PUBLIC AMENITY, ANCHORS REDEVELOPMENT
IMPLEMENTATION: MUST BE PAIRED WITH ADDITIONAL STORMWATER INFRASTRUCTURE, SUCH PUMP TO CEDAR CREEK

4 GREEN STREETS
BENEFITS: DECREASED STORMWATER RUNOFF, IMPROVED WATER QUALITY, DECREASED CHRONIC FLOODING
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS, CAN TIE INTO MS4 SYSTEM

5 RAISED BALLFIELDS MAINTAIN RECREATIONAL OPPORTUNITIES
BENEFITS: STORMWATER DETENTION, ACCESS TO RECREATION AFTER RAIN EVENTS, WAVE ATTENUATION
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS

6 SOUTH END BERM
BENEFITS: REDUCED RISK FROM ACUTE STORM SURGE EVENTS, PUBLIC AMENITY
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS, NEEDS ADDITIONAL STORMWATER INFRASTRUCTURE

7 ADAPTING SEASIDE PARK (THROUGHOUT)
BENEFITS: RESTORED HABITAT, IMPROVED WATER QUALITY, PUBLIC AMENITY, IMPROVED RECREATIONAL SPACES, STORMWATER STORAGE, WAVE ATTENUATION, REDUCED MAINTENANCE
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS AND IN PHASES

8 MIRROR LAKE AND OUTFALL
BENEFITS: IMPROVED WATER QUALITY, INCREASED STORMWATER STORAGE, HABITAT
IMPLEMENTATION: CAN BE CONSTRUCTED INDEPENDENTLY OF OTHER PROJECTS, CAN TIE INTO MS4 SYSTEM

Focus Area Components

With implementation funding awarded through Rebuild by Design for a pilot project earmarked to reduce flood risk in and around Marina Village, further design work was conducted in the portions of Seaside Park and the South End: West of Park that had the potential to meet that objective. The projects depicted on the map to the left and described on the following pages form the menu of options that ultimately resulted in the selection of the first investment to be made towards Resilient Bridgeport. Each project was guided by the urban design and planning principles established at the onset of Rebuild by Design. These projects strive to be a visible example of resilient planning in a coastal environment and together form a complementary system for decreasing chronic and acute flooding within the South End of Bridgeport. Though the pilot project funding was targeted for Marina Village and environs, all of these projects enabled further exploration of the types of projects that could be deployed elsewhere to address chronic flooding along the coast. All the components are explicitly designed to complement one another and, implemented over time, expand the impacts and benefits of prior projects with limited additional funding through investments with independent utility.

In evaluating this menu of potential pilot projects components, the design team, along with the Bridgeport community, prioritized making the South End safer. Goals included **reducing chronic flooding** caused by rainfall, and mitigating some of the effects of climate change. The funded project:

- Supports sustainable adaptation and growth because it **improves dry egress** during storms, and enhances the viability of sites for residential and commercial development.

- Enriches the daily lives of residents, because it **enhances connections and amenities**, and improves neighborhood aesthetics.

- Aims to strengthen the environment, bolster the identity of Bridgeport, and serve as an **exemplary and replicable project** that stakeholders can collaboratively develop and successfully operate and maintain.

After introducing the potential pilot project components on the following pages, the participatory stakeholder engagement process and evaluation criteria used therein will be described, outlining the process that lead to the pilot project selection. With ambitious objectives and multiple project component alternatives, the available amount of funding and ability to create a complete system with independent utility and future expansion were critical factors in decision-making. The resulting pilot project was the best, practicable, and affordable investment to reduce flood risk in and around Marina Village, and a first step towards a larger system of resilient infrastructure for this neighborhood and a demonstration of Resilient Bridgeport.

Adapting Seaside Park

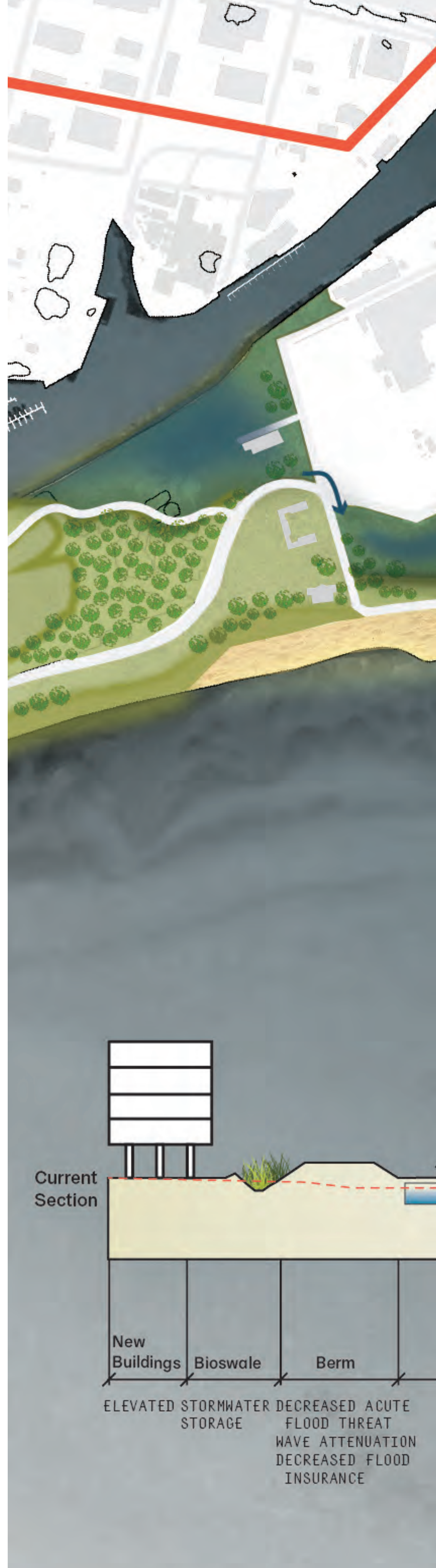
Seaside Park has the potential to become a resilient landscape while still preserving the historic character intended by Fredrick Law Olmsted, the park's famous landscape architect.

In 1865, the park began to emerge from the industrial coastline along the Pequonnock and the swamps to the west. The land was drained and filled in to the create the earth that Seaside Park and many of the neighborhood streets in the South End now occupy. Olmsted's vision of a publicly accessible rolling park along a vast swath of the oceanfront still persists today; Seaside Park is one of the **largest stretches of public waterfront in coastal Connecticut.** [8]

The park's greatest asset — and challenge — is its proximity to several waterways: Long Island Sound, Cedar Creek, and the Pequonnock River. The park must adapt to changing water levels, increasing frequency of storm events, changing soil salinities, warming local temperatures, shift in USDA plant hardiness zone, and saltwater intrusion into the groundwater table. This future evolution can be accommodated by replanting shoreline vegetation that is native and salt tolerant, and **excavating areas for water storage** while using the excavated fill to build up higher areas. By building up and cutting away at the relatively flat topography of the park, a **range of new landscape types** can be introduced: maritime forest, salt marshes, dunes, and tidal marshes. These specific landscapes can serve to provide additional stormwater storage, increase biodiversity and habitats, and create educational areas for the preservation of natural systems. Marshes can also improve water quality, while maritime forests can store water vertically; an average large tree is able to hold upwards of 36,500 gallons of water per year. [9]

Improving connections within the park will make the adaptations more accessible, enabling visitors to directly experience new landscape types, such as marshes, dunes, and forest. A system of paths, trails, and boardwalks is envisioned to link the different zones during both dry and wet weather. Existing roads and new pathways would also be able to accommodate a shuttle system that traverses the long coastal park; the vehicles could run on clean fuel and be self-driving as a way to test implementing new transportation technology in Bridgeport.

Sections along the shoreline would host different solutions, creating a varied landscape, adaptable to highly localized conditions and fund availability. The drawing at right represents one possible sample section through part of Seaside Park. Other options and construction implications for coastal edge and habitat restoration can be found in Restore the Edge, page 28.




Field
Marsh
Parking
Field
Maritime Forest
Soundview
Tidal Wetlands
Breakwater
HABITAT
INCREASED BIODIVERSITY
WETLAND MITIGATION CREDITS
STORMWATER STORAGE
HABITAT
INCREASED TREE COVER
EXISTING
SHORE STABILIZATION
HABITAT
WAVE ATTENUATION
HABITAT
WAVE ATTENUATION

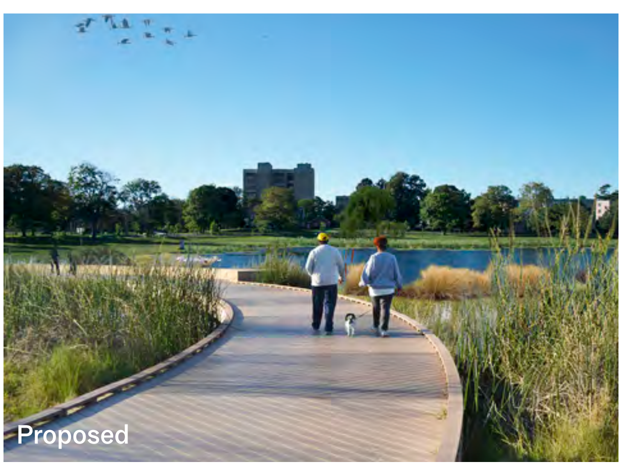
Stormwater Retention Areas and Outfalls in Seaside Park

Mirror Lake's outfall to Long Island Sound can be transformed into a stormwater management asset while also expanding habitat areas within in the green edge.

Through moderate adaptation, the existing Mirror Lake, near the edge of Seaside Park, can become a **functioning treatment wetland**. Stormwater from a new separated system could be rerouted to Mirror Lake and filtered through an expanded wetland system. This move will create additional storage for water and improve the quality of water that is released into Long Island Sound. Rather than the engineered lake that currently exists, a more natural looking winding path fulfills Frederick Law Olmsted's original design vision for Seaside Park,

Mirror Lake could **evolve in time** as sea levels change when designed as a natural resilient landscape. First phases could include replanting the perimeter, regrading to create a few sub-basins, and restoring the existing outfall into the lake. New pathways would provide direct access to the water, and could be elevated like a boardwalk, as shown below. Subsequent phases could open up the edge of the lake along Soundview Drive and connect it to Long Island Sound to create a tiered living shoreline. Several unknown variables in this system affect the cost and scheduling, include the existing outfall condition, the location of the groundwater, and soil salinity. Additional research is required to better understand these factors.

The restoration of Mirror Lake is a prime example of an isolated formerly coastal wetland condition that exists all along the coast. Coupled with its location within the historic area of Seaside Park, this replicability could attract robust civic partnership to attract resources and facilitate implementation. Here, conversations with the Garden Club of Fairfield and The Nature Conservancy have already begun. Landscape types in Seaside Park and their benefits are discussed in Restore the Edge on page 28.


Proposed


Existing


Maritime Forest
HABITAT
Marsh
STORMWATER STORAGE
HABITAT
Boardwalk
ACCESS
Maritime Forest
HABITAT
Soundview
EXISTING
Tidal Wetlands
SHORE STABILIZATION
HABITAT
WAVE ATTENUATION
Breakwater
HABITAT
WAVE ATTENUATION

Raised Ballfields

Elevating the existing ballfields and storing stormwater below provide more storage capacity for an expanding separated sewer system in the South End.

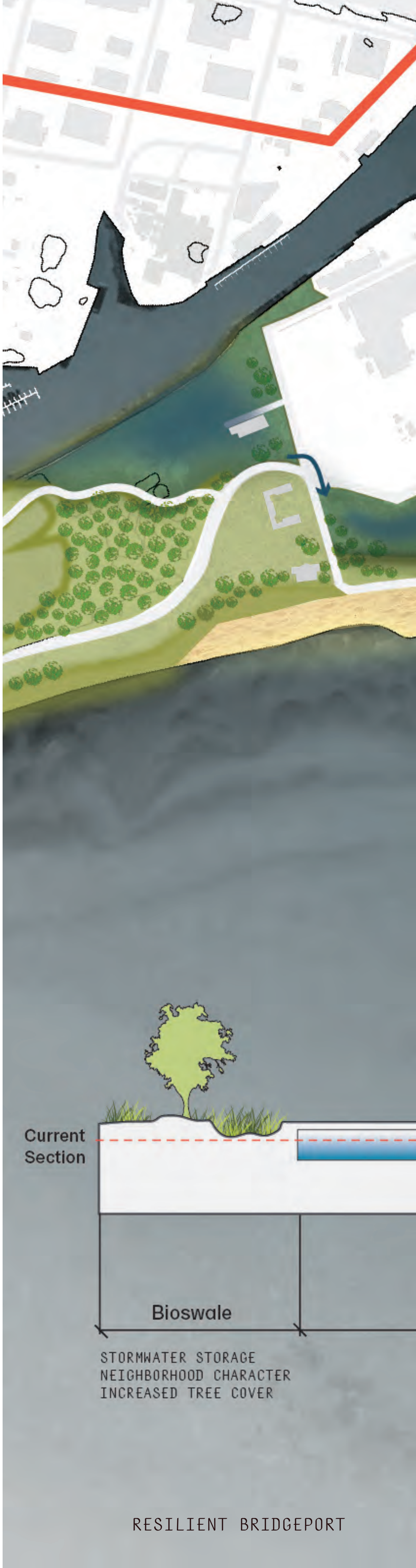
Elevating the existing ballfields and storing stormwater below supplements the South End's ability to manage stormwater outside of the aged combined sanitary and stormwater system. This project would **improve the quality of public space** within Seaside Park, allowing access after smaller storms, by creating additional subsurface **stormwater storage**. Systematically raising the ballfields in Seaside Park would yield a range of overlapping benefits, including:

- Increased stormwater storage
- Wave attenuation
- Improved access to recreational fields after minor rainfall events
- Variation in topography can create more varied habitats for plants based on inundation frequency.

This stormwater storage system can be **linked to a green infrastructure** system behind the potential storm surge alignment through the South End.

Several unknown variables exist within this proposed project that could impact potential cost and implementation including: timeline of the other proposed components, the location of the groundwater table within Seaside Park, and the extent of a separated stormwater system build out. The issue of time, construction phasing within the South End, would determine where the stormwater to fill the subsurface storage would be directed from, either behind some surge alignment structure or from the surrounding neighborhood directly. Planning principles could greatly impact the potential cost for this system.

Additional information on separated stormwater systems can be found on page 36, Delay and Convey, and in the Stormwater Report.



Field

STORMWATER STORAGE SUBSURFACE
RECREATION AREA
INCREASE COMMUNITY HEALTH

Marsh

HABITAT
INCREASED BIODIVERSITY
WETLAND MITIGATION CREDITS
STORMWATER STORAGE

Seaside Park Berm

As funding becomes available, alignments can be constructed around pockets of coastal Bridgeport to reduce risk from storm surge and sea level rise in neighborhoods.

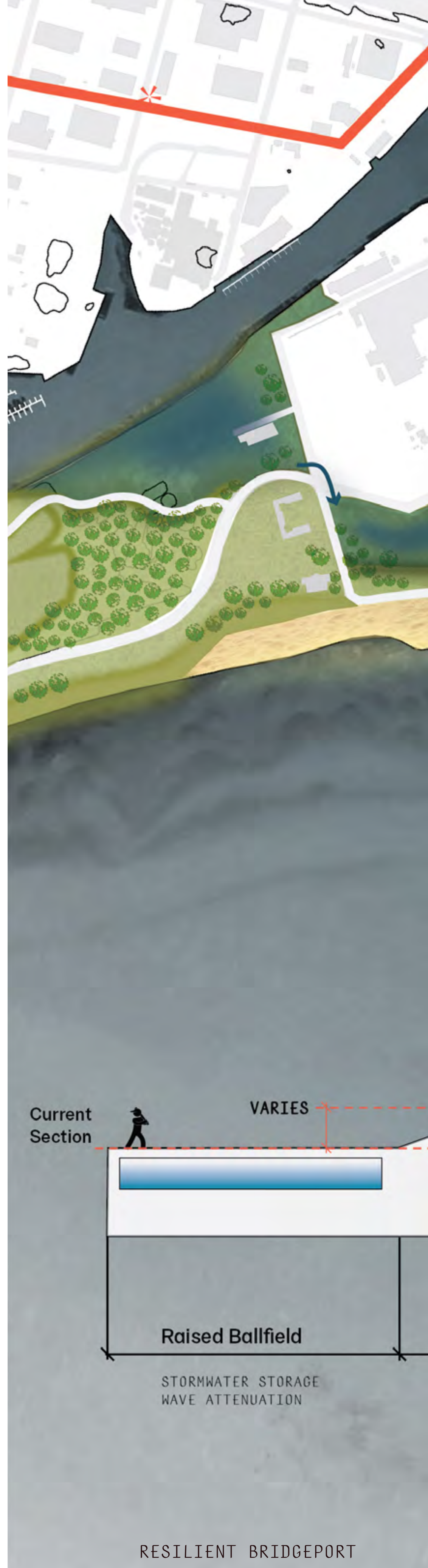
The benefits of this system include greatly improved safety of residents during acute storm events. At right, the potential surge alignment, illustrated by the red line, provides **flood risk reduction for existing residential areas** in the floodplain, but does not represent the actual footprint of the alignment. Larger sites for potential commercial development, as well as a small number of existing residences, are outside of the barrier; in these cases, architectural adaptations such as elevated buildings would be a practical strategy to decrease damage due to storm surge.

A berm can also be designed to **function as a public space**, with a multi use path on top that provides connections for pedestrians, cyclists, and people exercising. This could create a recreational loop around Seaside Park and the South End neighborhood, encouraging residents to walk, run, or bike and be physically active, which would improve public health. Another benefit of an accessible berm path is providing elevated views of the surrounding area, including the water.

There are many unknowns and variables within the design of this alignment option including:

- The specific flood risk reduction measures that would comprise the alignment, e.g. berm, flood wall, etc.
- The top of wall elevation for the system, as additional analyses are required to balance design elevation with interior drainage
- The integration of a raised road for egress with the structure
- Current subsurface conditions, i.e. what utilities need to be coordinated
- Interior drainage and stormwater management systems on the inside of the alignment

All of these variables would have an impact on cost, and should be weighed against the number of structures inside the alignment, as well as other benefits. Other options and cost implications for protection alignments are explored in Adapt to Rising Seas, page 32.




ADDITIONAL PUMPS MAY BE NEEDED
Berm
Bioswale
Iranistan Ave. Raised
Columbus Elementary
DECREASED ACUTE FLOOD THREAT
WAVE ATTENUATION
DECREASED FLOOD INSURANCE
FEMA CERTIFICATION
PUBLIC SPACE
STORMWATER STORAGE
INCREASED TREE COVER
DRY EGRESS
STORMWATER STORAGE

Upland Detention Systems

Upland detention reduces the amount of flooding from the combined sewer system in lowland areas.

Detaining and **storing stormwater where it falls** is one of the best ways to **decrease chronic flooding events in lowland areas**, like the South End of Bridgeport. Water should be detained upland to decrease flooding in lowland areas. Upland Bridgeport has the best soil for infiltration. Possible benefits of upland detention areas include:

- Retainage of stormwater
- Decrease in lowland chronic flooding
- Creation of new public green space
- Provide neighborhood amenities
- Improvements to neighborhood identity

Costs associated with Upland Detention sites vary based on area, soil composition, additional amenities provided, and land ownership. Not all detention areas need to be used as green space. Redevelopment sites could also perform as stormwater storage beneath parking and green space. For more information related to stormwater management, reference Delay and Convey Stormwater on page 36.

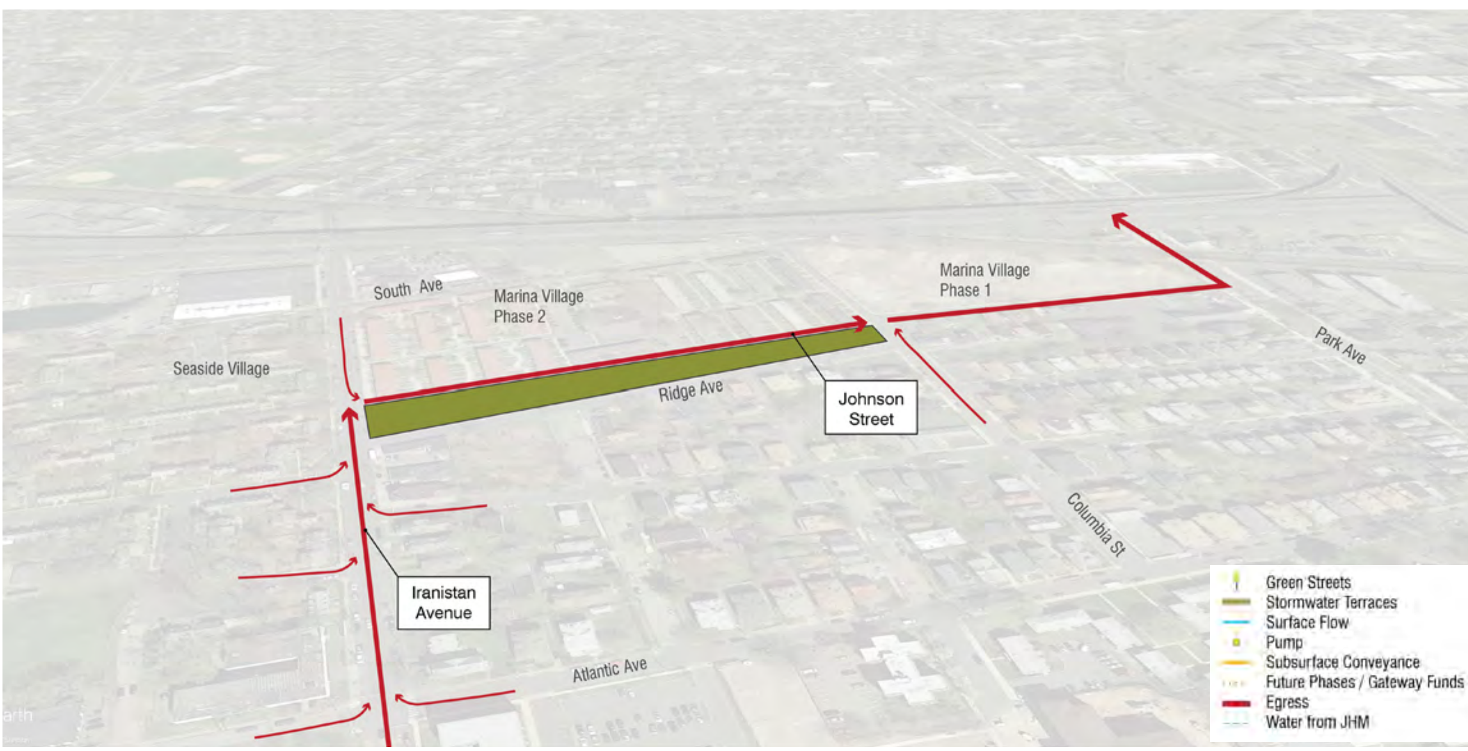
Raised Egress

Raised egress corridors create opportunities for redevelopment, egress and evacuation, and access for emergency vehicles. Several streets within the South End are good candidates to expand this system.

Raised streets for **access and egress** were considered in several places within the South End as components of the pilot project. Iranistan Avenue could be a raised corridor linking the neighborhood to greater Bridgeport. The new corridor would dry provide egress during a 10- to 25-year storm event, and increase the ability for **emergency vehicles to navigate** Iranistan during larger storms. If the street was used to store water, corridor would also decrease chronic street flooding. To expand the dry egress route, Iranistan could also be raised from University Avenue to Johnson Street Extension, creating a system of raised streets for safe neighborhood circulation during rain and storm surge events.

Cost for these systems is highly reliant on coordination of utilities, cost of fill material, easements, and the implementation of a separated stormwater system around the raised roads. This strategy for adapting to climate change can be replicated across Bridgeport in areas such as Black Rock Harbor south of Wordin Avenue or along the Pequonnock River. Additional information can be found in Access and Egress on page 40.

Green Infrastructure Areas within Bridgeport
The above map shows large potential sites for upland detention taking into account soil types and topography. Parks in solid green and redevelopment parcels are dotted, overlaid on areas ideal for green infrastructure.



Potential Egress Routes
The above diagram shows some of the potential raised egress corridors within the pilot project Focus Area.

Stormwater Park + MS4

The separation of the sewer system in the South End: West of Park to create a municipal separated stormwater system (MS4) and creation of visible stormwater management would decrease the number of chronic flooding events.

The major stormwater components of this projet are a **stormwater park, stormwater pump, and force main to Cedar Creek**. Paired with a raised egress corridor on Johnson Street, this combination of components allows for the redevelopment of the former Marina Village site by addressing egress in acute flooding events. The municipal separated stormwater system (MS4) provides a framework to expand to other surrounding streets, including in Seaside Village.

This stormwater park will benefit the surrounding neighborhood, including the Marina Village redevelopment site, in both chronic and acute flooding by providing a **visible system** to express the route of water through the neighborhood while providing a public amenity. This project would also **decrease the total number of combined sewer overflow** events occurring in the South End each year. More information on stormwater systems and MS4 can be found in Delay and Convey on page 36.

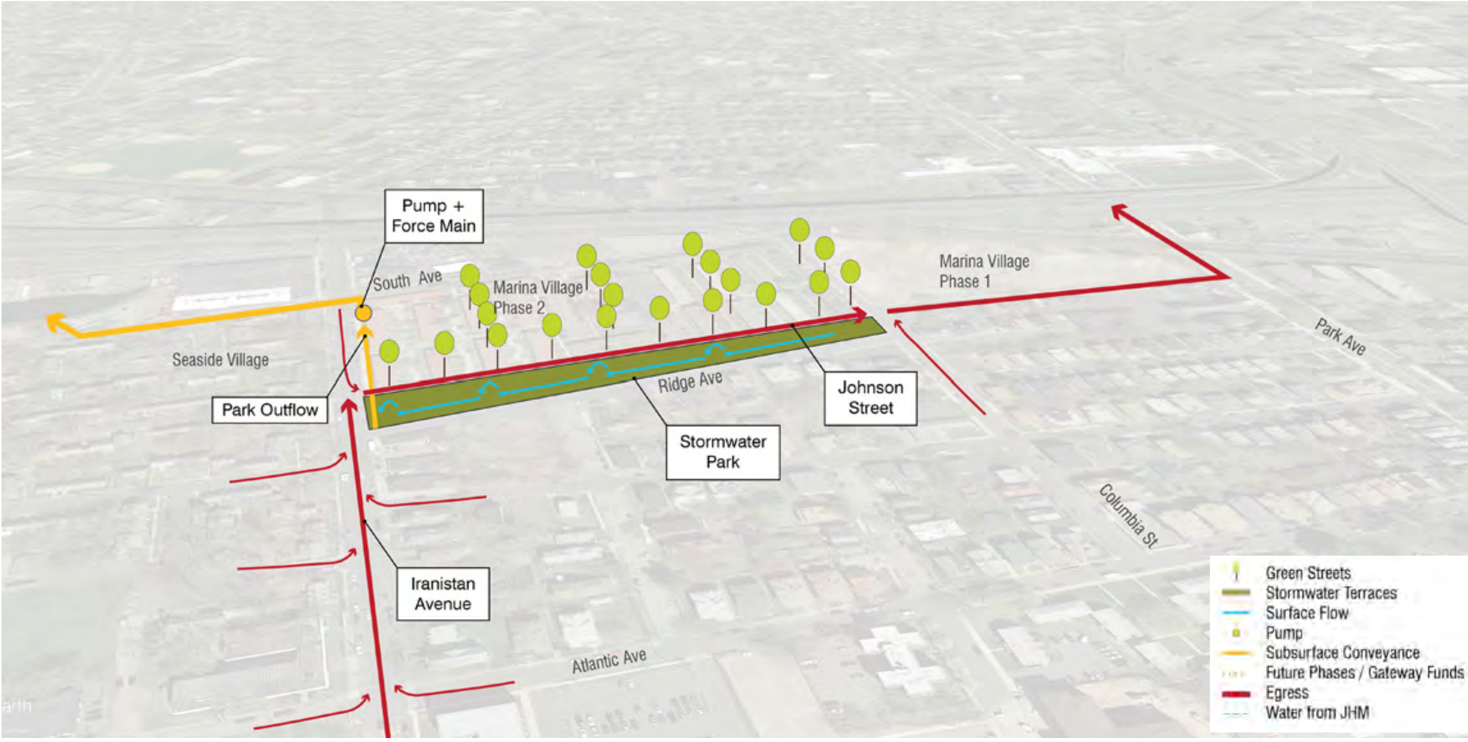
Green Streets

Runoff from upslope areas contributes to flooding in low-lying areas. Enhancing streets on high ground — with bioswales, rain gardens, pervious paving, and trees — helps to hold water upslope and infiltrate it into the soil. This reduces runoff and flood risk for lower areas within the watershed.

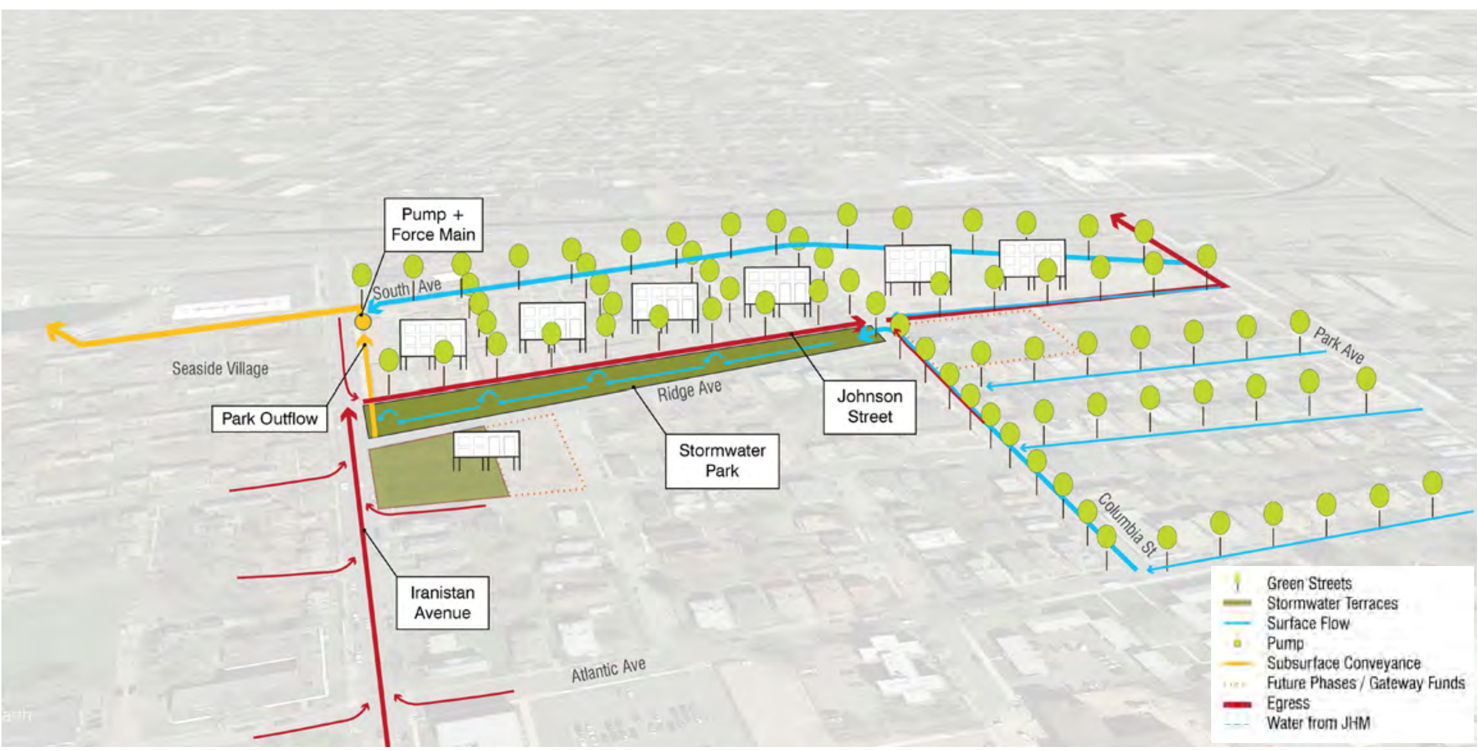
Within the project area watershed, upland green streets could be tied into a separated stormwater system and potentially decrease flooding in the South End. After the stormwater modeling analysis, it was determined that the upland green streets could not be tied into the pilot project park without significant regrading of the area, much of which falls on private property, and a massive rebuild of the stormwater system. This component was ruled infeasible for inclusion within the funded pilot project, but upland green streets could be implemented and tied into s future expansion of the MS4 stormwater system. In addition to **decreased chronic flooding,** green street benefits potentially include:

- Reduced heat island effect by expanding the urban tree canopy
- Increased habitats for birds
- Increased quality of streetscapes within the neighborhood
- Introduction of pocket parks into neighborhood

Additional information on types and benefits of green infrastructure can be found in Delay and Convey on page 38.



Funded Pilot Project
Above, a diagram of the pilot project a complete demonstration stormwater system that could act as a future backbone for a separated stormwater system within the South End: West of Park.



Green Streets Network
In addition to Johnson Street, other surrounding streets (such as Gregory) could be improved to store and convey stormwater. Tree lined streets shown in the diagram could tie into a separated stormwater system. The same elevation and soil criteria discussed in upland detention systems would be used to prioritize green street location.

Design Team Workshop
Left: The design team discusses option for the pilot project at a workshop in March 2017.

Pilot Project Selection Criteria

The area west of Park Avenue including Seaside Village and Marina Village redevelopment was selected through an assessment of information, community engagement, and preliminary design and engineering.

An **iterative process** of team workshops, public events, and stakeholder meetings guided the selection of a pilot project. Component testing occurred, as previously described and as further documented in the stormwater report. The multidisciplinary design team, along with the Director of Resilience for the State of Connecticut, established the following project selection criteria:

What do we know?

The area around Marina Village faces a range of challenges, including flooding and blizzards, sea level rise, limited emergency egress, few public spaces, limited resources, and aging infrastructure.

What are we working towards?

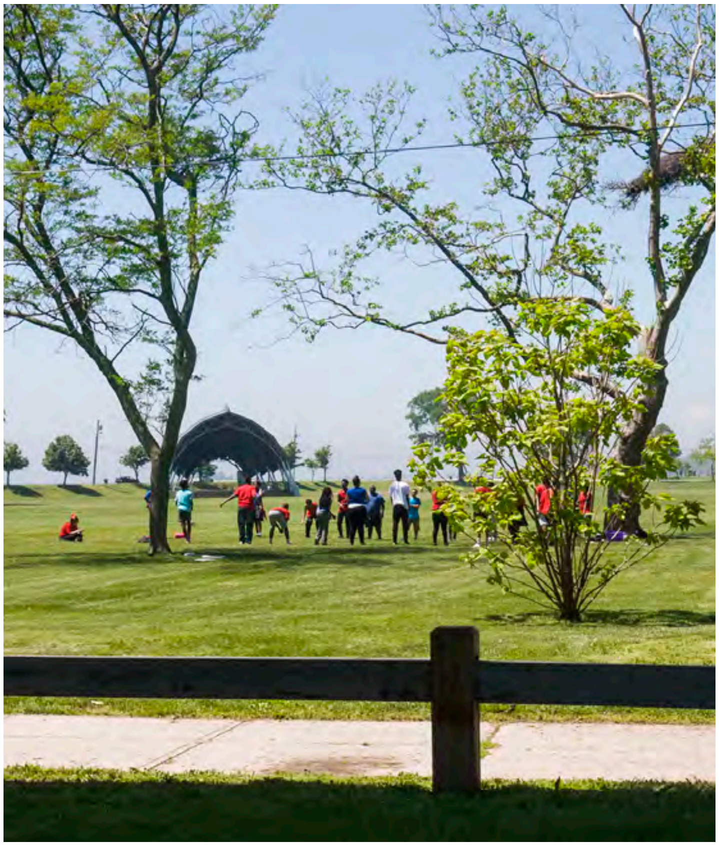
First and foremost, the project seeks to:

- Provide dry egress
- Be highly visible within the community, to support on-going resilience conversations
- Leverage additional investments
- Address chronic flooding
- Push adaptation and build community capacity

The secondary goals of the project include:

- Building city capacity
- Integrating natural systems
- Stabilizing property values
- Providing public amenities
- Creating an educational tool
- Strengthening the neighborhood's sense of place
- Creating adaptive design details
- Enhancing connectivity within, and to and from, the South End

Thirdly, the pilot project also aims to enhance ecological processes within the neighborhood, bury overhead utilities, serve as a destination or attraction for residents and visitors, and create an interactive environment.



The Community
Above: Summer day camp at Seaside Park, near Mirror Lake
Right: Children walk home after school through Marina Village

Whom does the project serve?

The community
Those directly affected:

- South End residents, present and future
- Owners of assets and businesses, institutions
- City of Bridgeport and agencies
- Flora and fauna

A larger audience
Those who may become aware of the project, but are not directly impacted:

- Future funders and investors
- Connecticut coastal residents, visitors
- Regulators and agencies
- Regional, national, and international design communities

What are deal breakers?

The project will have failed if it is:

Single purpose
Only addresses flooding, for example.

Does not mitigate flooding
And does not address acute flooding.

Does not provide dry egress
Does not assist Marina Village redevelopment.

Not visible
Or perceived to have not worked.

Fails before its planned term
Does not account for climate risk.

The pilot project and the criteria will **continue to evolve** as the funded project moves into final design and implementation. These criteria will continue to evolve and test the pilot project during the EIS process. The Environmental Impact Statement (EIS), required by The National Environmental Policy Act (NEPA), assesses the environmental impacts of a project before it moves forward.


Easter Egg

Public Workshops, Central to Engagement
The Resilient Bridgeport team hosted a range of public workshop activities:
Top right: Community members helped build storm surge protection alignments through an interactive model
Right: Conversation during a design workshop at 7 Middle
Opposite, top: Team based design activity for the pilot project park site, held at Marina Village during Bridgeport public school spring break
Opposite, bottom: Same design activity, held in the evening for adults

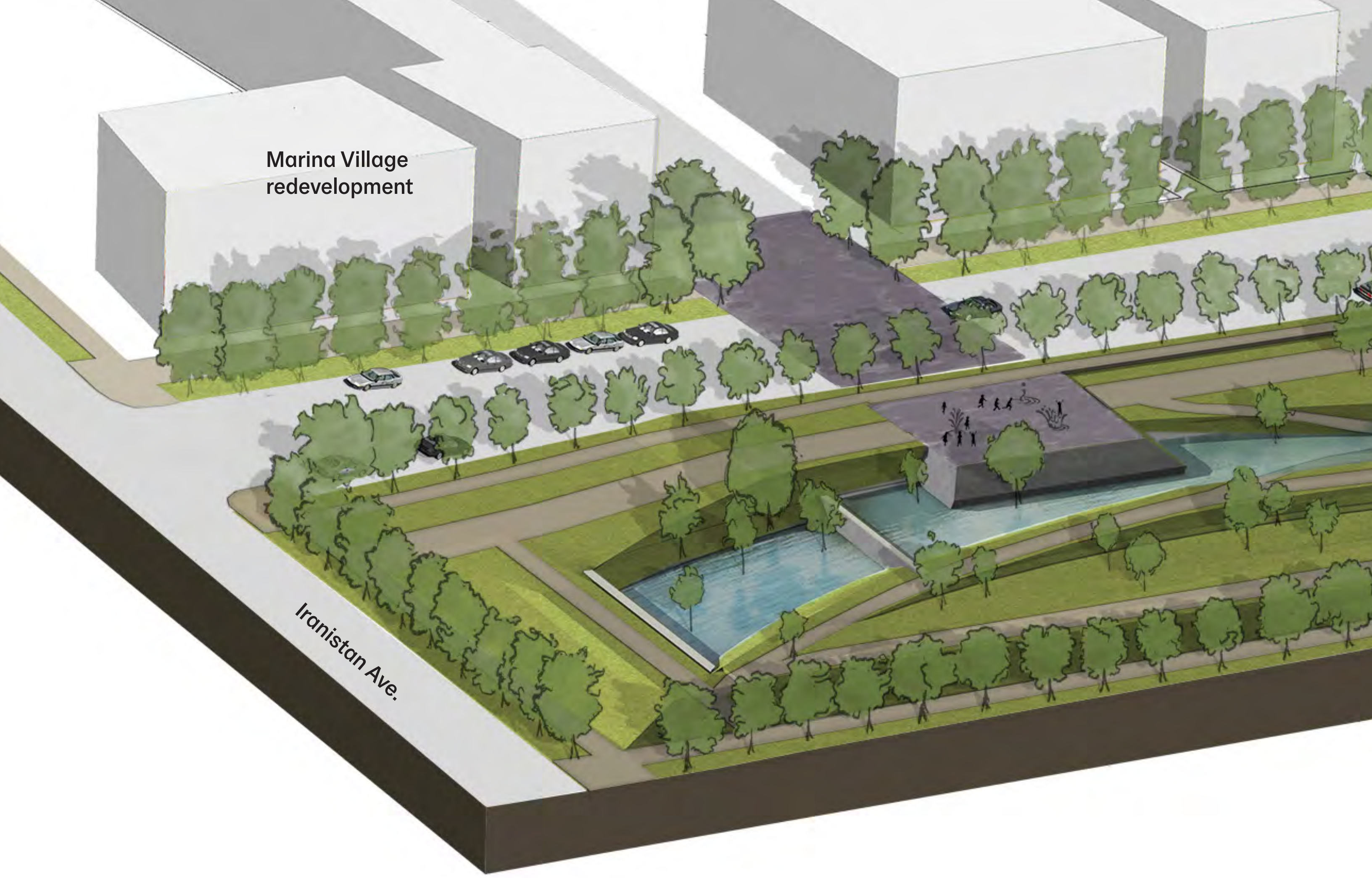
For more information on this process and events see the Community Engagement Report.

Engaging the Community

Community members and stakeholders played a huge role in the selection and design of the pilot project.

Integral to the design process, the design team held **regular design workshops, meetings, and lectures** with local stakeholders and community members. Event participants were encouraged to ask questions and share their thoughts through **interactive activities**, such as building surge alignments on a topographic model, and designing and drawing their ideal park on large on plans.

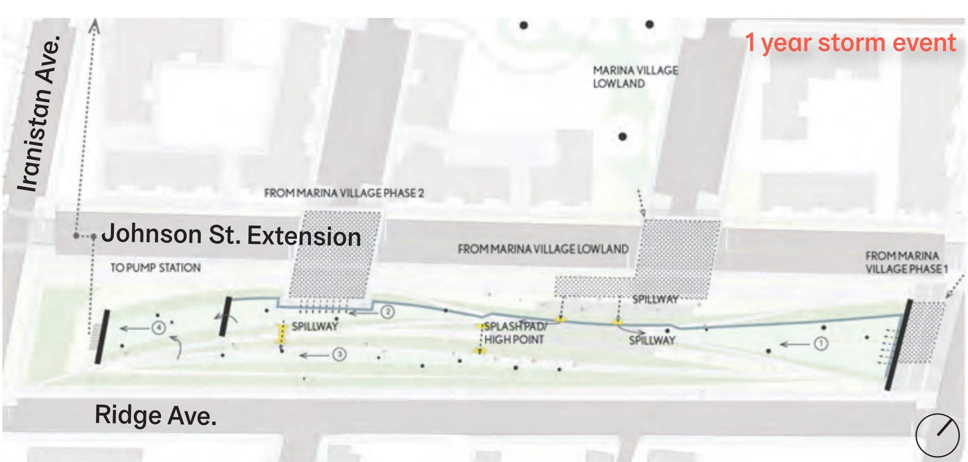
Education plays a key role in the workshop process, helping residents stay informed of the latest science concerning sea level rise and climate change in order to make informed comments on the design. During the workshops, design team members and community members **made design decisions together** to collectively and actively move the process forward. Various tools used in the meetings ranging from physical models to drawings to note-taking from facilitated conversations allowed the team to record all ideas discussed.



Pilot Project Design Goals

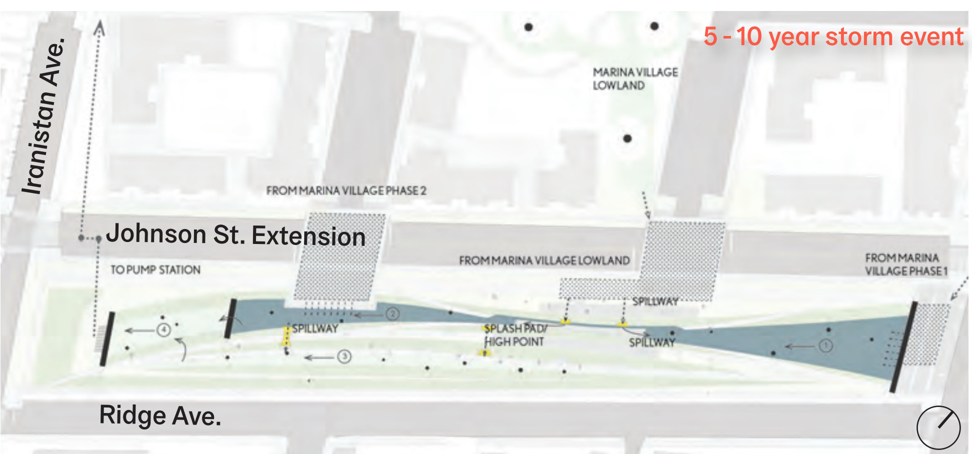
The Resilient Bridgeport pilot project is a combination of green and grey infrastructure components integrated within new, multifunctional public spaces to facilitate a more resilient neighborhood during chronic and acute storm events. This investment centers around a new Stormwater Park south of a raised egress corridor along an extended Johnson Street.

Raised Johnson St. Extension
By elevating and extending Johnson Street, dry egress is provided to a vulnerable population in the South End during storm surge events. This street will be an example of **high quality public space**, providing a multifunction sidewalk, street plantings, and subsurface stormwater storage.



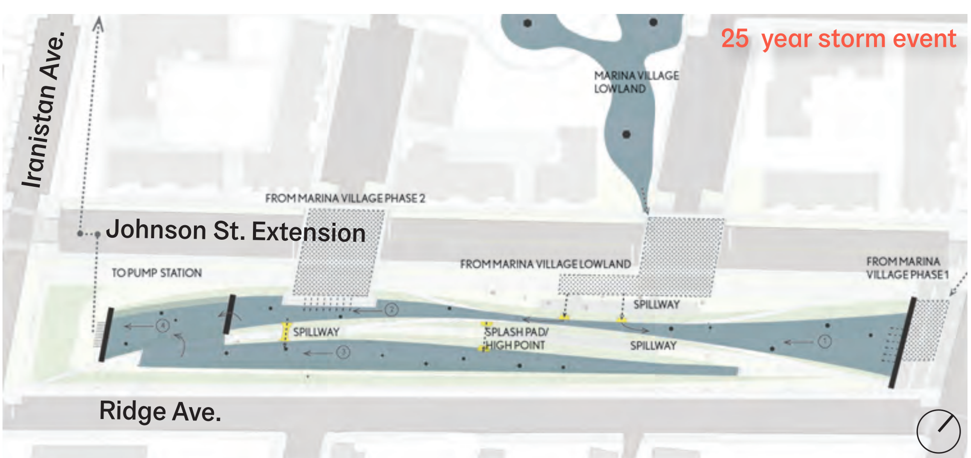
Space for People and Water

With a range of areas for different activities, landscape elements, and gathering places, the stormwater park will also temporarily hold a large amount of water to minimize impact on the combined sewer system.



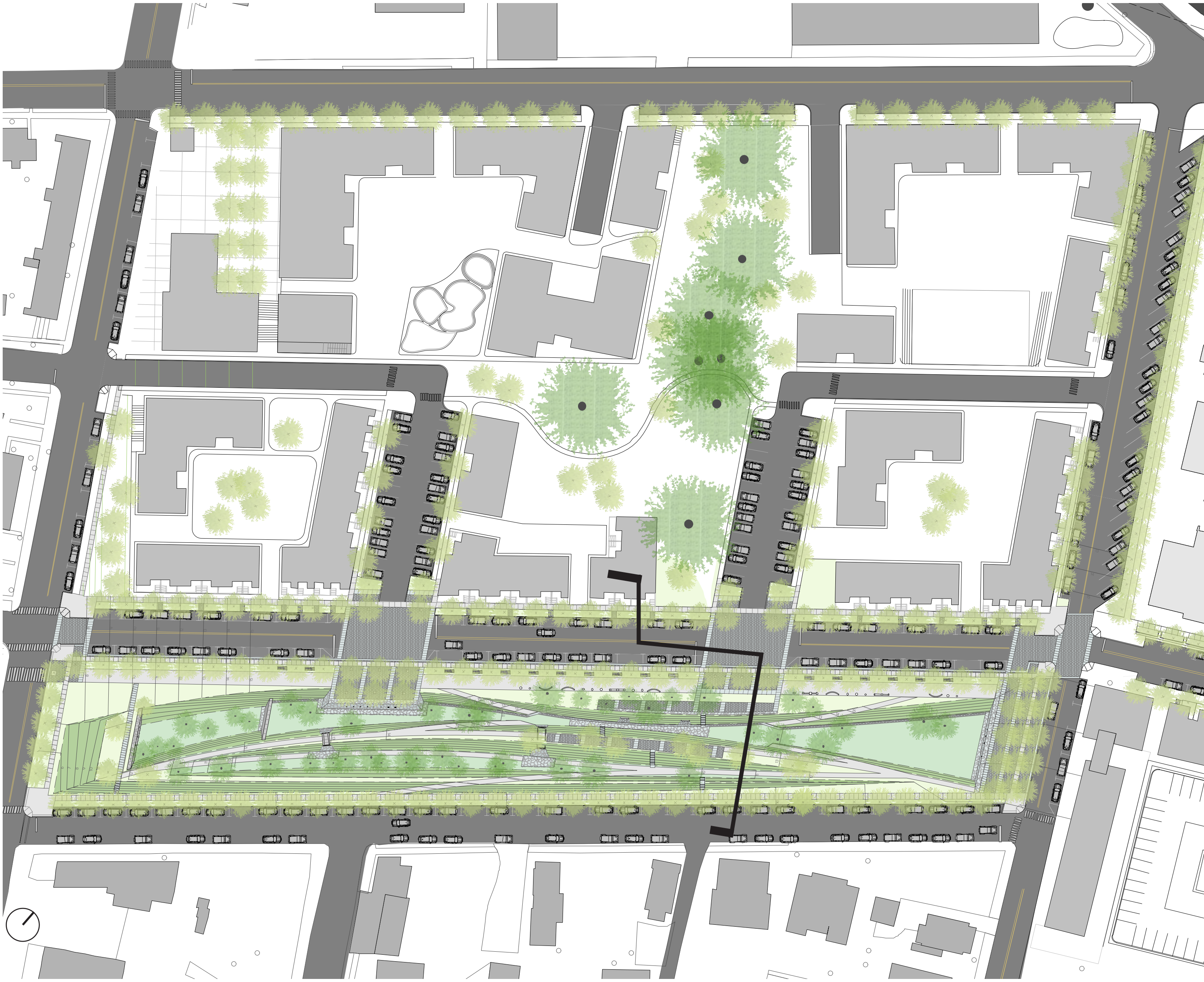
Stormwater Park

The approximately 2.5 acre stormwater park will accept water from upland areas and retain, delay, and improve the quality of the stormwater entering local waterways. The park will also function as a neighborhood **amenity with play equipment, open fields, and shaded areas**. As currently designed the terraced park contains several basins that will detain store and filter water after smaller storm events.



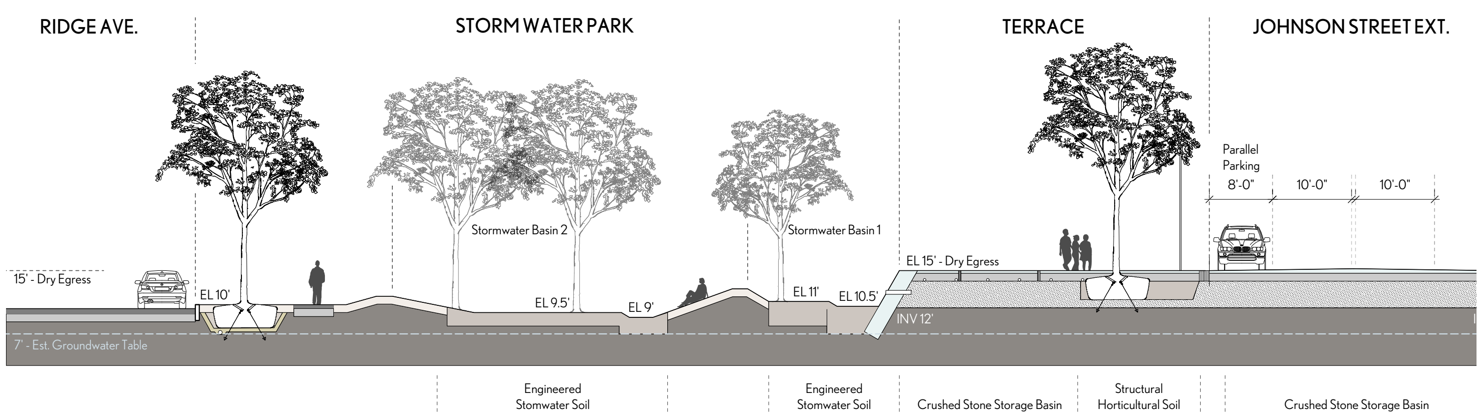
Pump and Force Main

At the low ponding point of the park, water will collect into a gravity fed pipe and be relayed to a pump at Iranistan and South Avenues. At this point, a new underground force main will transfer water to an existing outfall at Cedar Creek. This water, which formerly would have contributed to flooding in the neighborhood and combined sewer overflows, will now flush Cedar Creek with **fresh, cleaner water**, improving creek ecology.



Resilient Redevelopment Opportunity

The project acts as a “zipper” to connect the Marina Village housing redevelopment site and the **neighborhood fabric**. The new Johnson Street extension continues the existing street grid to Iranistan Avenue.



Pilot Project Design

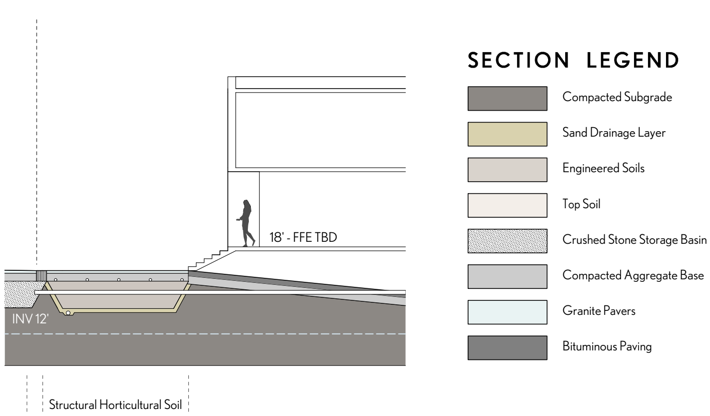
The pilot project is part of a broader set of investments and ideas, the first step towards citywide transformation, and is a tangible result of activities since Sandy that brought stakeholders together, served as the basis for collective visioning of the future, and demonstrates how to move forward.

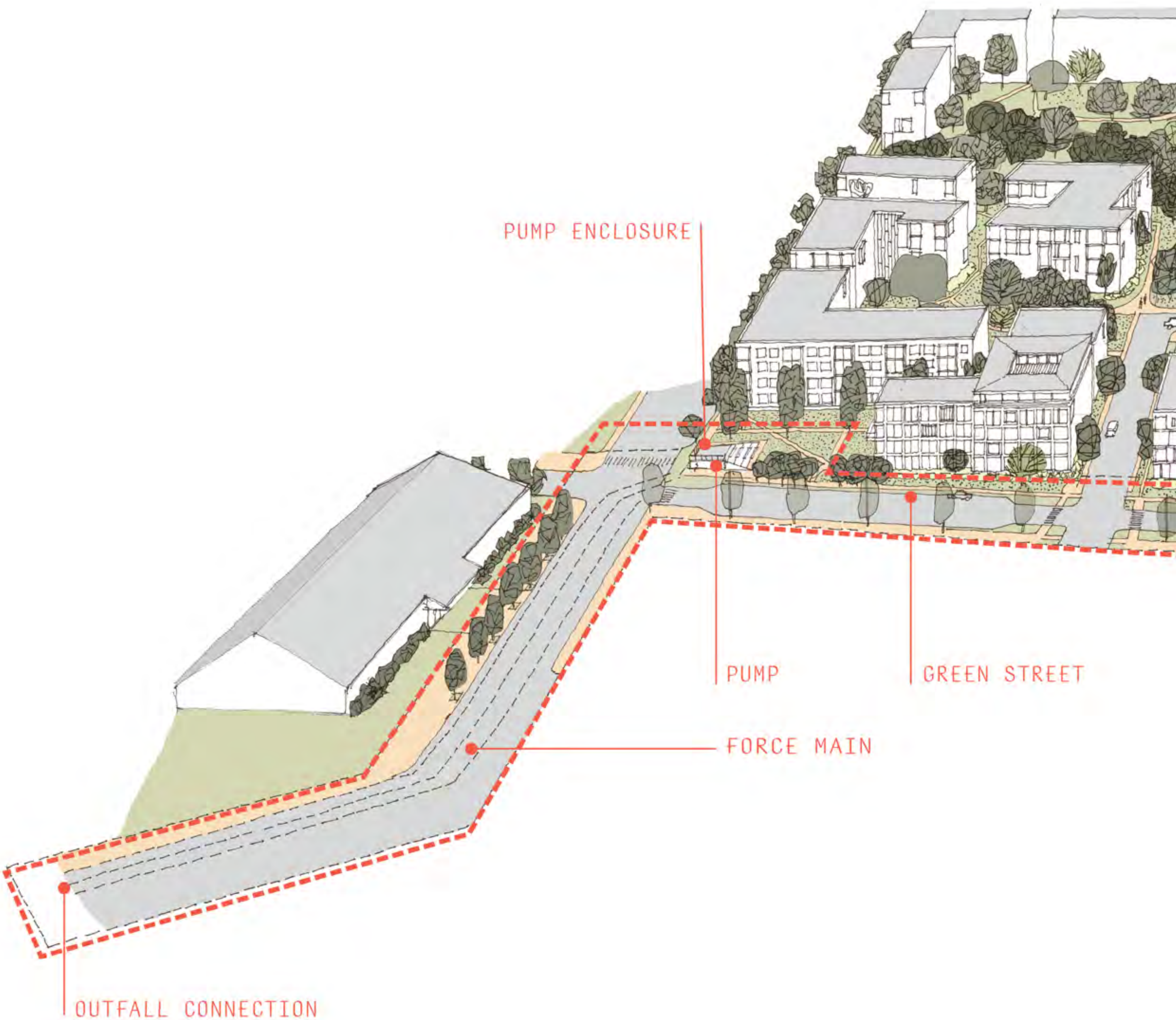
By applying the selection criteria, such as providing egress to Marina Village, addressing chronic and acute flooding, leveraging additional investment, pushing towards adaptation, and project visibility, the pilot project components were assembled. The funded project is composed of:

- An MS4 (Municipal Separate Storm Sewer System) microgrid with reduce chronic flooding in and around Marina Village by keeping stormwater out of the combined system and discharging it directly into Cedar Creek utilizing grey infrastructure (gravity pipes, pumps, and force main) and green infrastructure (rain gardens, subsurface storage, and surface storage)
- 2.5 acre stormwater park with green infrastructure and passive recreation
- Raised egress corridor linking the Marina Village redevelopment to adjacent high ground with subsurface stormwater storage

This selection of components is designed to layer both **infrastructure and urban amenity**, with as much attention paid to park features and street design as to addressing chronic flooding within the neighborhood. Although the project is mandated to serve the housing redevelopment site, the team sought to serve the larger community, providing a unifying asset for the South End. The development site is anticipating both surface and subsurface parking, with a total of approximately 324 spots.

For 30% design drawings of the pilot project reference Appendix A.

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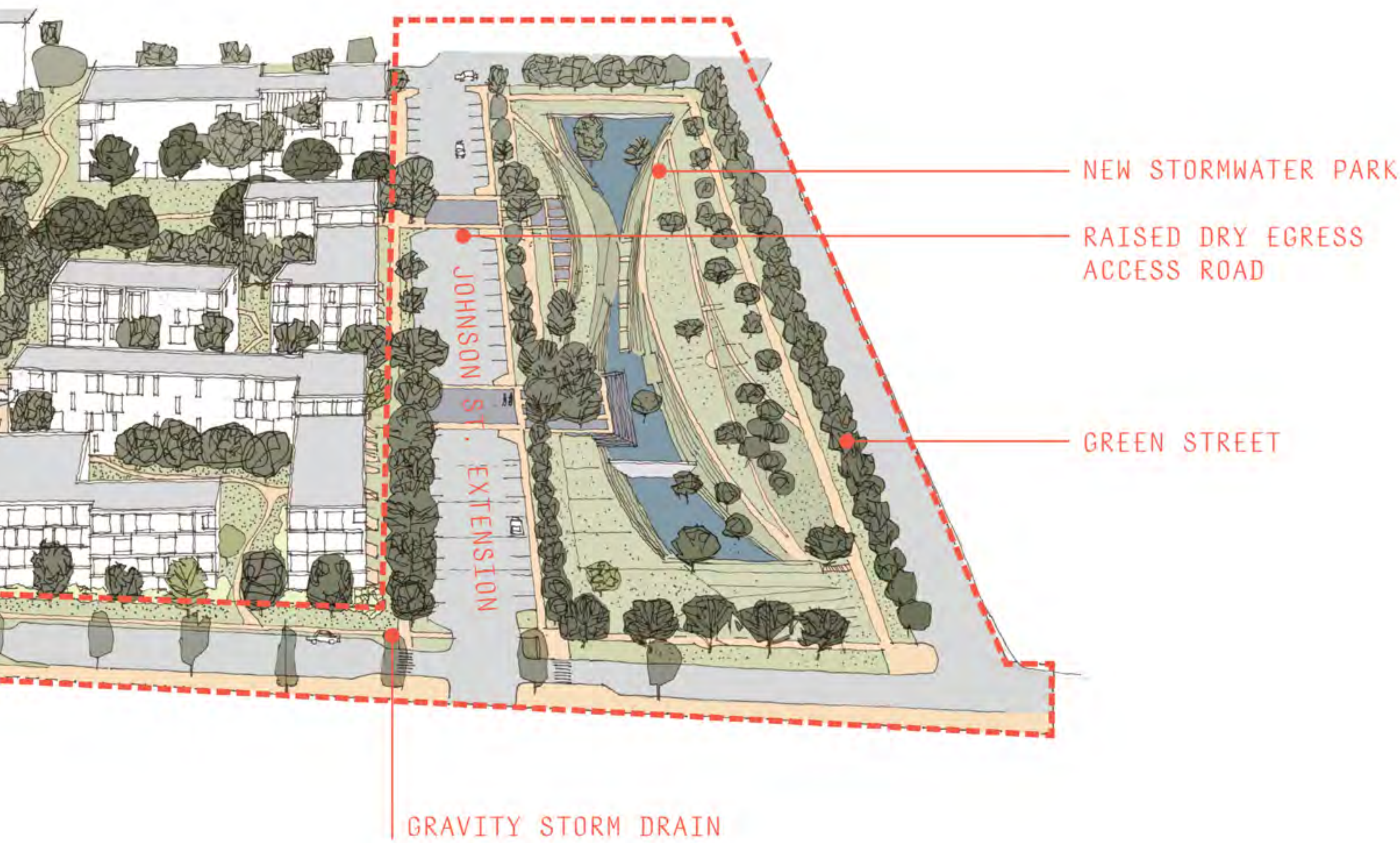
FORCE MAIN
OUTFALL CONNECTION



A More Resilient South End

The proposed pilot project attempts to layer as many resilient features as possible within a limited budget. As currently designed, a 2.5 acre stormwater park will feed into a new MS4 stormwater microgrid system, composed of gravity fed lines to a pump and force main at South Ave and Iranistan Ave, which pumps stormwater to an existing outfall in Cedar Creek. Alongside the park, a raised egress corridor with subsurface stormwater storage, Johnson Street Extension, will link the Marina Village redevelopment to adjacent high ground.

Action Plan and Community Call

July 5, 2015
The Seasides
Image Credit: Marcella Kovak

Workforce Development and Volunteer Opportunities
Teachers and teenagers from a green jobs training program install a rain garden and trees at an elementary school in New Orleans.

Active Community Participation
Top: Community members actively aid designers in exploring option for flood risk reduction measures in the South End of Bridgeport.

Action Plan: Next Steps

Emphasis on taking short term action that results in visible, quantifiable impact that builds buy-in and establishes Bridgeport as a place from which to learn, for the rest of the region and beyond.

Bridgeport is quickly becoming a model for coastal Connecticut by taking an active role in resilience planning efforts. Resilient Bridgeport has created several resources to help increase stakeholder buy-in, educate residents, and leverage additional funding. There are many short term actions and parcel scale adaptations that can result in a visible impact in the South End of Bridgeport and coastal Connecticut.

A larger effort in the South End is centered around the Resilient Bridgeport projects, the pilot project in the South End West of Park and the National Disaster Resilience funded project on the east side of the South End. Both projects will require community and stakeholder support moving into the environmental review process in 2018.

Implementation Approaches

Strategies that allow multiple stakeholders — citizens, businesses, institutions, neighborhood groups, agencies, NGOs — to take part at multiple scales and levels of investment, and address a range of other objectives

High-level **coordination of capital projects**, planning, and operations for agencies and other stakeholders who shape the city (WPCA, Parks, Housing, Engineering, Board of Education, Harbormaster, regional utilities), with both human and economic resources dedicated to the process of coordination, constant learning and sharing, data collection, and clear definition of shared goals and objectives.

- Lead: DOH, Mayor's Office, *new regional authority*
- Support:

High-level guidance in the form of resolutions, cooperative endeavor agreements, and new policy drafted with the support of state and national agencies, NGOs, and institutions, with the intent of creating model regulations that can then be adopted by other New England cities. Ask partnering stakeholders to assist with funding, technical support, and data collection.

- Lead:
- Support: DOH, DEEP, Army Corps, EPA, University of Bridgeport, other local institutions and NGOs such as the Nature Conservancy

Pilot projects and programs that **build awareness and focus on education**, including 7 Middle, broadsheets, and partnerships to build capacity and provide opportunities for engagement; the objective is to build buy-in and excitement.

- Lead: *New Citizen Leaders Group,* Board of Education
- Support: City Council, Mayor's Office, NRZs, institutions like museums and higher education

Specific Action Groupings

Coordinated investments in flood risk reduction, water quality improvements, and groundwater management, through governance, capital projects, and new approaches to operations and maintenance.

- Lead: WPCA, Public Works, Army Corps, *new stormwater entity*
- Support: DOH, HUD

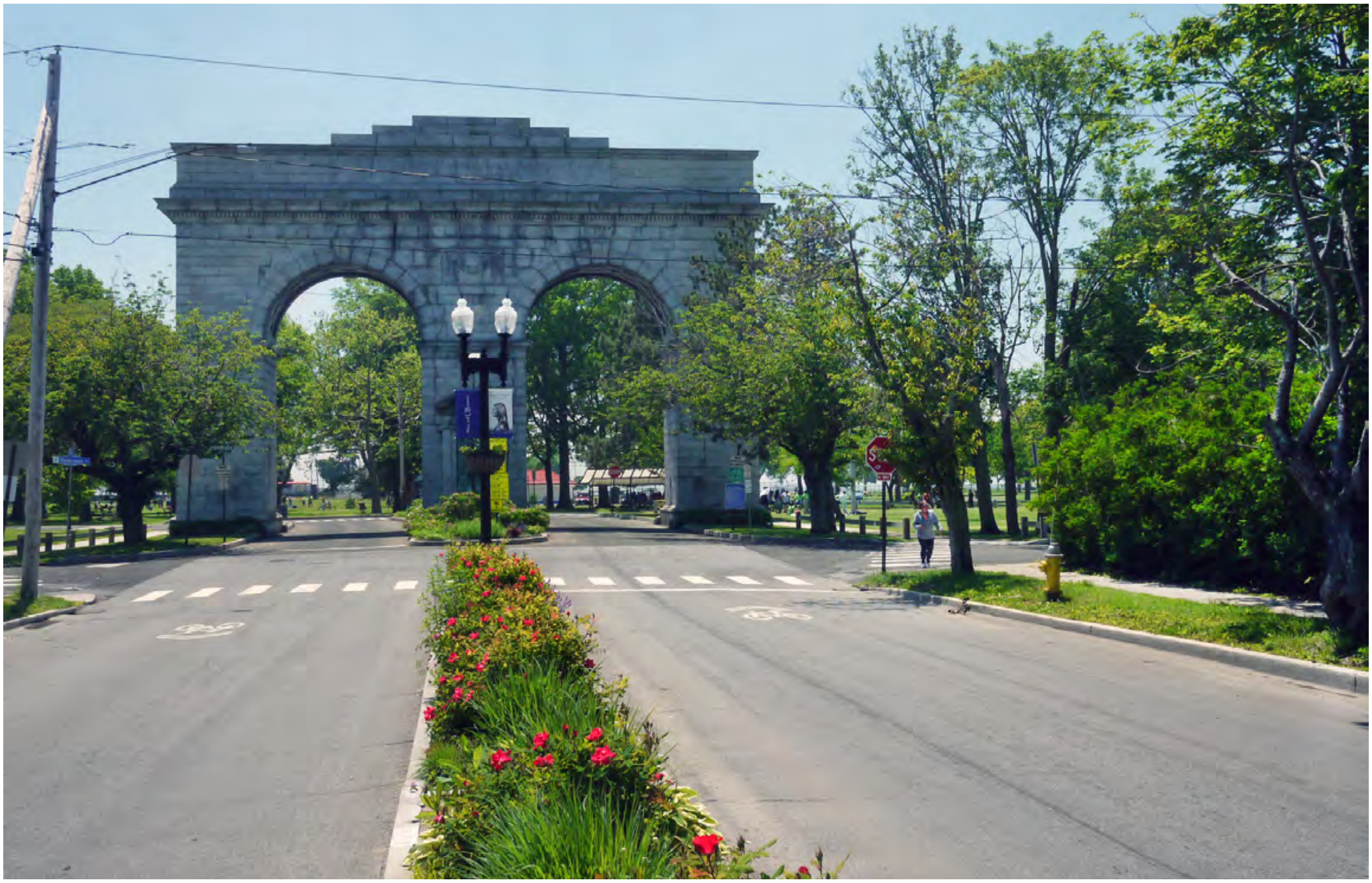
Ecological adaptation zones, with investments in parkland to strengthen coastal and stormwater buffers, clean and infiltrate stormwater and combined sewer overflows, enhance habitats and recreational amenities, and enhance identity of city.

- Lead: Parks and Recreation, WPCA, *new stormwater entity*
- Support: DEEP, Trust for Public Land, Groundwork

Economic investment zones, with investments in 21st century energy, transportation, housing, and green infrastructure systems to support sustainable development — each with distinct identity and marketing.

- Lead: OPED, regional business development group like BRBC
- Support: Utilities, transportation companies, regional and national developers and industries

National Disaster Resilience (NDR), an ongoing effort that will build upon the Rebuild By Design (RBD) work of the pilot project, to further advance the vision of a future Bridgeport while creating a range of opportunities for creative community engagement and input.



Resilient Bridgeport is a Test Case

The Resilient Bridgeport project follows many projects that began with grand initial ideas and moved into implementation and policy changes.

One such project, Dutch Dialogues, a partnership between Waggonner & Ball and the Royal Netherlands Embassy emerged in the aftermath of Hurricane Katrina in the New Orleans region. This idea brought together a team of experts from the Netherlands with local professionals to re-imagine the city and its water infrastructure. This effort gave birth to The Greater New Orleans Urban Water Plan, a resiliency planning study to develop sustainable strategies for managing the water resources of St. Bernard and the East Banks of Jefferson and Orleans Parishes. The project addresses three basic issues: flooding caused by heavy rainfall, subsidence caused by the pumping of stormwater, and wasted water assets. Many of these principals were later implemented in Article 23 of the City of New Orleans Comprehensive Zoning Ordinance, Landscape, Stormwater Management, & Screening and the NDRC Funded Gentilly Resilience District, to reduce flood risk, slow subsidence, and encourage neighborhood revitalization. The creation of the Greater New Orleans Urban Water Plan, with an emphasis on education, has supported efforts like Ripple Effect an effort to establish water literacy in New Orleans Schools.

Like Dutch Dialogues, Rebuild by Design has served as the tipping point for bringing awareness to resilience planning. Furthermore, like the Greater New Orleans Urban Water Plan, Resilient Bridgeport and the state-wide Resilience Roadmap has set the planning framework for implementation of resilience projects in Bridgeport and outlined larger strategies for the Northeast. An inspiration for other cities throughout the region as a model for coastal resilience, Bridgeport is contributing to the conversation surrounding planning for climate change as well as the marketing of related work. Resilient Bridgeport is not an isolated project tacking isolated issues, but one approach to the problems facing all coastal communities today. This connection to the region is critical for leveraging funds, expanding ideas, and utilizing knowledge gained in other communities.

Community Call: What's at Stake

Bridgeport can become a leader in New England demonstrating its capacity to adapt and to thrive in rapidly changing conditions. Resilient Bridgeport can serve as a catalyst for redevelopment in the city addressing the waning tax base and disconnected employment opportunities. Resilient Bridgeport is posed for revitalization as a destination for commerce and industry, but to attract new companies, Bridgeport must solidify its strong historic connection and relationship to Long Island Sound and the Pequonnock River. Resilient Bridgeport is the precursor to a Resilient Connecticut.

Engagement Through Design
Bridgeport families develop design ideas for the pilot project stormwater park during a public charrette, or design activity, in April 2017.

What's Happening Next

This document captures the planning phase of Resilient Bridgeport. This document is by no means the end of design in Bridgeport. The design of individual projects will continue to advance as funding becomes available. The timeline for implementation starts today. The work created by the design team and the community jump started the implementation of the South End West pilot project. The stormwater park design is 30% complete in the summer of 2017. The design of the west side of the South End has begun. The suite of Resilient Bridgeport projects will enter the Environmental review process in 2018, with construction slated to begin in late 2019 and wrap up by September 2022. Throughout the upcoming years there will be opportunity of community and stakeholder input as well as encouragement for related projects in the South End and other neighborhoods in Bridgeport.

Partnerships

LOCAL AND REGIONAL PARTNERS - BOTH PUBLIC AND PRIVATE - SUPPORTING THESE EFFORTS INCLUDE:

- CITY AGENCIES
- PARK CITY COMMUNITIES
- J.H.M.
- UNIVERSITY OF BRIDGEPORT
- HOUSATONIC COMMUNITY COLLEGE
- NATIONAL TRUST HOPE CREW
- CONNECTICUT S.H.P.O.
- GROUNDWORK
- AUDUBON NATURE CONSERVANCY

What You Can Do

The first step of action is education. There are several Resilient Bridgeport resources available to help educate designers about resilience planning in Bridgeport, spur stakeholders to action, and provide guidance for residents looking to participate. Residents of Bridgeport can commit business and institutions to the greater effort to achieve resilience by participating in workshops, and being good stewards of existing infrastructure systems. Residents can demand action through media, social media, through representatives, schools, neighborhood groups. Become a leader by joining a citizen leaders group or running for local office.

Play a role in defining what these principles, strategies, and actions mean for you and your community by contacting Resilient Bridgeport at info@resilientbridgeport.com

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January 15, 2015
The Seasides
Image Credit: Marcella Kovak

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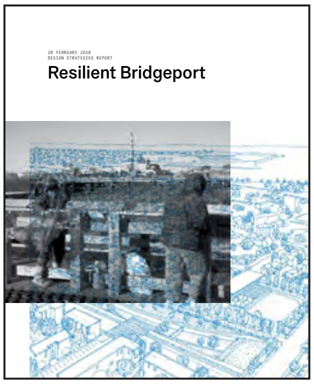
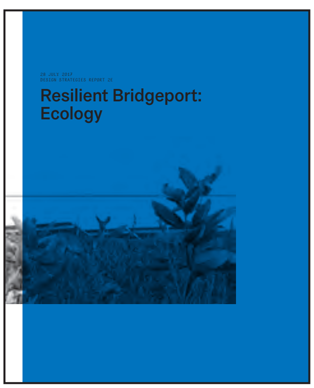
Reports and Appendices

The Resilient Bridgeport Strategy is a set of reports with cross-referenced information as outlined below. All project information is available at www.resilientbridgeport.com.

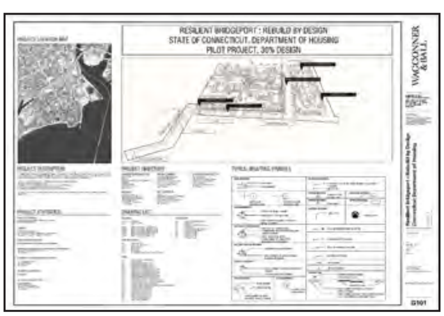


1.0 **Resilient Bridgeport** presents the overall resilience strategies. This document is a physical object, imbued with agency to support local stakeholders acting out their roles within a Resilient Bridgeport. This document is a collection of ideas at a particular moment in time, to be modified and updated as new concepts, participants, and funding become available.



2.0 **Design Strategies Reports** is a collection of individual reports that more technically address topics briefly described in the resilience strategies document, Resilient Bridgeport. Reports include:

- 2A **Design Elevation Criteria**
- 2B **Benefits**
- 2C **Focus Areas Conceptual Cost Outline**
- 2D **Policy Recommendations**
- 2E **Ecology**
- 2F **Community Engagement**



3.0 **Appendix - 30%** captures the design of the focus area pilot project at the current phase of design, 30%. These documents will lead the project into the Environmental Impact Statement process in the Fall of 2017.

- 3A **Design Documents, 30%**
- 3B **Stormwater Report 30%**
- 3C **Groundwater and Subsurface**
- 3D **Fifth Substantial Amendment to the Action Plan: Identification of Final Rebuild by Design Project**

Additional Resources

For additional information on the Resilient Bridgeport project, visit the website **www.resilientbridgeport.com**. A digital copy of this document and all the accompanying reports, as well as the Bridgeport Atlas: Design Conditions Report, and Broadsheets are available for free, along with updates on the project status, information on past community engagement events, and links to social media.

Other related projects:

REBUILD BY DESIGN:
WEBSITE: WWW.REBUILDBYDESIGN.ORG

RESILIENT BY DESIGN:
WEBSITE: WWW.RESILIENTBAYAREA.ORG

NATIONAL DISASTER RESILIENCE COMPETITION: U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
WEBSITE: WWW.HUDEXCHANGE.INFO/PROGRAMS/CDBG-DR/RESILIENT-RECOVERY

100 RESILIENT CITIES:
WEBSITE: WWW.100RESILIENTCITIES.ORG

THE CONNECTICUT INSTITUTE FOR RESILIENCE AND CLIMATE ADAPTATION:
WEBSITE: WWW.CIRCA.UCONN.EDU

THE SEASIDES: MARCELLA KOVAK
WEBSITE: WWW.THESEASIDES.COM

B GREEN 2020: CITY OF BRIDGEPORT
WEBSITE: WWW.BGREENBRIDGEPORT.ORG

BRIDGEPORT WATERFRONT PLAN: CIVICMOXIE
WEBSITE: WWW.BRIDGEPORTCT.GOV

CORRIDOR JOURNAL: ISSUE ONE OF AN ANNUAL JOURNAL THAT FOCUSES ON THE ARCHITECTURE AND BUILT LANDSCAPES OF BRIDGEPORT CONNECTICUT

GREATER NEW ORLEANS URBAN WATER PLAN:
WEBSITE: WWW.LIVINGWITHWATER.COM

Resilient Bridgeport proposes incremental change through catalytic projects, and for the integration of urban development with natural systems, so that Bridgeport can become a model city, for itself and for coastal Connecticut and places throughout New England.

RESILIENT
BRIDGEPORT