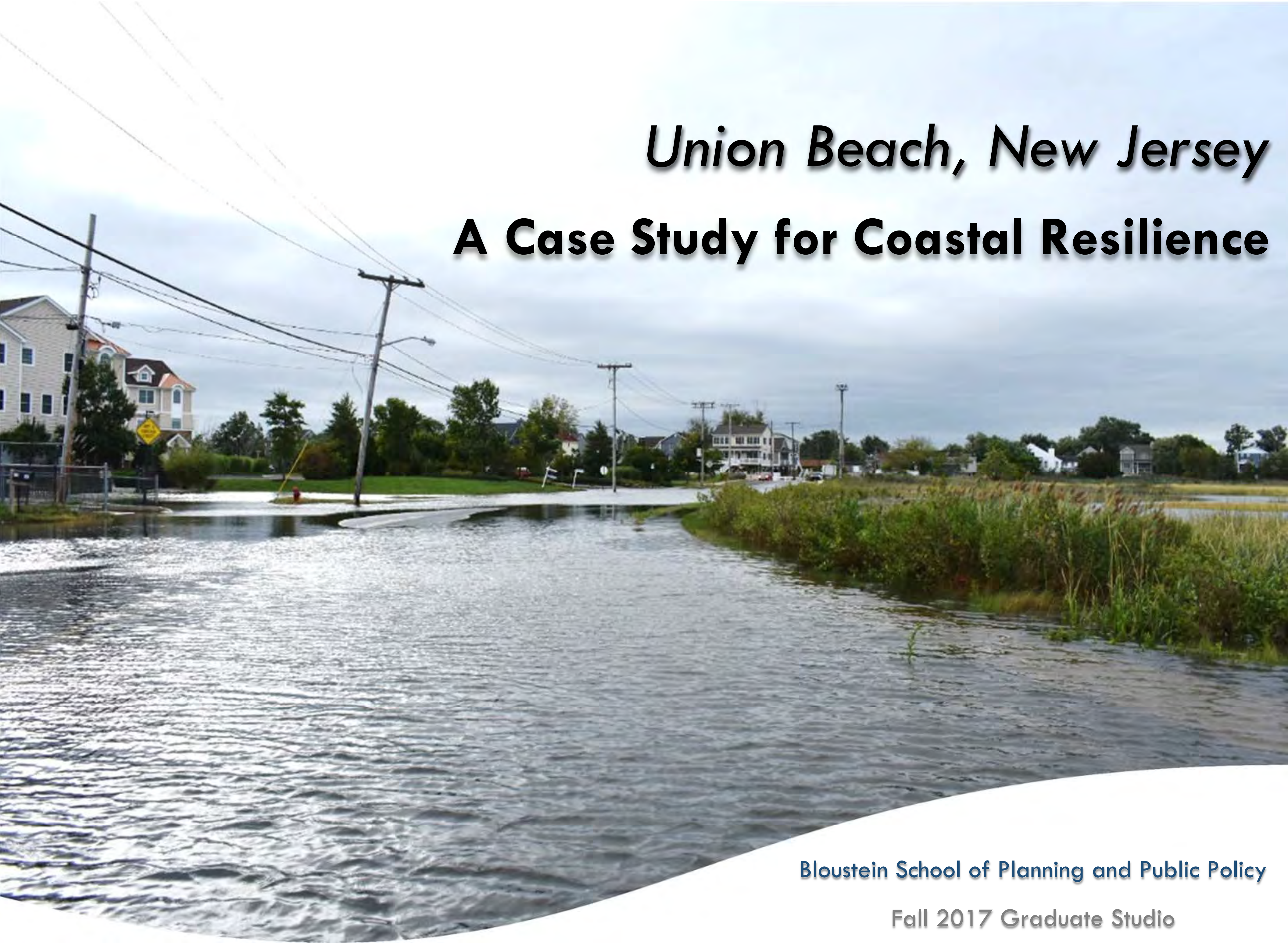

Union Beach, New Jersey

A Case Study for Coastal Resilience

Bloustein School of Planning and Public Policy

Fall 2017 Graduate Studio

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Table of Contents

Summary of Findings

This studio report serves as an overview of the Borough of Union Beach, New Jersey through the lens of transdisciplinary studies of coastal resilience. With this exercise, we were able to better understand the risks and vulnerabilities that a mainly residential coastal community faces. By studying the economic, social and demographic trends before and after extreme weather events, we were also able to analyze the proposed flood management projects and the redevelopment projects that the community expects to see completed in the near future.

Our methods of analysis included:

- A review of the U.S. Army Corps of Engineers plans and a meeting with engineers at the New York District office to further understand the proposed project and the process to build it.
- A review of the redevelopment plans and communication with the town planner.
- Participation in community events to better understand the culture of Union Beach.
- Conducting a focus group to learn about the residents' vision for the future of their town.
- A fiscal analysis of the impact of flooding events on the municipal and school budget, as well as the real estate market.
- A suitability analysis of Union Beach's topography, soils and groundwater recharge areas using ArcGIS to identify sites for different types of water management through green infrastructure.

A review of the Community Rating System and the ways in which Union Beach has already received points in order to recommend activities and actions the town could take to increase their rating.

Introduction

New Jersey has over 100 miles of coastline along the Atlantic Ocean, and according to the 2010 US Census Bureau estimates, roughly 1.8 million people live within coastal counties. With increasing impacts from extreme weather affecting coastal communities, understanding ways in which these residents, their local, state and federal representatives, and important stakeholders can work to become more resilient is imperative.

During the 15 weeks of the Fall 2017 semester, the Edward J. Bloustein School of Planning and Public Policy and the Coastal Climate Risk and Resilience Program brought eleven students from diverse academic backgrounds together to assess the Borough of Union Beach's resilience against future coastal storm flood damage.

This report and related presentation reflect a semester-long exercise in how to solve a complex problem using a transdisciplinary approach. Students came from numerous different departments at Rutgers within the School of Environmental and Biological Sciences, the School of Arts and Sciences, the School of Engineering, and the Bloustein School of Planning and Public Policy. Assistance and input was given from the Mayor of Union Beach, Union Beach residents and township administrators, various Rutgers University professors and staff, and the New York District of the U.S. Army Corps of Engineers in order to provide important outside perspectives throughout the semester.

At weekly class sessions students shared updates of research and analyses completed, and with guidance from Professor Andrews, worked together to determine next steps. Throughout the semester, students also engaged with residents of Union Beach by participating in several borough functions, as well as hosting a focus group in which borough residents were encouraged to voice their visions for the municipality's future.

On Monday, December 11th, 2017, the Mayor Paul Smith, residents of the town, town administrators and a representative from the Army Corps of Engineers joined students as they presented their findings at Union Beach Borough Hall.

In this report, readers will find a historical overview of the Borough of Union Beach, demographic trends, future risks the community faces, existing conditions and vulnerabilities, and effects from Superstorm Sandy. Additionally, they will find discussion and analysis on the fiscal impact of different flooding scenarios and existing flood management and redevelopment projects. Finally, recommendations for supplemental flood management actions, such as green infrastructure, are made with proposals for the most suitable locations within Union Beach to implement such actions.

This studio provided many lessons to students on how to thoughtfully analyze a coastal community's resilience and contributed to their understanding of transdisciplinary studies.

Historical Background

Union Beach is a small, beachfront borough in Monmouth County, New Jersey. The residential shore town sits on the southern border of the Raritan Bay across from Staten Island and has a magnificent view of the towering skyscrapers of Manhattan. Like many small towns in the northeastern United States, Union Beach (at the time part of Middletown Township) was primarily comprised of farmland in its early days during the fifteenth and sixteenth centuries. However, beginning in the 1840s and continuing into the 1920s, farms in Union Beach were sold and slowly replaced with shore homes occupied by city vacationers during the hot New Jersey summers (Burket, 1998).

In early 1925, New Jersey Governor George Slizer signed a bill that established Union Beach as an independent borough. Shortly thereafter, Union Beach held its first election for mayor and borough council. Unfortunately for the new borough, its establishment coincided well with the timing of the Great Depression in America beginning in 1929. Residents of Union Beach were not immune to financial struggles during this time, and it left many unable to pay taxes. This in turn left the borough unable to meet its financial obligations. By 1940, the New Jersey Municipal Finance Commission took financial control of Union Beach's finances and its school district (Burket, 1998).

First Election of Mayor & Council - May 12, 1925

Throughout the mid-1900s, Union Beach found itself repeatedly battered by coastal storms. It seems, throughout its history, the borough has come in dangerous contact with the ocean it enjoys so much during the summer months. Whether it be avoiding nuisance flooding during an exceptional high tide or rebuilding after an extreme event like a hurricane, the Borough of Union Beach has had to learn how to incorporate flooding resilience into their lives (Burket, 1998).

During the year 1955, the last piece of farmland in Union Beach was sold marking the end of the borough's transition from a farm town into a residential homeland. This time in the town's history is also marked by families establishing their homes in Union Beach as their permanent homes rather than summer or vacation homes. This is reflected in the population growth experienced by the borough in the mid to late-1900s (Burket, 1998).

By 1975, the New Jersey Municipal Finance Commission declared Union Beach fiscally solvent and released control of the town's finances and school back to the borough's leaders. The borough experienced continued growth during that last two decades of the twentieth centuries with the construction of new municipal buildings and beach restoration in 1996. Despite this growth and expansion of residential and municipal buildings, Union Beach has struggled to maintain a commercial district since its founding. Residents historically have gone to neighboring towns for shops, doctors' appointments, and restaurants (Burket 1998).

In the face of the many hardships the Borough of Union Beach has encountered, whether it be hurricane damages or financial struggles, the borough and its residents have been consistent in their resilience. Many residents who grow up in Union Beach choose to stay and grow old there. There is a spirit within the small borough that is optimistic of the future and what it holds in store for Union Beach (Burket 1998).

Damaged infrastructure in Union Beach following a storm in the 1900s

Demographics

Based on Figure 1, Union Beach is a relatively small town in terms of population when compared to its neighbors. According to the 2016 American Community Survey (ACS) 5-year estimate, Union Beach has declined in population to 5,770 from the 6,245 people accounted for in the 2010 Census – a 7% decline overall. To put this in context, neighboring waterfront boroughs Keyport and Keansburg experienced between a 1-2% decline in total population during this same time period.

Working age adults

While the 4.5% decline in the "working age" population (those between 18 and 65) between these two surveys is minimal and may be accounted for by the margin of error of the American Community Survey 5-year estimates, the 30% decline in school age children (those between 5 and 18) is significant and far outstrips the margins of error accounting for those populations. These effects were not shared across the region: Keyport's working age population increased marginally with no change to the school age population, whereas Keansburg's working population grew slightly (4.2%), though they also experienced a significant drop (~24%) in school age children.

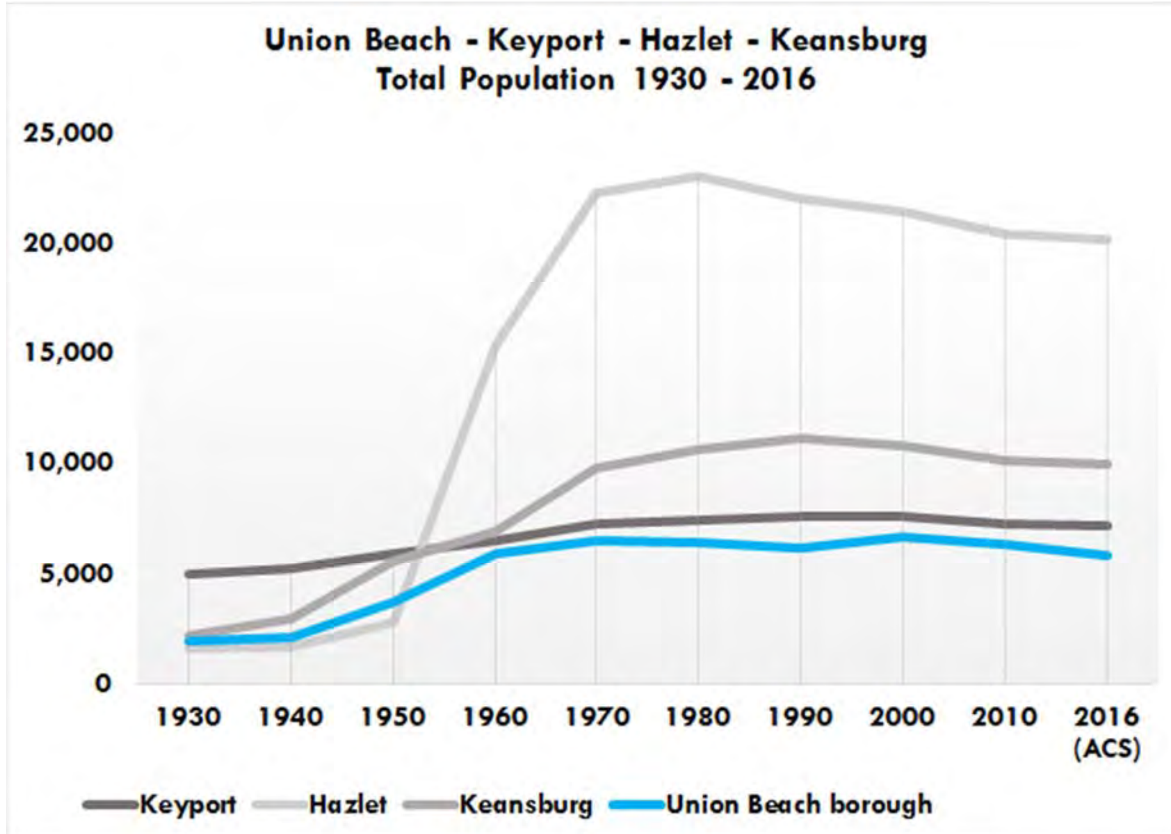


Figure 1: Total Population Change in Union Beach and its Neighbors

School Age Children

Today, approximately 790 residents (13.7% of the total population) of Union Beach are school age. Of those, 643 (11.1%) attend grammar school within Union Beach and 147 (2.5%) attend high school in a neighboring borough.

The number of high school aged children (between 14 and 18) in Union Beach has halved since the 2010 Census while the number of grammar school aged children has declined by more than 25%. That the biggest decline in grammar school student population has been in students aged 5-9 is an indicator that Sandy prevented families with young children from moving to or staying in Union Beach to enroll their young children. Though there has been an 11% boost to the population under the age of 5 during this time.

Seniors

The senior population (those 65 and over) across all boroughs remained relatively unchanged. This makes the waterfront boroughs an anomaly in the region as well as the state: neighboring Hazlet experienced more than a 15% increase in senior population, which is in line with the growth of seniors as a cohort both in Monmouth county (more than 13% increase) and New Jersey (more than a 10% increase).

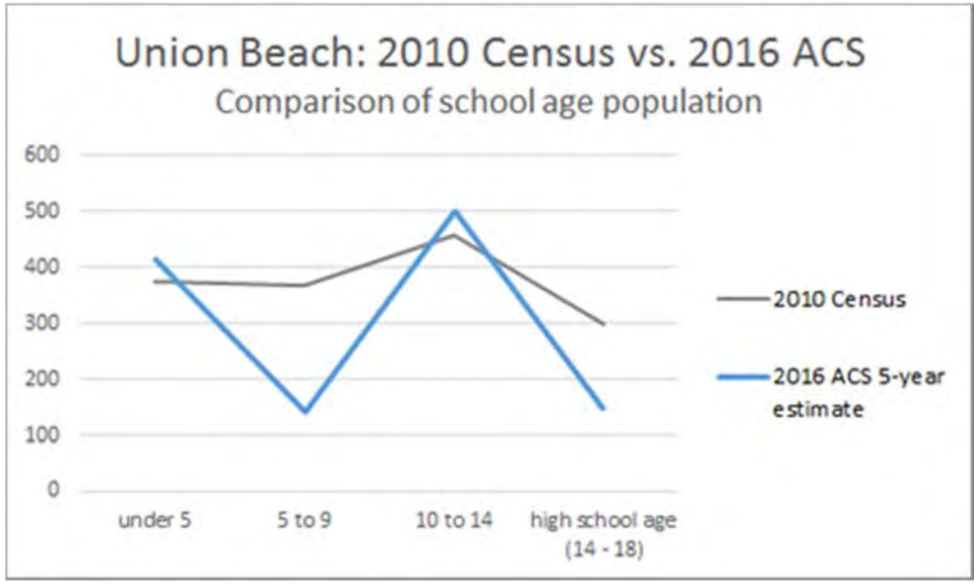


Figure 2: Comparison of latest estimates and 2010 Census data for school aged children

Race

In the neighboring communities of Keyport and Keansburg, the non-white population increased and the white population decreased both in absolute number and in share of the total population. Total population is down overall across all three waterfront boroughs. The drop in white population accounts for the entirety of that decline in Keyport and Keansburg, and the majority of that decline in Union Beach. Across all boroughs the white population is a solid majority, which is in line with the racial demographics across Monmouth County, though with a higher concentration of whites than across New Jersey overall.

Housing

The 2016 ACS also indicates a decline in total housing units, from 2,269 total units in 2010 to 2,194 per the 5-year estimate, a decline of just over 3%. Keyport is the only other neighboring borough that experienced a decline (5%). Keansburg and Hazlet, along with Monmouth County and New Jersey as a whole, show an increase in total housing units.

Risks Facing Union Beach

Sea Level Rise

The location and geography of Union Beach puts it at greater risk of climatic changes than other small towns in the United States. Being a coastal town that expands into the Raritan Bay far more than its neighbors makes Union Beach highly vulnerable to future sea level rise and coastal storms. Coastal New Jersey is already experiencing higher than average rates of sea level rise. This is due to the fact that New Jersey sits on a location that was once elevated by ice sheets during the Last Glacial Maximum. Since those ice sheets have melted away, New Jersey is sinking to its pre-glacial position. Further subsidence is occurring in northern New Jersey from groundwater withdrawal, which allows sediments beneath the Earth's surface to compact and reduces New Jersey's elevation (Miller et al., 2013).

Sea level rise projections for New Jersey were established in 2016 by a group of scientists and technical experts in response to a need from stakeholders and practitioners. The goal for the scientists and experts was to review the current science of sea level rise and future coastal storms in order to produce projections that could be used by stakeholders and practitioners to plan for the resilience of New Jersey's people and assets in the wake of these future risks (Kopp et al., 2016).

	Central Estimate	Likely Range	1-in-20 Chance	1-in-200 Chance	1-in-1000 Chance
Year	*50% probability SLR meets or exceeds…*	*67% probability SLR is between…*	*5% probability SLR meets or exceeds…*	*0.5% probability SLR meets or exceeds…*	*0.1% probability SLR meets or exceeds…*
2030	0.8 ft	0.6 – 1.0 ft	1.1 ft	1.3 ft	1.5 ft
2050	1.4 ft	1.0 – 1.8 ft	2.0 ft	2.4 ft	2.8 ft
2100 Low emissions	2.3 ft	1.7 – 3.1 ft	3.8 ft	5.9 ft	8.3 ft
2100 High emissions	3.4 ft	2.4 – 4.5 ft	5.3 ft	7.2 ft	10 ft

Figure 3: Projected SLR estimates for New Jersey, STAP report

The Science and Technical Advisory Panel (STAP) concluded that sea levels were expected to rise 0.8 feet by 2030, 1.4 feet by 2050, and between 2.3-3.4 feet by 2100 depending on the levels of anthropogenic greenhouse gases emissions over the next few decades (Figure 3). These projections are representative of the central estimates of sea level rise produced by the STAP. In other words, these levels of sea level rise are 50% likely to be met or exceeded by their given years. The STAP suggests that these central estimates of sea level rise be used when planning for the resilience of less vulnerable and less consequential assets, such as roadways and piers. Another way to view these central estimate projections is to understand that they may represent the level of nuisance flooding for the future. Therefore, the height of a new moon flood or sunny day flood in the year 2050 is expected to be 1.4 feet (Kopp et al., 2016). In order to plan for the resilience of more vulnerable and more consequential assets including hospitals and emergency meeting centers, the STAP suggest planning for a less likely scenario of sea level rise. For example, for a 1-in-200 chance sea level rise scenario, water levels would be 1.3 feet by 2030, 2.4 feet by 2050, and between 5.9-7.2 feet by 2100 (Figure 3). Although these levels only have a 0.5% chance of being reached in a given year, they are representative of what flood levels could be like during future coastal storms. Therefore, it is important that vulnerable and vital infrastructure is resilient to these flood levels because they need to be able to withstand these water levels during an emergency (Kopp et al., 2016).

Coastal Storms

Union Beach and the rest of the New Jersey shoreline are familiar with the damages and risks associated with coastal storms. Since 1950, nineteen tropical storms have passed within 100 miles of Union Beach with varying costs and damages. The list of storms in Figure 4 does not include the numerous winter storms or Nor'easters that can also cause extreme flooding and wind damage along the coast (NOAA, 2017).

Scientists have projected that the frequency of coastal storms in not likely to change significantly in the foreseeable future. However, they are expecting the intensity of storms to increase over time. Increasing ocean temperatures will allow tropical storms to gain more energy as they form in the equatorial Atlantic, and it is this additional energy that will increase the intensity of future hurricanes (Kopp et al., 2016).

However, regardless of changes to future storm intensity and frequency, sea level rise will increase the flood levels experienced by shore communities during a coastal storm (Kopp et al., 2016). For example, consider the flood levels Hurricane Sandy would produce if it were to strike the New Jersey coast in the year 2050 when sea levels are expected to rise by 2.3 feet.

Figure 4: Storm Timeline, not including Nor'easters

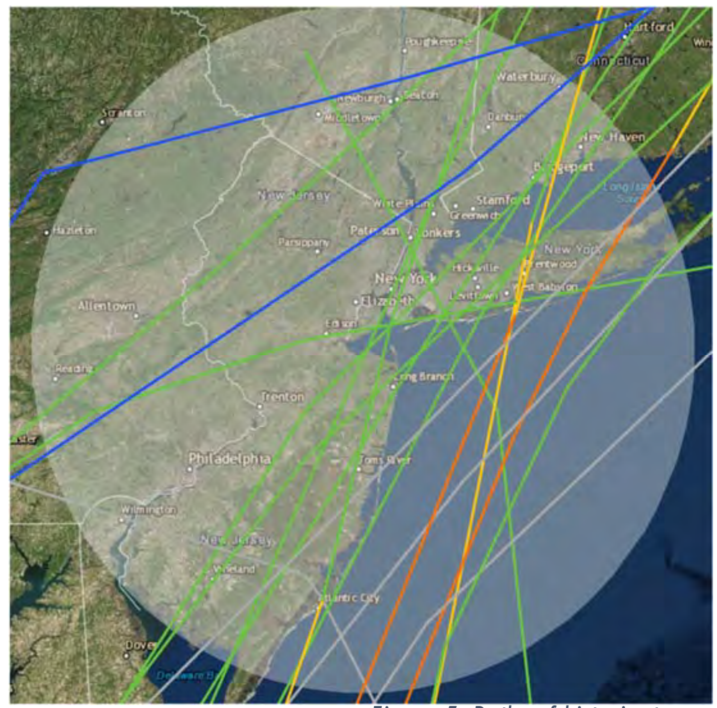


Figure 5: Paths of historic storms

Existing Conditions

To understand the resiliency of Union Beach we looked at various existing conditions within the Borough. With a total area of 1.9 square miles, Union Beach is a relatively small community when compared to its Raritan Bay neighbors (U.S. Census, 2010). Despite its small size, there is a great deal of physical and environmental features that make this community unique. However, there are attributes of Union Beach that make the Borough vulnerable to flooding. By identifying these vulnerabilities, we can determine actions the Borough can take to enhance its resiliency measures.

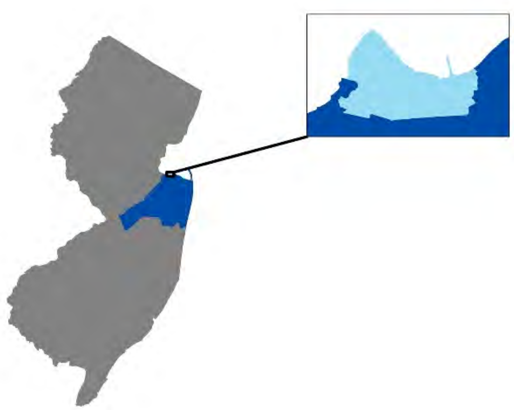


Figure 6: Geographic Location of Union Beach

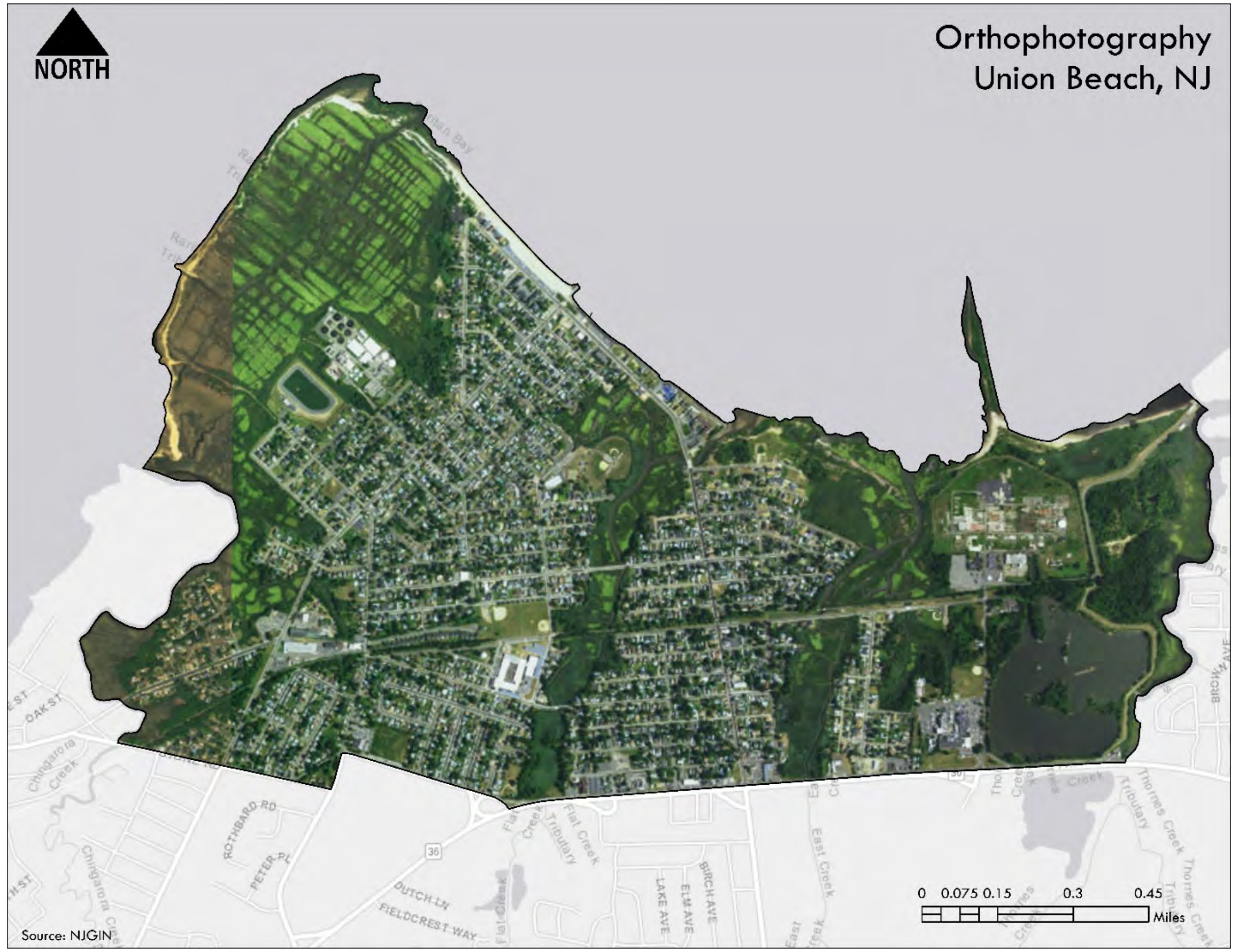


Figure 7: Orthophotography Map

Land Use

The Land Use map was generated using 2012 data provided by the NJ Department of Environmental Protection's (NJDEP) Office of GIS. As indicated by the Land Use map, the Borough is characterized primarily by medium-density residential uses (Figure 8). Using the Roadways map as a reference, commercial activity is seen along the southern border of the town and dispersed along Union Ave and Front Street. Front Street is the location of the waterfront promenade, a park, and other amenities enjoyed by residents.

There are several notable natural features dispersed throughout the town. The northeast marsh area, Natco Lake in the southwest, and the number of wetland areas and patches of forest and shrub land indicate a fair amount of environmentally sensitive lands. Another important feature is the International Flavors and Fragrance (IFF) corporate campus which is characterized by mixed urban, industrial, marsh, wetland, and forested land uses.

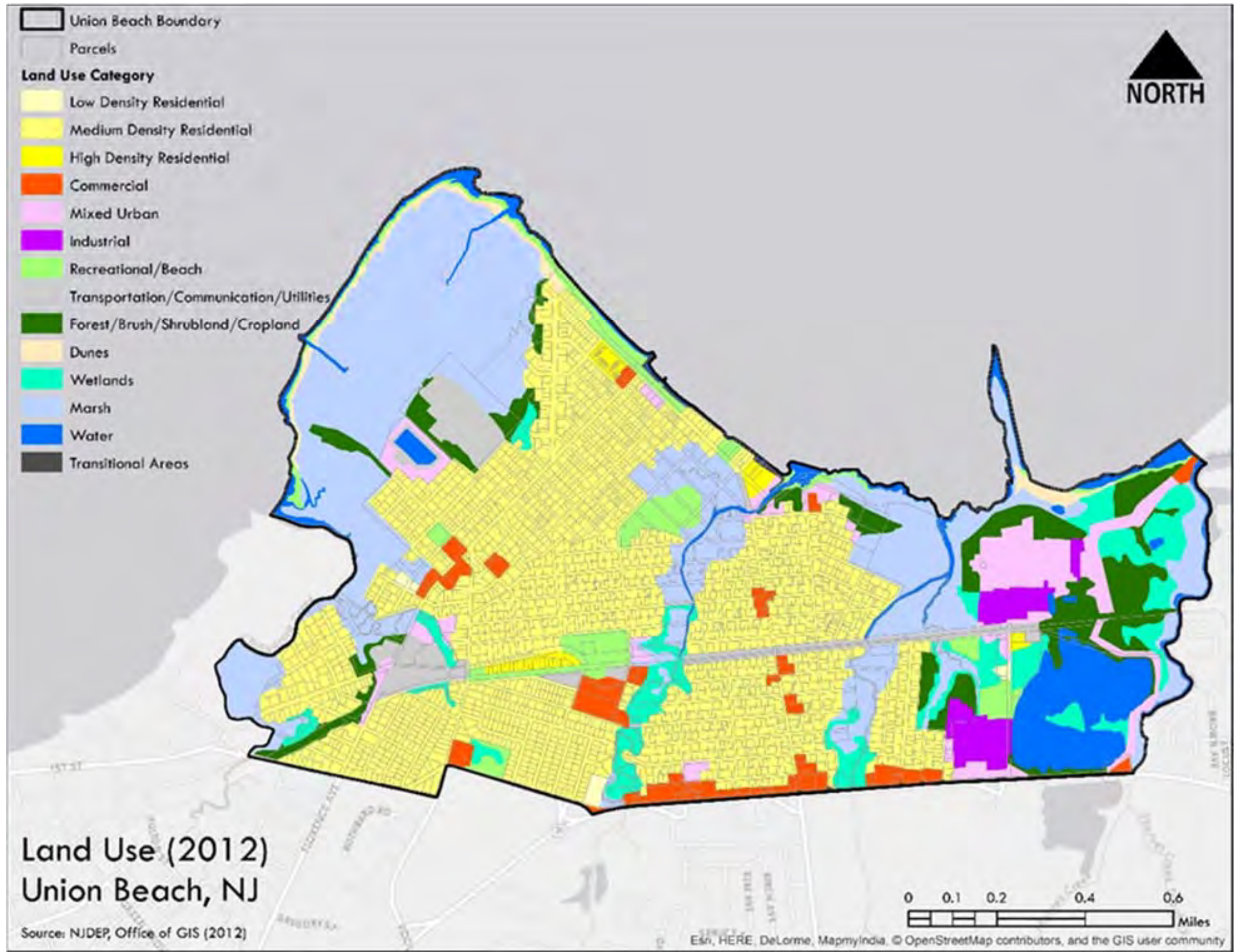


Figure 8: Land Use map

Land Use Change

The Land Use Change map shows the extent of land use shifts from 1986 to 2012 (Figure 9). The primary shift was an increase in commercial activity. Most of the commercial activity was previously along Route 36. Over the past few decades, mixed uses have been introduced throughout the Borough.

There have also been more areas designated as wetlands since 1986. Due to the presence of the IFF campus, the forested and beach areas in the northeast portion of the town were altered. These shifts reflect the population changes and subsequent development throughout the past century.

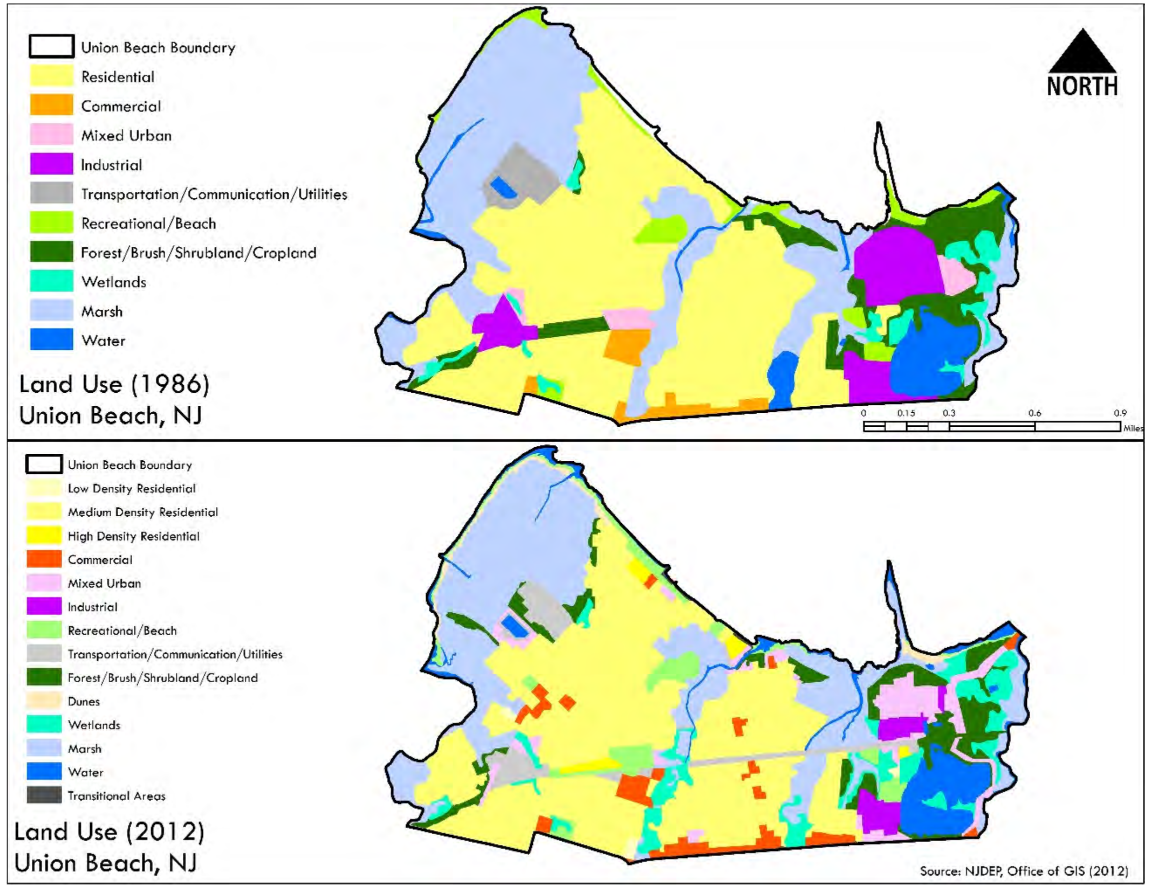
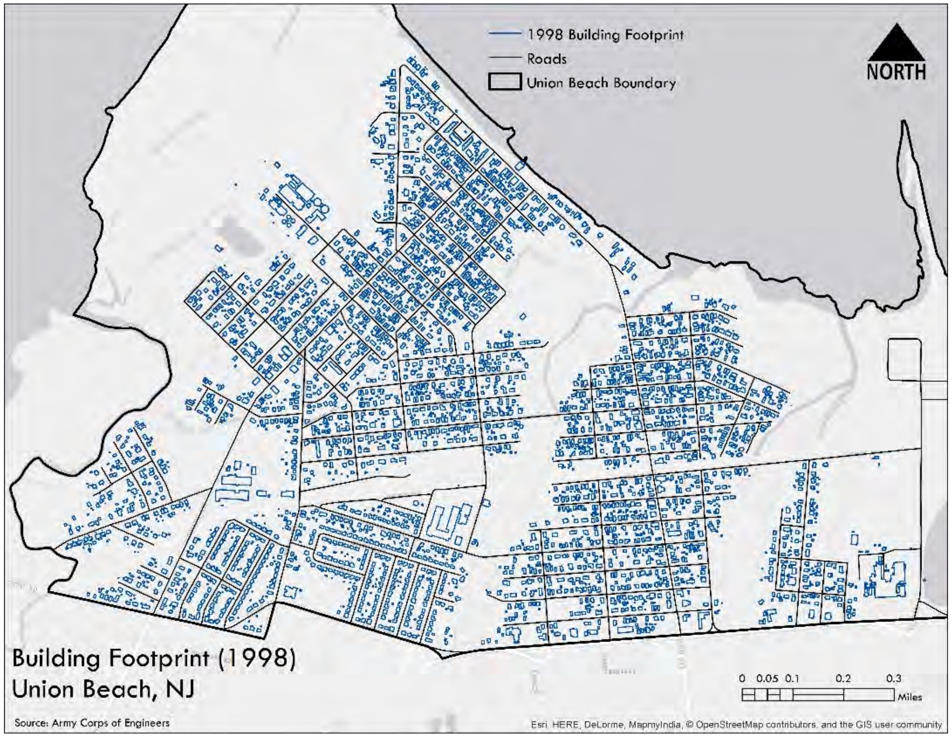


Figure 9: Land Use change between 1986-2012



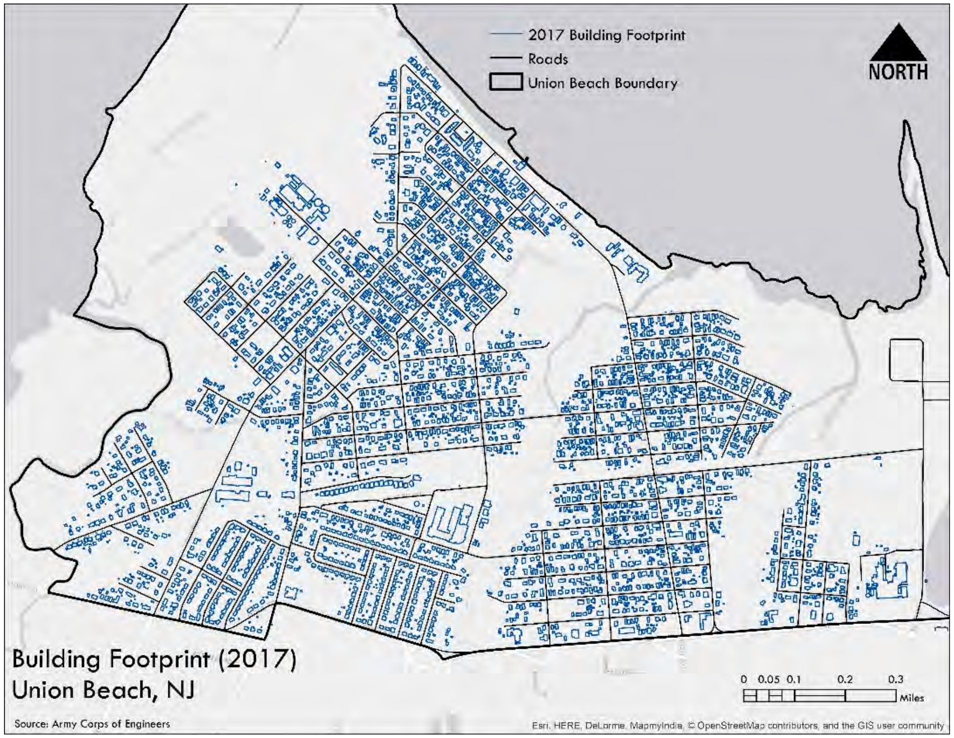


Figure 10: Building Footprints - 1998-2017

Built Environment

In addition to looking at the Land Use Change maps, observing the Building Footprint maps can also show the physical changes that have occurred in the Borough. These maps show changes to the built environment between 1998 and 2017 (Figure 10). The 1998 footprint was provided by the Army Corps of Engineers.

By using recent aerial imagery, we omitted buildings that no longer exist to create the 2017 footprint. Primary changes can be seen through increased development in the southern central portion of the town as well as changes to waterfront areas due to the effects of Superstorm Sandy. These recently vacated lots provide development opportunities for the Borough.

Zoning

The current zoning of the town can be seen in the Zoning map (Figure 11). Reflective of the Land Use map, Union Beach is primarily zoned for residential uses. Despite the prominence of residential zoning, the Land Use and Orthophotography maps tell a different story. These maps show that there is commercial activity and public spaces throughout the Borough.

Paying mind to areas zoned as Light Industrial, Townhouse, Neighborhood Business, and Office Residential, these are areas targeted for redevelopment. Existing zoning coincides with anticipated changes for the Borough. Lastly, the IFF campus is zoned as Corporate Campus, raising questions regarding what the land can be used for in the future. The question is especially pertinent due to the contaminated sites located there, as indicated by Figure 12.

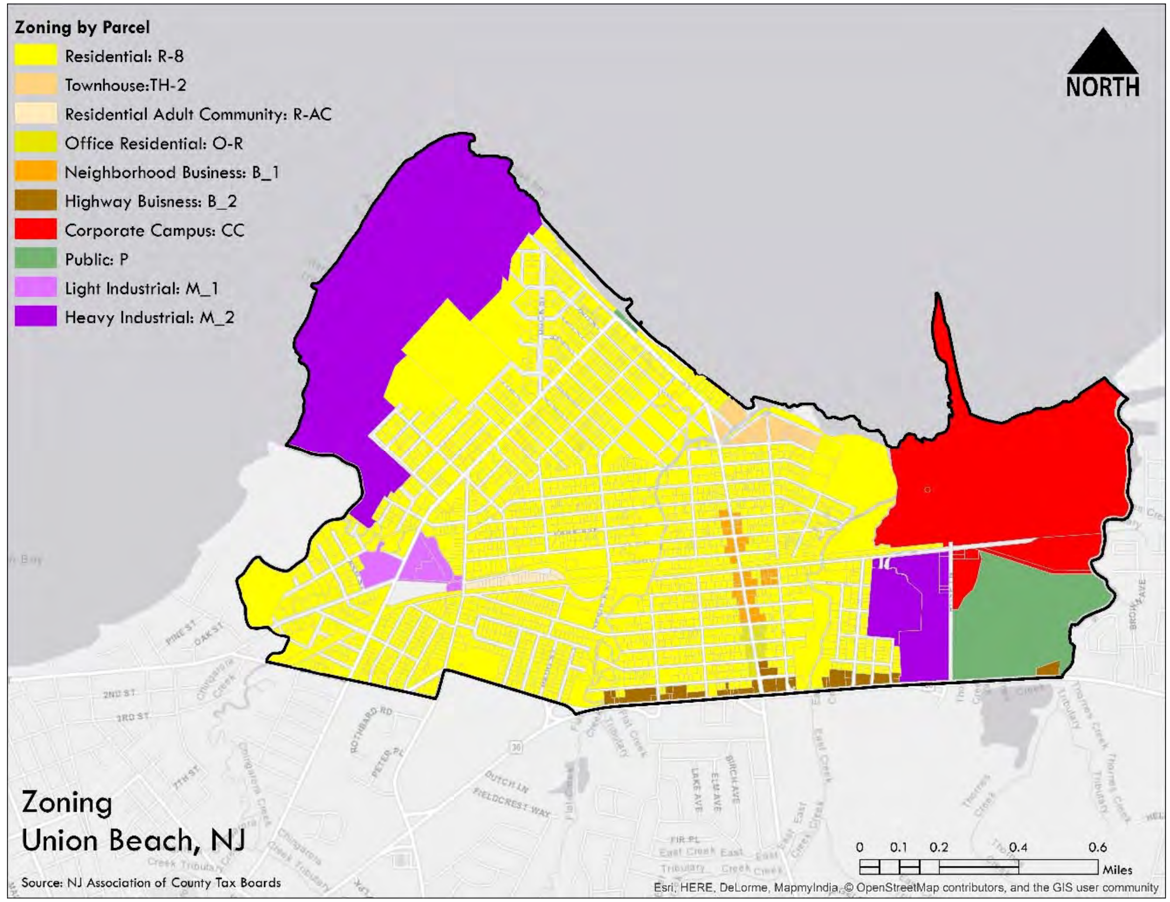


Figure 11: Zoning Map

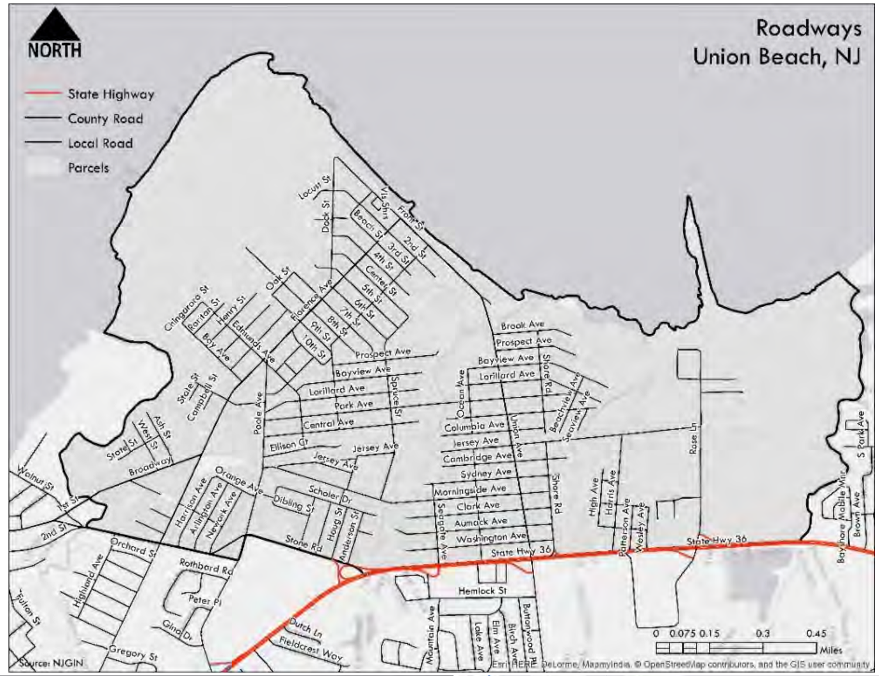
Figure 12: Contaminated Sites at IFF Campus

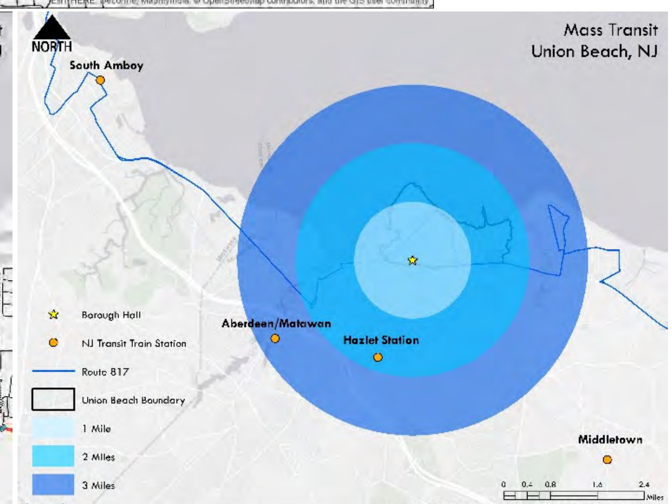
Transportation

Union Beach contains mostly local roads. Connector roads include Union Avenue, Front Street, and Florence Avenue. The major arterial road that connects the Borough to surrounding communities is State Highway 36.

In addition to roadways, there are other transit opportunities for residents of Union Beach. NJ Transit has many bus stops along Union and Florence Ave, providing connections to surrounding municipalities. The route seen in the first Mass Transit map is the 817 line, which has multiple stops along the coastline, including a transfer in Perth Amboy in order to reach Port Authority in New York City. This line also stops at the South Amboy station, providing additional opportunities to commute to North Jersey and NYC.

As per the second Mass Transit map, other stops near Union Beach include Hazlet, Aberdeen/Matawan, and Middletown.





Figures 13-15: Roadways, Bus Stops, Train Stations

Waterbodies

Observing the Water Bodies map, the number of water bodies that exist throughout Union Beach is apparent. Not only does Raritan Bay sit along the northern border of the town, but there are several tidally influenced creeks that segment the Borough. Chingarora Creek, Flat Creek, East Creek, and Thornes Creek all touch Union Beach at various locations. Raritan Bay, in addition to these creeks, presents Union Beach with significant vulnerability to flooding.

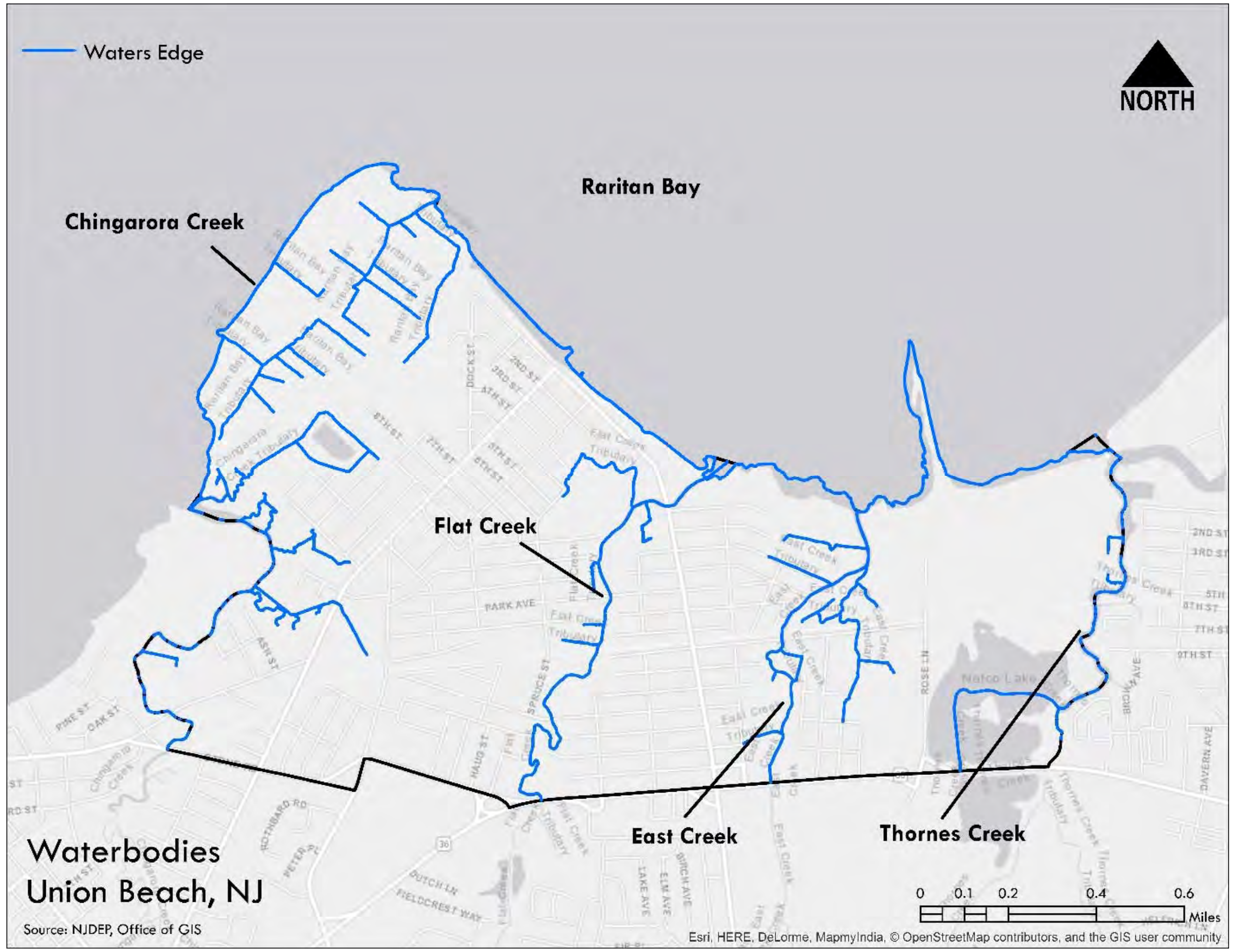


Figure 16: Waterbodies map

Elevation

The Elevation map shows that the prevalence of low-lying areas creates another vulnerability for this coastal community. The highest point of elevation is 22.8 feet above sea level and the lowest point sits 3.7 feet below sea level.

The darker areas are of higher elevation and the lighter areas are of lower elevation. It is no surprise that the lower-lying areas are along the creeks and Raritan Bay.

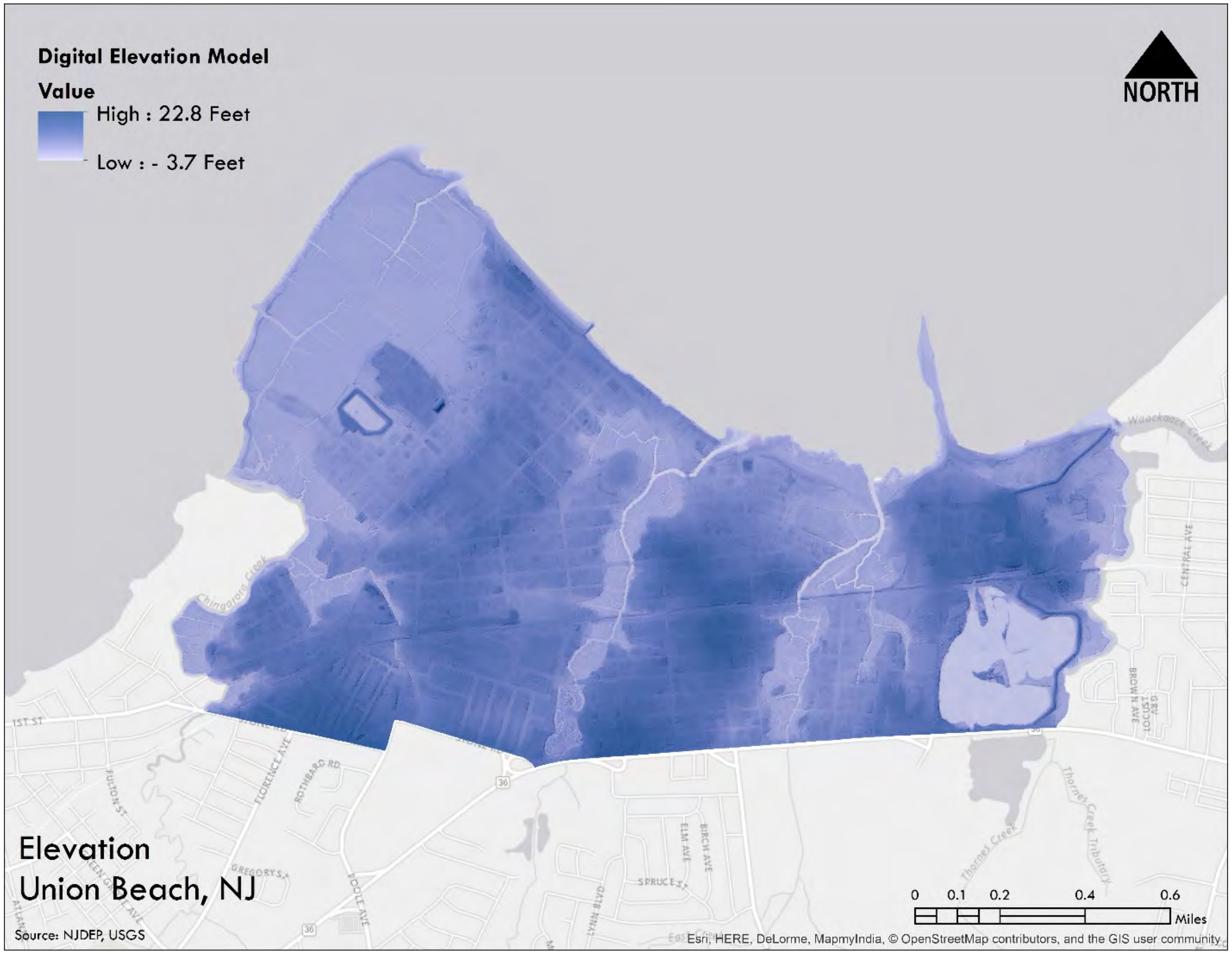


Figure 17: Elevation map

Flood Zones

The Flood Zone map complements the details shown in the Elevation Map. Before drawing comparisons, it is important to define the different flood zone designations. A 100-year flood represents a flood that has a 1% chance of occurring in any given year. This flood level is represented by the VE and AE flood zones in the map. The VE zone represents areas susceptible to high velocity water, which includes wave action. The AE zone is less susceptible to such wave action but still lies in the 100-year flood zone. A 500-year flood represents a flood that has a 0.2% chance of occurring in any given year. Lastly, the X zone includes areas outside of the 500-year flood zone.

These zones dictate if, and which kind, of flood insurance is required for a homeowner. Comparable to the Elevation map, the lighter areas in the Flood Zone Map, the 100-Year Flood Zone, lie in areas of lower elevation. The 500-year flood zone and the X zone are in areas of higher elevation. Flood zones are representative of the vulnerability of buildings and their occupants; thus, flood insurance rates are determined based on this susceptibility to flooding.

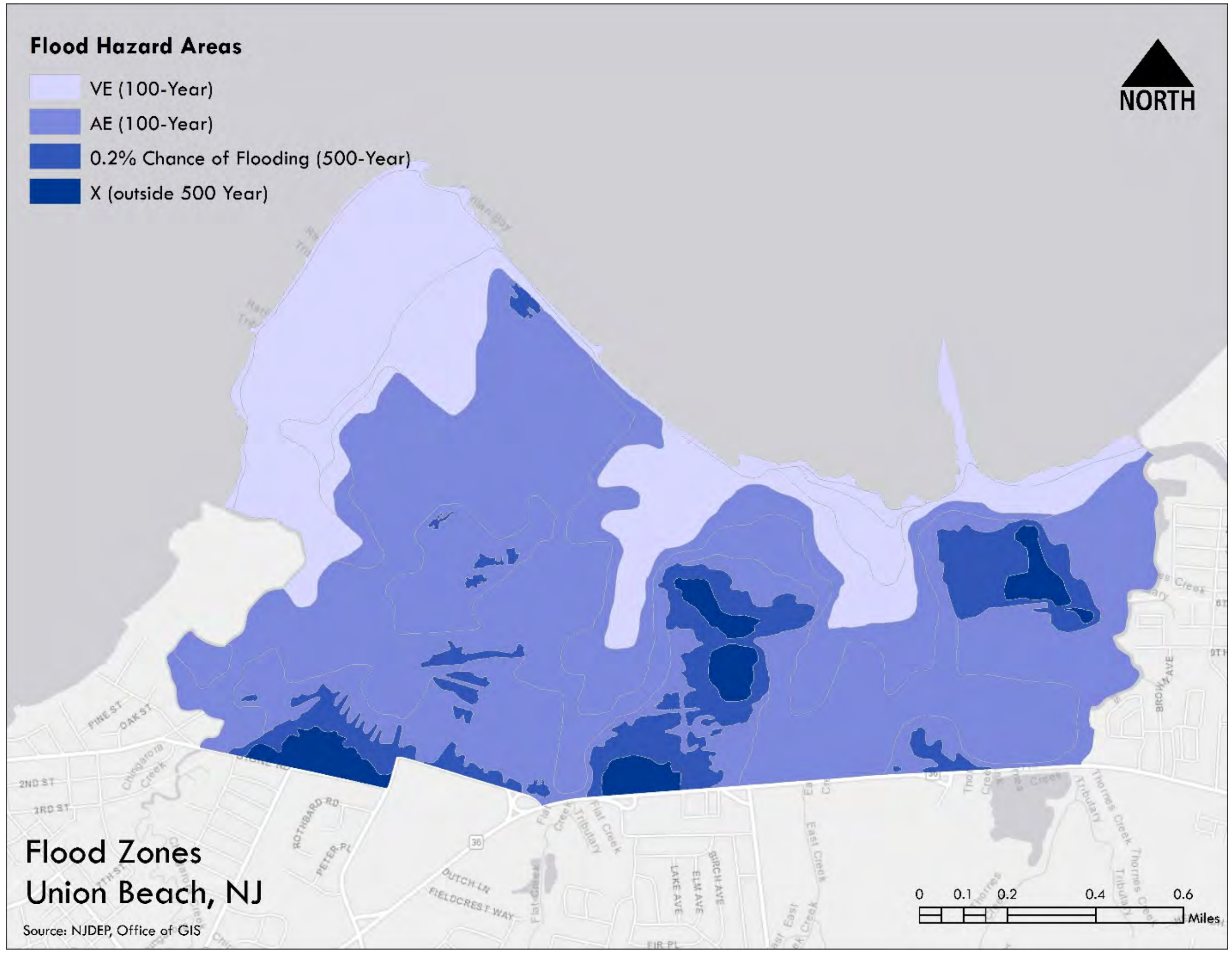


Figure 18: Flood Zone map

Township Projects

Army Corps

Project Overview

The borough of Union Beach has historically experienced a large amount of damage from hurricanes and Nor'easters. Both systems bring significant quantities of rain, wind damage, and a storm surge to the region. As a result, numerous studies and reports were conducted to assess the borough's need for protection.

A report put forth in February of 1960 by the Chief of Engineers highlighted the need for beach erosion control from the Highlands, NJ to South Amboy, NJ. Years later, in 1993, Union Beach was addressed in a Reconnaissance Report of the Raritan Bay and Sandy Hook Bay area. Although the report focused Port Monmouth, the federal government expressed interest in Union Beach (US Army Corps of Engineers - New York District, 2017).

In March of 1996, a preliminary-feasibility study was conducted in Union Beach to gauge interest levels in conducting a larger feasibility study. Upon its completion, support for a full feasibility study was given at both the state and federal levels, and in 2003, this study was conducted (US Army Corps of Engineers - New York District, 2017). It identified reasonable solutions for tidal flooding and shoreline erosion in Union Beach, which included a combination of levees, floodwalls, tide gates, pump stations, a dune and beach berm with terminal groins (US Army Corps of Engineers - New York District, 2017).

In 2007, an Authorized Plan was created that consisted of specific wall alignment and project components. This Authorized Plan was revised in the Hurricane Sandy Limited Reevaluation Report (HSLRR) in 2017, to account for changes made in design criteria since Hurricane Sandy.

Neighboring Projects

The project in Union Beach is part of a larger effort by the Corps of Engineers to strengthen the shoreline, particularly in Monmouth County. For example, in the Highlands Borough, which saw more than 1000 homes damaged during Hurricane Sandy, investigations were conducted to install bulkheads and floodwalls (US Army Corps of Engineers - New York District, 2017). Keansburg, a direct neighbor of Union Beach, currently has a completed project consisting of floodwalls, levees, pump stations and other elements like those proposed in the Union Beach project. Port Monmouth is also in the construction phase of a project that involves pump stations, road raisings, closure gates, levees, and floodwalls (US Army Corps of Engineers - New York District, 2017). Union Beach's other neighbor, Keyport, is one of the few towns not receiving a project due to a lack of federal interest in a coastal storm risk management project, despite the town's frequently flooded low-lying waterfront (US Army Corps of Engineers - New York District, 2017).

Project Components

The proposed storm protection project for Union Beach consists of several key components. These include levees, floodwalls, a dune, a beach berm, terminal groins, pump stations and closure gates. The town's western boundary will be bordered by a floodwall and several levee segments. This barrier intersects the Chingarora Creek and separates the town from the wetland on its western boundary. Along the shorefront, a 17 ft dune lines the beach with a berm at its back (US Army Corps of Engineers - New York District, 2017). A combination of levees and floodwalls protect the eastern side of Union Beach near Flat Creek and East Creek. A smaller, interior levee protects homes near High Avenue and Harris Avenue (US Army Corps of Engineers - New York District, 2017).

Three pump stations, capable of moving varying volumes of water, will be installed at three locations in the town. A 40-cubic foot per second (CFS) station is located on Bay Avenue near Florence Street, and a 250 CFS station is located near the intersection of

Union Avenue and Flat Creek. Finally, a 100 CFS pump station is proposed to be along Jersey Avenue near East Creek. Tide gates at Flat Creek and East Creek are also planned for installation (US Army Corps of Engineers – New York District, 2017). Table 1 contains dimensions of the major project components. Figures 19 and 20 show the components of the Army Corps Project.

Table 1: Army Corps Components	
Levees	
Top Elevation (NAVD88)	14ft
Crest Width	10ft
Interior Levee	
Top Elevation (NAVD88)	7ft
Crest Width	2ft
Floodwalls	
Top Elevation (NAVD88)	14ft
Shorefront Element	
Length of Beach and Dune	3160ft
Width of Dune Crest	50ft
Elevation of Dune (NGVD29)	17ft
Elevation of Beach Berm (NGVD29)	9ft
Total Dune Width	305ft

Figure 20: 2D Model of Army Corps Project

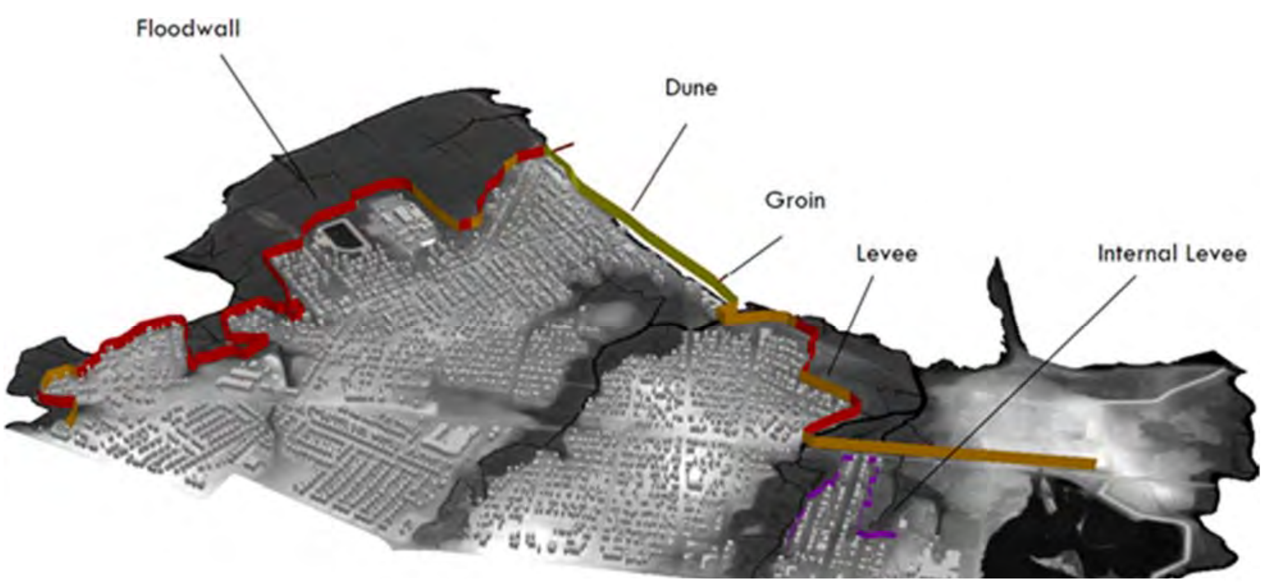


Figure 19: 3D Model of Army Corps Project

Cost

The cost to construct the Army Corps project has risen significantly since its inception for numerous reasons. Certain elements have been reallocated and realigned to comply with current design criteria. For example, the wall alignment in the 2007 Authorized Plan encroached on land designated for environmental preservation. Therefore, the 2013 plan rearranged the wall to an acceptable alignment. Additional design criteria modifications, as well as increases in material and labor costs, caused the initial project costs to rise significantly.

Table 2 displays how the cost-benefit ratio has decreased between 2003 and 2017. In 2003, the estimated total annual benefit was approximately $11 million and the annual cost was almost $7 million, which resulted in a cost-benefit ratio of 1.6. The 2017 HSLRR saw the benefits increase to a little over $14 million, but costs also increased to approximately $13 million. This resulted in the decrease of the cost-benefit ratio to 1.1.

Table 2: Cost-Benefit Ratio		
	2003 Feasibility	2017 HSLRR
Total Annual Project Benefits	$11,159,5000	$14,361,500
Total Annual Project Costs	$6,864,000	$13,011,600
Benefit to Cost Ratio	1.6	1.1
Net Excess Annual Benefits	$4,295,500	$1,349,900

Strengths

Storm Surge Resistance: The proposed Army Corps project will be able to withstand large storm surges. With the dune standing 17 feet tall and the levees and floodwalls extending 14 feet in the air, the barrier would resist most storm surges.

Change in flood zone designation: The project's construction allows certain flood zones in the town to change. For example, parts of the town that were previously in a VE zone will now be in an AE zone. This is important because it would allow construction to occur in previously restricted areas. The Brook Avenue Redevelopment plan is contingent on the Army Corps project's completion.

Long Term Protection: Various components of the project, if designed to expected standards and properly maintained, will be durable and able to serve Union Beach for many years to come.

Weaknesses

Line of Sight (Figure 23)**:** Currently, a person standing along Front Street in Union Beach has an unimpeded view of the New York City skyline. With the proposed dune constructed, this view will be blocked. To investigate this, we sketched a section view of Front Street including the dune, and placed a 5' 10" figure on the sidewalk. Then, we extended a line of sight from eye-level to the top of One World Trade center, located approximately 20 miles away. The red line of sight in Figure 21 intersects the 17-foot tall dune.

Less sustainable: Given the cost of the materials needed to construct the storm surge barrier, it is generally less sustainable than other alternatives. Floodwalls are often some of the most expensive hard barriers to construct (FEMA, 2007).

Nuisance Flooding: The current Army Corps project focuses on the preventing high intensity events, such as a large storm surge. However, this does not address the nuisance flooding the town experiences due to lunar tides, sunny day flooding, etc.

Cost-Benefit Ratio: Another weakness of the project is its low cost-benefit ratio, which has decreased from 1.6 to 1.1 in the HSLRR (US Army Corps of Engineers - New York District, 2017). The project has become increasingly difficult to justify and this is a result of the cost and quantity of materials being used to construct its various components.

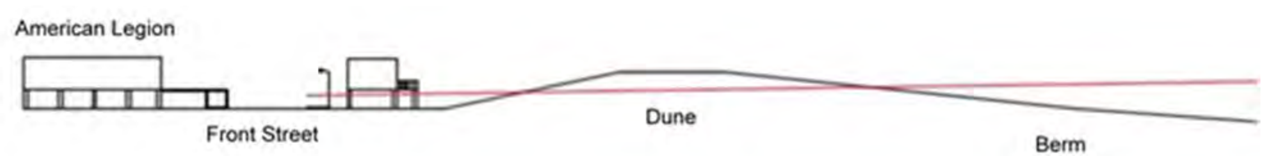


Figure 21: Line of Sight Analysis

Threats

High Maintenance: All structures require maintenance throughout their lifespan, and this primarily involves reinforcing locations that have deteriorated over time. To do this in an effective manner, labor and time needs to be properly allocated. A project the size of the Army Corps will require a significant effort to maintain, adding to its expenditure in the long run.

Disrupts natural shoreline processes: Shoreline structures can disrupt ecosystems and negatively impact shoreline erosion (Climate-ADAPT, 2015). These factors should also be taken into consideration before their construction.

Waterfront economic development: Given the height of the proposed storm surge barriers, economic development may be hindered along the waterfront.

Opportunities

Green Infrastructure: Aside from the dune located along the shorefront the project does not include green infrastructure. This presents an opportunity to include green infrastructure in the project plan in suitable locations. The inclusion of green infrastructure could reduce the impacts surges and tides would have on the project's various components by reducing runoff and dissipating wave energy.

Brook Avenue Redevelopment: As previously mentioned, the Brook Avenue Redevelopment Project would only be able to occur once the Army Corps project is built. This presents an opportunity for residents to move back into a region that was previously devastated by Hurricane Sandy.

Real Estate Investment: With the Army Corps project in place, there will be a greater likelihood of real estate investment. Investors would have reassurance that their structures would be well protected and would feel more comfortable investing in real estate.

Lower Insurance Premiums: Finally, the installation of the numerous storm surge barriers around the town and ultimate adjustment of flood zones would change insurance premiums for residents (FEMA, 2017). Flood insurance typically increases in zones with a higher flood hazard.

Commercial Corridor

Anecdotally, commercial development in Union Beach stalled when Route 36 was completed, allowing traffic headed down the shore to bypass the town. Union Beach aimed to capitalize on the opportunity to rebuild in a resilient and sustainable manner following Sandy. The Strategic Recovery Planning Report adopted following Sandy identified the need to, "…renew efforts to make the Route 36 Corridor redevelopment area a priority" (T&M Associates, 2014).

Resiliency plan (2015)

To that end, the Commercial Corridor Resiliency Plan was drafted with the understanding that "Resilient businesses make strong communities" (T&M Associates, 2015). The plan sought to combine flood protection and commercial revitalization affording environmental as well as economic resiliency into the future. This corridor was targeted specifically because it was largely located outside of FEMA preliminary flood maps and already had access to significant transportation infrastructure. Additionally, Union Avenue was included in this plan as the other major commercial corridor in the Borough. Together, Union Ave. and Route 36 served as the "commercial corridors" targeted for resiliency and redevelopment.

Figure 22: Commercial Corridor Project Location

"The vision for the corridors center on an aesthetic and functional enhancement of the highway uses along Route 36 and the establishment of a multi-modal downtown center surrounding the intersection of Union Avenue with the Henry Hudson Trail" (T&M Associates, 2015). The vision articulated for this plan include recommendations echoed by this report, notably the incorporation of green infrastructure on (then) vacant lots throughout the corridors to mitigate flood conditions from rain events. These improvements, in some cases taking the form of "pocket" parks, achieve the stated goals of both aesthetic and functional enhancement of the commercial corridors. Additionally, the resiliency plan recommended a relaxing of zoning rules regulating building height & lot coverage to encourage commercial growth and the accommodation of flood design standards.

Redevelopment plan (2015)

Following the Commercial Corridor Resiliency Plan, a Commercial Corridor Redevelopment Plan was released in 2016. The redevelopment plan's recommendations were significantly more design-focused, with specifications for street elements such as lighting, vegetation, street furniture, and signage.

The resiliency plan also identified four areas within the commercial corridors, each with suggested uses and design standards guided by site-specific goals and objectives.

Department of Public Works

The Department of Public Works (DPW) Redevelopment Area is comprised of Block 103, Lots 3 and 3.01 on the Borough of Union Beach Tax Map, totaling approximately 5.28 acres. The area is currently zoned M-1 Light Industrial. The DPW Redevelopment Area is located within the Federal Emergency Management Agency (FEMA) Flood Area designated as AE 13 Zone (1% chance of annual flooding).

Union Beach plans to use the DPW Redevelopment Area as an area to promote the development of senior citizen housing. To move the project forward, Union Beach must work to transition the M-1 Light Industrial land use at the subject site away from its current use as the Department of Public Works offices and municipal garages into a Residential Land Use. Union Beach hope the change of land use and construction of the senior center will help facilitate resilience to future storm events, incorporate existing environmentally sensitive features into site design for recreation, conservation, and stormwater management, meet housing needs of residents, and uphold and promote the goals and objectives of the Union Beach Master Plan.

Figure 23: DPW Project Location

Brook Avenue

The Brook Avenue redevelopment project is a housing development which was drafted after Superstorm Sandy and subsequently adopted in August of 2015. The plan includes the restoration of the Brook Avenue neighborhood, which was devastated by the storm. The redevelopment plan proposes the development of a residential community phased around the construction of a flood protection berm that has been proposed by the U.S. Army Corps of Engineers. The Brook Avenue site is located within a FEMA flood zone and is split between the VE zone to the north and the AE zone to the south. The construction of the berm to the north would allow the conversion of the VE zone to an AE zone, thereby permitting a greater development yield by allowing the construction of multifamily housing structures.

The proposal includes the construction of two building types: single family attached housing and multifamily attached housing. The other requirement of this proposal is that the number of housing units is limited to a total of 120 units. Based on these requirements a Fiscal Impact analysis was conducted.

Figure 24: Brook Ave Project Location

Fiscal Impact analysis of Brook Avenue

Whenever land is developed, regardless of the type of development, there are a host of expenditures incurred by the town to extend infrastructure and services to the new development. In addition to expenditures, the new development expands the property tax base thus bringing in additional revenue to the municipality. It is crucial for the municipalities to determine if the revenues brought in by the new development balances out the costs that are incurred by the provision of infrastructure and services to the new development.

Fiscal impact analyses provide a means by which the financial impact of a particular development is estimated. The fiscal impact analysis only deals with public or governmental costs and revenues.

Methodology

The Fiscal Impact Analysis of Brook Avenue was conducted based on a per capita multiplier method. Under this technique, service costs per unit of population (person, pupils and employees) are derived and then applied to population generated by the development.

First, the number of parcels of the residential properties in Union Beach were divided by the total number of parcels. For 2016, Union Beach contained 2046 residential parcels out of a total of 2312 parcels, equivalent to 88.49 percent share. Similarly, the residential parcel value was calculated, which equaled 85.61 percent share. These two values were averaged to calculate the percentage of the municipal budget to be allocated for the provision of services to the residential uses of Union Beach. Averaging the residential parcel share of 88.49% and residential property value of 85.61% yields a value of 87.05%.

The residential share of the property tax levy was calculated by multiplying the Municipal tax levy by 87.05%. This value of $5,497,599, which was obtained by multiplying the above, is the amount of money it takes the Borough to service its residential land uses. The per capita cost of 1032 was calculated by dividing $5,497,599 by the local population. Similarly, school costs per pupil were calculated by dividing the property taxes raised for school levy ($6,184,946) by the total number of students (644). This yields a per student cost of $9,603.

For the purposes of this analysis the per capita worker cost was not calculated as the Brook Avenue Redevelopment plan does not include any commercial or employment generating projects.

Once the per capita costs were calculated, demographic multipliers from 'Who lives in New Jersey Housing' were used to predict the total population and pupils that would result from the development. The demographic multipliers indicate the average number of people (household size multipliers) and pupils in the different types of housing units. Demographic multipliers vary according to the size and the type of housing units.

For Brook Avenue, there are two primary building types, single family attached and multifamily attached, further split into single family attached 2-bedroom unit, single family attached 3-bedroom unit, multi-family attached 1-bedroom unit and multifamily attached 2-bedroom unit. The total municipal costs and school district costs for each of the building types were calculated by multiplying the per capita resident cost with the respective multiplier, by multiplying the per capita school cost with the respective multiplier for the given building type, and then finally adding the two. Tables 3-6 show the total costs incurred by each of the four building types.

Tables 3-6

SFA (2-bedroom) Residential property			
	Multipliers	Property Tax supported cost per person	Total Costs
Municipal			
Person-related cost	2.44	1032.5	2519.3
Worker-related cost	0	0	0
Total Municipal			2519.3
School (District School)			
PSC-related cost	0.096	9603.95	921.9792
Total (municipal and school)			3441.2792

SFA (3-bedroom) Residential property			
	Multipliers	Property Tax supported cost per person	Total Costs
Municipal			
Person-related cost	1.914	1032.5	1976.205
Worker-related cost	0	0	0
Total Municipal			1976.205
School (District School)			
PSC-related cost	0.283	9603.95	2717.9179
Total (municipal and school)			4694.1229

MFA (1-bedroom) Residential property			
	Multipliers	Property Tax supported cost per person	Total Costs
Municipal			
Person-related cost	1.68	1032.50	1736.67
Worker-related cost	0.00	0.00	0.00
Total Municipal			1736.67
School (District School)			
PSC-related cost	0.07	9603.95	662.67
Total (municipal and school)			2399.34

MFA (2- Bedroom) Residential property			
	Multipliers	Property Tax supported cost per person	Total Costs
Municipal			
Person-related cost	1.844	1032.5	1903.93
Worker-related cost	0	0	0
Total Municipal			1903.93
School (District School)			
PSC-related cost	0.105	9603.95	1008.4148
Total (municipal and school)			2912.3448

Revenues, in terms of the annual property taxes, were calculated for an average residential property based on the value of the average residential property and the municipal tax rate. Similarly, school revenues were calculated by multiplying the school tax rate with the property tax levied for the school budget. The total local revenues from the property taxes for an average residential property was calculated by adding the municipal revenue with the school revenue.

In order to calculate the net fiscal impact (the difference between the property tax supported costs and the property tax revenues) for each of the building types, the costs were subtracted from the revenues. Tables 7 to 10 presents the net fiscal impact on each of the four building types.

Tables 7-10

SFA (2-bedroom) Residential property Local Net Fiscal Impact (Property Tax)			
	Costs	Revenue	Net Fiscal (Revenues minus Costs)
Municipal	2519.30	2494.95	-24.35
School	921.98	2443.02	1521.04
Total Local	3441.28	4937.97	1496.69

SFA (3-bedroom) Residential property: Local Net Fiscal Impact (Property Tax)			
	Costs	Revenue	Net Fiscal (Revenues minus Costs)
Municipal	1976.21	2494.95	518.75
School	2717.92	2443.02	-274.90
Total Local	4694.12	4937.97	243.85

MFA (1-bedroom) Residential property Local Net Fiscal Impact (Property Tax)			
	Costs	Revenue	Net Fiscal (Revenues minus Costs)
Municipal	1736.67	2494.95	758.29
School	662.67	2443.02	1780.34
Total Local	2399.34	4937.97	2538.63

MFA (2- Bedroom) Residential property Local Net Fiscal Impact (Property Tax)			
	Costs	Revenue	Net Fiscal (Revenues minus Costs)
Municipal	1903.93	2494.95	591.02
School	1008.41	2443.02	1434.60
Total Local	2912.34	4937.97	2025.62

Once the total net fiscal for each of the building types was calculated these values were multiplied with the number of housing units for each building type to arrive at the total net fiscal impact by the entire development.

Additionally, for each of the building types, the minimum assessed value of when the particular building type would break even fiscally from the municipal and school perspectives was calculated. The total assessed value of all the building types were added to determine the total change in the assessed value that the development would generate.

Results

The Brook Avenue Redevelopment Project would increase the total assessed value by 3% for the year 2016. Similarly, the property tax base would expand by $195, 718 or by 3% of the property tax base for 2016 (Table 11).

Table 11

Local Net Fiscal Impact			
Property Tax			
Building Type	**Net Fiscal (Revenues minus Costs)**	**No.of Units**	**Total Net Fiscal Impact**
SFA (2-bedroom) Residential property	1497	19	28437
SFA (3-bedroom) Residential property	244	29	7072
MFA (1-bedroom) Residential property	2539	28	71082
MFA (2- bedroom) Residential property	2026	44	89127
Total	**6305**	**120**	**$195,718**

Vulnerabilities

As discussed earlier, to become more resilient a community should acknowledge the ways that it is vulnerable. In addition to structural vulnerabilities, Union Beach like many other coastal areas, has economic, social and environmental vulnerabilities. Resilience refers to the capacity to recover quickly from difficulties. What does it take to bounce back after a disaster? Vulnerability refers to the degree of exposure or the amount of potential loss in the event of a disaster.

As a coastal town, an economic vulnerability is the town's dependency on property tax base. When damaged by an extreme weather event or made less attractive by high insurance rates, this source of revenue is not reliable. This impacts not only the town's future budgeting abilities, but directly impacts its ability to rebuild municipal services, both physical and systemic. Additionally, the town is dependent on flood management projects being built in order to become more attractive for businesses in potential commercial corridors or for construction of redevelopment projects.

Social vulnerabilities are sometimes harder to quantify. Older residents may be more sensitive to extreme weather events because of their health. This could be because of their limited ability take action to protect their home, evacuate, or their dependence on stable electricity for their physical well-being.

Source: Julie Dermansky

Storm events are also harder for low income residents because of their potential inability to save, and therefore, pay for repairs to their property.

Environmental vulnerabilities in Union Beach are easy to see. As we have shown in the previous maps, much of the town is at a low elevation which makes its infrastructure, assets, and residents susceptible to storm surge or stormwater flooding. Additionally, Union Beach's marshes and coastal wetlands are susceptible to rising sea levels and impacts from storm surges.

Effects of Sandy

Superstorm Sandy brought extensive damage to Union Beach in the form of storm surge and wind damages. As per a post-storm survey, the town reported almost 60 properties were destroyed and 629 (22% of the total housing stock of Union Beach) properties were damaged (T&M Associates). Almost 90% of the borough's land was flooded with water depths ranging from 2 to 10 feet. The Borough was without power for up to two weeks following the storm. Due to the damages inflicted on municipal buildings, services provided by the municipality were unavailable for almost a month. Many schools and parks were closed due to flood damage. The impact of the storm was so severe that it affected Borough owned vehicles and this limited emergency response capability when it was needed most.

The four major roads of Union Beach were severely damaged. This damage was caused mainly from storm surge, wave action, and heavy traffic of emergency vehicles. The damages were inflicted to the roads by the stagnant salt water following the storm. Additionally, the storm shifted the shorelines of lakes and creeks located near main roads causing the water to erode the neighboring roadways. Scholer Park, which is the town's main recreational park, was flooded with 8 feet of water. The storm surge also damaged the park's infrastructure and amenities.

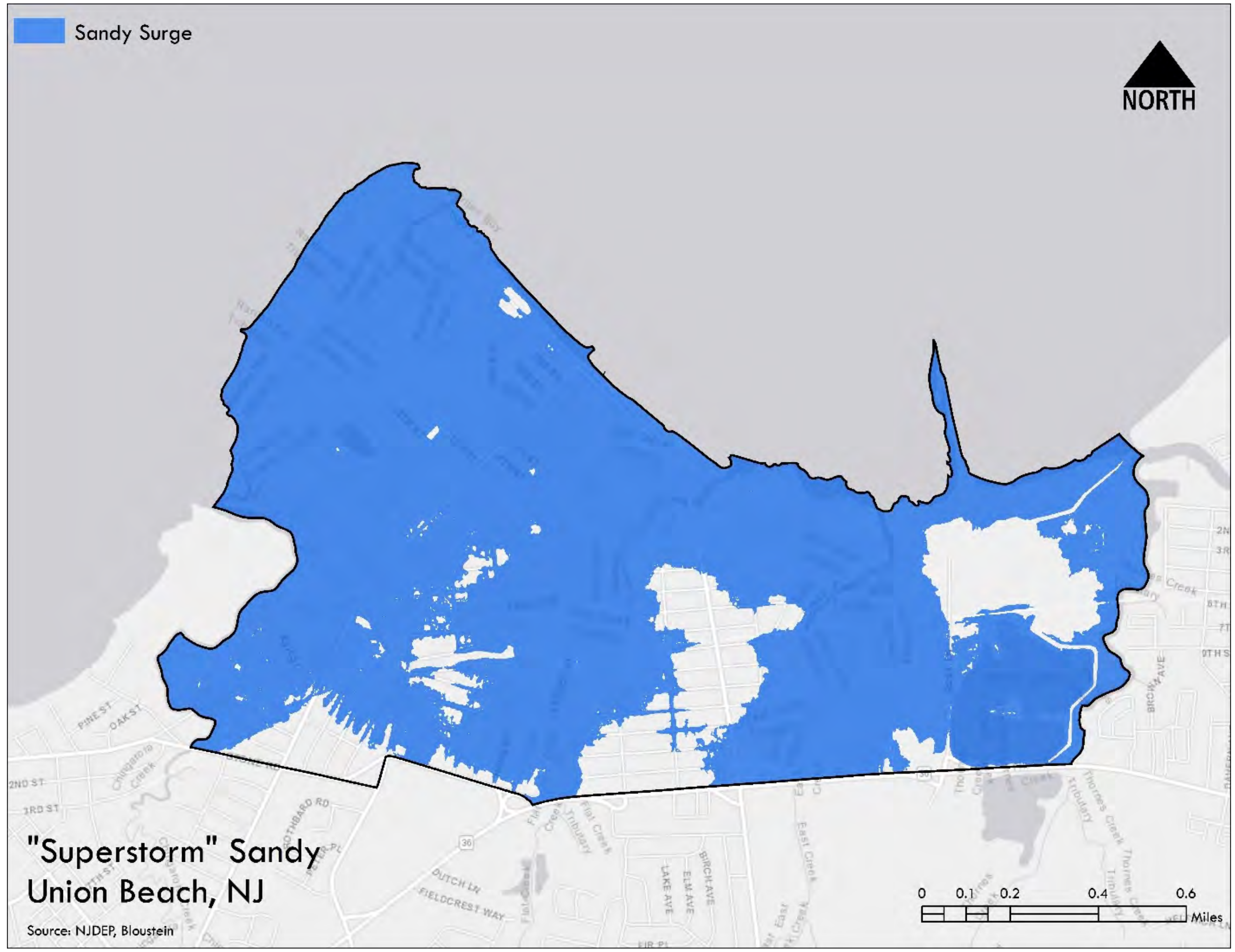


Figure 25: Extent of Sandy

The entire borough was covered by almost 24,000 tons of storm debris. Figure 25 shows how severe the flooding was. The pattern is reflective of the previously shown Elevation and Flood Zone maps.

Community Engagement

Meeting with Mayor Smith

The class was introduced to the Borough of Union Beach on September 18th, 2017. A productive meeting with Mayor Paul Smith, Bob Howard and Dennis Dayback was held at Borough Hall. Discussion included questions about the borough's current resiliency plan, such as if residents supported the plan and whether or not it included green infrastructure. Then, the class toured the town to view important locations, like the Department of Public Works, Brook Avenue, the waterfront, and the Sewerage Treatment Authority.

New Moon High Tide Observations

After hearing about how residents experience regular nuisance flooding during the meeting with Mayor Smith, the class was motivated to observe the flooding in person. On September 20th, two students traveled to Union Beach to observe the new moon high tide flood waters. This type of flooding classifies as nuisance flooding because it inhibits the everyday lives of residents. Front Street and neighboring streets were blocked off to prevent vehicle damage, so residents are forced to create alternate travel routines for a few hours until the tide recedes. Storm drains were also flooded during these tides.

Clean Communities Day

Our studio also participated in Union Beach's Clean Communities Day on October 7th, 2017. This event allowed the students to observe how residents interacted with the beachfront and with each other. It was immediately apparent that Union Beach residents are very civic-minded. The event was well-attended, with nearly 100 participants. The beachfront was decorated with infant loss awareness ribbons. One resident who is a Department of Public Works employee invited two students to plant a tree on the beach front. This tree planting is part of a program associated with FEMA which distributes free trees to communities that lost a significant number of trees during Superstorm Sandy.

Union Beach Day

Union Beach Day occurred on October 14th, 2017, and several students joined the festivities in order to further understand resident interactions within the town and to recruit residents to join a focus group. Civic-mindedness was again dominant during Union Beach Day as Borough fire trucks, police cars, and other emergency vehicles were on display for children to interact with (Image below). Additionally, the American Legion was bustling, and local organizations lined Front Street with tables to share information.

Focus Group

Many of the students within the class participate in Rutgers' Coastal Climate Risk and Resilience program. Throughout coursework for this program, instructors repeatedly emphasized resident support is key to a municipal project's success. As such, the students decided to hold a focus group with residents of Union Beach to assess their familiarity with the proposed U.S. Army Corps of Engineers flood management project, as well as the proposed redevelopment projects, and commercial corridor plans. Students also wanted to learn how these plans may compliment or detract from residents' most beloved aspects of life in Union Beach.

Sense of community was the most frequently mentioned positive aspect of life in Union Beach. Many residents have lived in the borough for decades. Some focus group participants mentioned moving back to the area after years of being away so that they could care for their aging relatives who continued to live in the town. Residents enjoy having friendly and helpful neighbors. Some other residents chose to move to Union Beach from other locations because they observed and appreciated that sense of community.

The second most beloved aspect of living in Union Beach is the waterfront view and proximity to water. Residents spoke about how they can see the Macy's 4th of July fireworks from the bay beach, were able to see the tragedy of 9/11 unfold in real time, and can view beautiful sunrises with the New York City skyline.

An additional reason for moving to Union Beach that residents shared during the focus group is that it is a relatively affordable neighborhood compared to nearby towns. Residents reported, however, that Union Beach is becoming less affordable due to tax increases. Some residents claimed their taxes have doubled since Hurricane Sandy. They are also concerned about elevating their homes as it will lead to less mobility for older family members, and they are curious to see if they will maintain their bay view when the proposed Army Corps of Engineers project is constructed.

All of the residents who attended the focus group were aware that the Army Corps of Engineers project exists and most understood its major components and its purpose to divert flood waters and reduce storm surges. Many participants also made the distinction between structures that are intended to prevent damage from wave action near the shoreline and other structures that are to prevent damages from flood water near the center of town with a lower elevation.

Some residents acknowledged that sea level would rise due to climate change, while others mentioned they did not believe a Hurricane Sandy level event would happen again for decades. All residents were interested in learning what additional methods (besides the Army Corps of Engineers Project) could be used to prevent wave action and flood damage. Residents were mainly interested in learning about options that did not include a sea wall or large dune because they feared these would negatively impact their prized skyline view. Thus, those alternative options are supplied in this report.

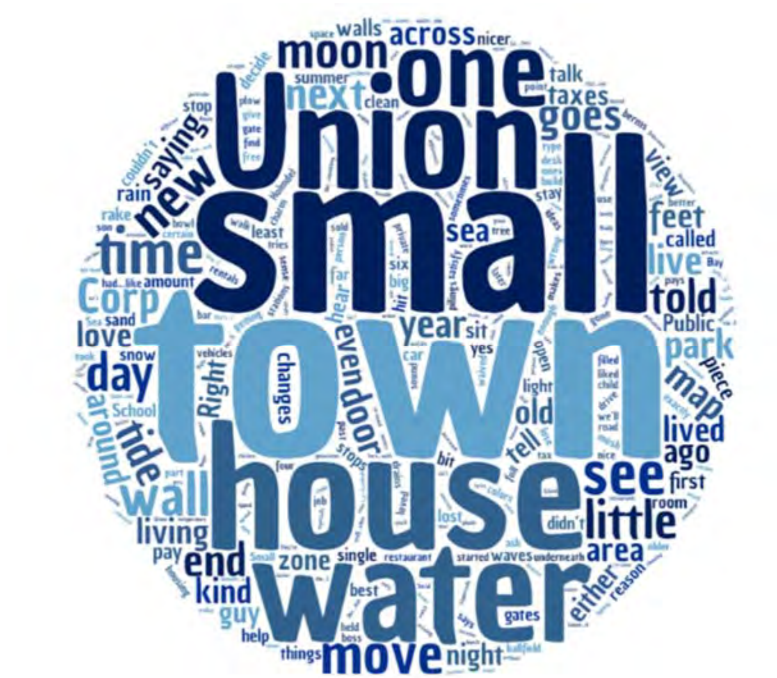
In addition to alternative infrastructure options, this report proposes ways to increase Union Beach's Community Rating System score via resident engagement. During the focus group, residents agreed that one silver lining to Hurricane Sandy was the coming together to help their neighbors in their time of need. Focus group participants were displaced from their homes from between one month to three years. School children were uprooted from their familiar friends and classroom teachers for months to years while their families lived in temporary housing, sometimes counties away from Union Beach.

Several focus group participants agreed that helping each other prepare for the storm, survive during the storm, and thriving after the storm, certainly brought them closer together as a community. A unique bond exists between Union Beach residents because they experienced these hardships together. Many residents, beyond those who joined us during the focus group, hope to continue the conversation and create a more resilient neighborhood. As such, we predict some residents will gladly serve as stakeholder representatives in future Community Rating System activities.

Lastly, focus group participants discussed how future flooding may impact a revitalized commercial corridor. All participants wanted more businesses within walking distance, and stated they frequently decide to leave town for doctor appointments, shopping, and nightlife. Participants stated that they would enjoy more businesses along the waterfront. However, they do not want to displace residents currently living along the waterfront, and they were reluctant to place new businesses so close to the water for fear of frequent rehabilitation after flooding events. The residents cited the local Jakeabob's restaurant as an example of a local business that required repeated assistance following flooding events.

Participants also supported a commercial corridor along Route 36 and added that the current state of Route 36 is "an eye-sore" and "depressing". They understand, however, that rehabilitating contaminated sites, such as those along Route 36, is costly and complicated.

The focus group demonstrated that Union Beach residents are not only well-informed about what is going on in their community, but they are also eager to be involved in actions to improve their community. Results from the transcript were used to create the "word cloud" below.



Real Estate Analysis

MOD IV Sale Price Analysis

There are several factors that influence the sales prices of real estate in Union Beach. In order to quantify the effects of Hurricane Sandy on real estate prices two linear regression models, one pre-Sandy and one post-Sandy, were performed on MOD IV tax data.

Background Data

State of New Jersey Department of the Treasury Division of Taxation – Sales Price Information

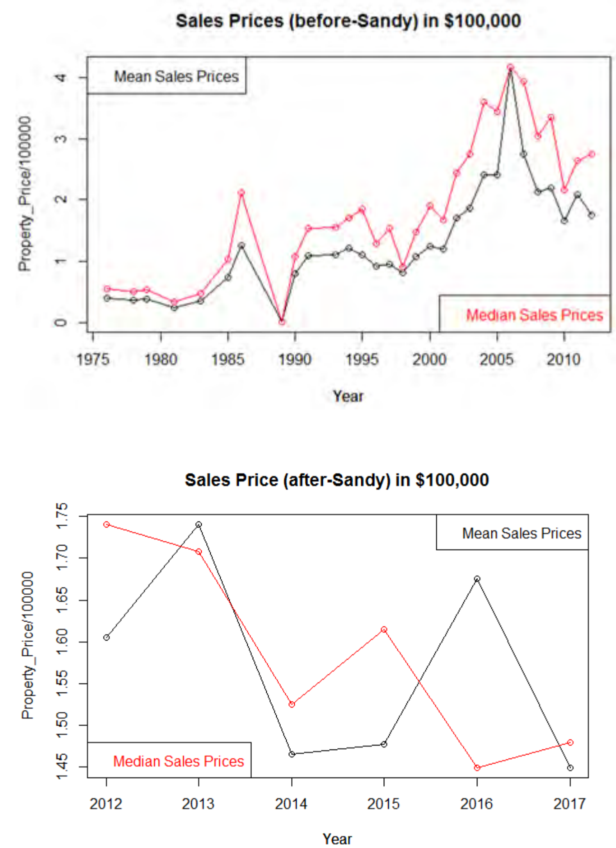
- In 2011, the average property sale price was $208,413.76. The median property sale price was $187,500.00. The mean total assessment was $228,670.40.
- In 2013, the average property sale price was $174,059.26. The median property sale price was $195,000.00. The mean total assessment was $184,448.10.

MOD IV variables believed to influence Sales Prices

Homeowners and business-owners consider the following variables when buying a home:

1. Square Feet
2. Year Built
3. Sale Date
4. Style Description
5. Storm Surge
6. Has Deck
7. Number of Rooms
8. Number of Beds
9. Number of Baths
10. Story Height
11. Foundation Type
12. Condition
13. Flood Zone
14. Distance to Coast
15. Owner Occupied
16. Property Class

Figure 26: Mean Sales Before and After Sandy



Mean sales prices were higher and more variable before Sandy. The prices overall fell after Sandy and there is a significantly narrower range. Before Sandy the minimum sales price was $24,700 and the maximum was $416,446.

After Sandy the minimum sales price was $144,934 and the maximum was $174,059, which is, on average, 10.8% lower than the pre-Sandy mean sales price. These datasets do not include extreme values for analysis purposes.

Statistical Analysis and Results

After the data was adjusted for significant outlying values, the datasets were merged and split into before and after-Sandy datasets. Assumptions for linear regression were checked and the models were run using R software. The square root of the response variable (sales price) was used to normalize the response.

The following is the set of coefficients from the pre-Sandy model:

(Intercept) -505.75	Sq_Ft 0.06	Yr_Built 0.36
Sale_Date 0.03	Tedeschi-LEVEL -149.61	StyDescBUNGALOW -228.36
StyDescCAPECOD -178.67	StyDescCAPERANCH -249.57	StyDescCOLONIAL -201.10
StyDescCONTEMPORARY -396.46	StyDescDUPLEX -143.50	StyDescMULTIFAMILY -185.45
StyDescOLDSTYLE -191.98	StyDescRANCH -191.49	StyDescSPLITLEVEL -175.21
surge 13.83	hasDECK1 11.44	ROOMS -0.03
BEDS 4.23	BATHS -6.94	HEIGHT 12.49
FoundationCONCRETE 180.96	FoundationCONCRETEBLOCK 157.76	FoundationCONCRETESLAB 166.00
FoundationPOST&PIER 140.95	ConditionFAIR -176.78	ConditionGOOD -186.81
ConditionNORMAL -175.05	ConditionPOOR -144.92	ZoneV 38.52
ZoneX 33.95	NEAR_DIST 0.00	OWNEROCCUPIED 20.29
PROPCLASS15C 117.01	PROPCLASS15F 56.21	PROPCLASS2 -46.76
PROPCLASS4A -136.53	ZoneV:OWNEROCCUPIED -16.55	ZoneX:OWNEROCCUPIED -4.20

The negative coefficients in the pre-Sandy model above will decrease the sales prices whereas the positive coefficients will increase the prices. The larger the coefficient, the larger the effect, relative to all the other variables.

The following is the set of coefficients from the post-Sandy model:

(Intercept) -2508.67	Sq_Ft -0.01	Yr_Built 2.14
Sale_Date -0.07	StyDescBUNGALOW -59.65	StyDescCAPECOD -9.30
StyDescCAPERANCH 50.27	StyDescCOLONIAL 56.24	StyDescMULTIFAMILY -154.70
StyDescOLDSTYLE 48.74	StyDescRANCH -64.06	StyDescSPLITLEVEL 130.61
surge 94.59	hasDECK1 -6.28	ROOMS 23.74
BEDS -62.25	BATHS 41.70	HEIGHT -142.31
FoundationCONCRETE -135.57	FoundationCONCRETEBLOCK -160.46	FoundationCONCRETESLAB -255.39
ConditionFAIR -11.44	ConditionGOOD 219.01	ConditionNORMAL 139.36
ConditionPOOR NA	ZoneV -30.97	ZoneX 23.49
NEAR_DIST 0.03	OWNEROCCUPIED -4.13	PROPCLASS2 -54.16
ZoneV:OWNEROCCUPIED 4.13	ZoneX:OWNEROCCUPIED 15.80	

The following is R output from the pre-Sandy model:

Residual standard error: 74.34 on 2223 degrees of freedom

(18 observations deleted due to "missingness")

Multiple R-squared: 0.6529

Adjusted R-squared: **0.6469**

F-statistic: 110 on 38 and 2223 DF, p-value: < 2.2e-16

The adjusted R-squared in the pre-Sandy output above explains 64.7% of the sales price variability associated with the sixteen MOD IV variables, indicating a relatively strong linear model.

The following is R output form the post-Sandy model:

Residual standard error: 116.7 on 328 degrees of freedom

(5 observations deleted due to "missingness")

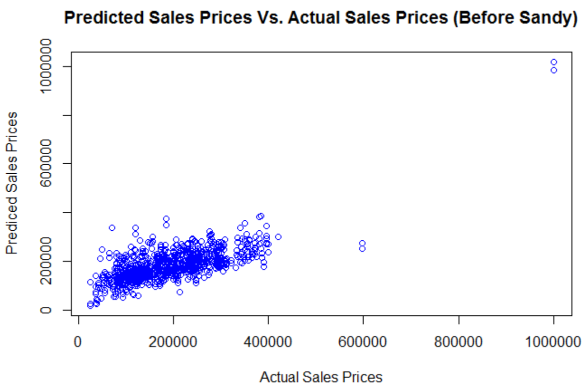
Multiple R-squared: 0.5911

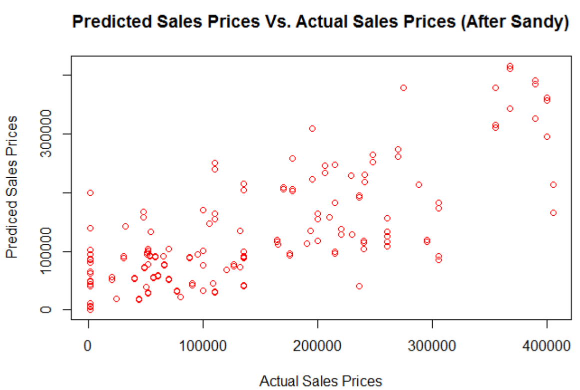
Adjusted R-squared: **0.5537**

F-statistic: 15.8 on 30 and 328 DF, p-value: < 2.2e-16

The adjusted R-squared in the post-Sandy output above explains 55.4% of the sales price variability associated with the sixteen MOD IV variables, indicating a relatively strong model even though it explains slightly less variability than the pre-Sandy model.

Figure 27: The predicted sales prices were plotted with the actual sales prices:





If the predicted sales prices predicted the actual sales prices well, the data would line up in a straight line, forty-five degrees from the Actual Sales Prices axis. The data mostly line up which further illustrates the 64.7% and 55.4% variability explained by the linear models.

The top 7 before-Sandy significant variables in order of rank:

1. Style Description
2. Condition
3. Foundation Type
4. Property Class
5. Flood Zone
6. Owner Occupied
7. Storm Surge

The top 7 after-Sandy significant variables in order of rank:

1. Foundation Type
2. Condition
3. Story Height
4. Storm Surge
5. Number of Bedrooms
6. Number of Bathrooms
7. Flood Zone

Parcel Data for FEMA Flood Zones

A flood zone layer map was joined with the MOD IV data in ArcMap and exported to MS Excel and R.

All Parcels in the dataset:

- Total Parcels in zone A: 1657
- Total Parcels in zone V: 46
- Total Parcels in zone X: 810

Table 12

Before	Min	Max	Mean
Zone A	$20,000.00	$597,500.00	$180,004.00
Zone X	$20,000.00	$1,000,000.00	$226,748.00

After	Min	Max	Mean
Zone A	$24,000.00	$405,000.00	$135,290.00
Zone X	$20,000.00	$305,450.00	$186,910.00

The table above also shows that prices in flood zone A are lower, on average, than in flood zone X before and after Sandy. In short, a location out of the flood zone reliably delivers a premium sales price. Even so, it is not clear how significantly the prices in zone X will increase, but there will probably be less inexpensive homes available.

Fiscal Analysis

Budget Overview

To illustrate the impact of Sandy on the overall budget, the municipal and school budgets were analyzed pre-Sandy and post-Sandy. Unsurprisingly a decline was seen in the entire budget after the storm. Figure 28 shows the impact of the storm on the total budget.

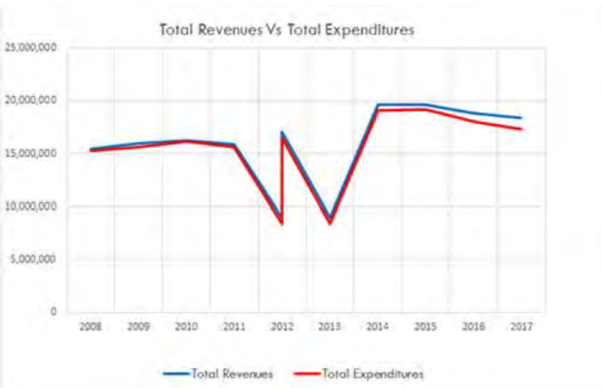


Figure 28: Storm Budget Impacts

Similarly, a decline was seen in the total property tax levied for both the Municipal and school budgets after the storm. As depicted in Figure 30, the property tax levied for the schools was higher than the property tax levied by the schools for the years before the storm. Post-storm, the property tax levied for the municipal budget was observed to be higher than that levied for schools with the gap wider between the two than for the years prior to the storm.

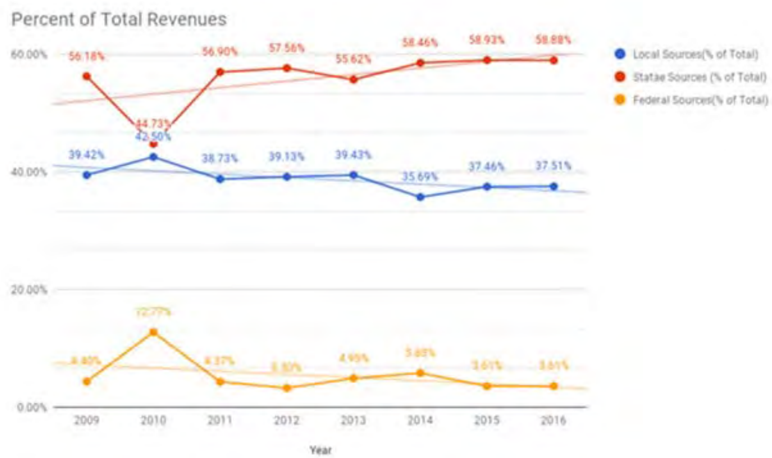


Figure 29: Total Revenues

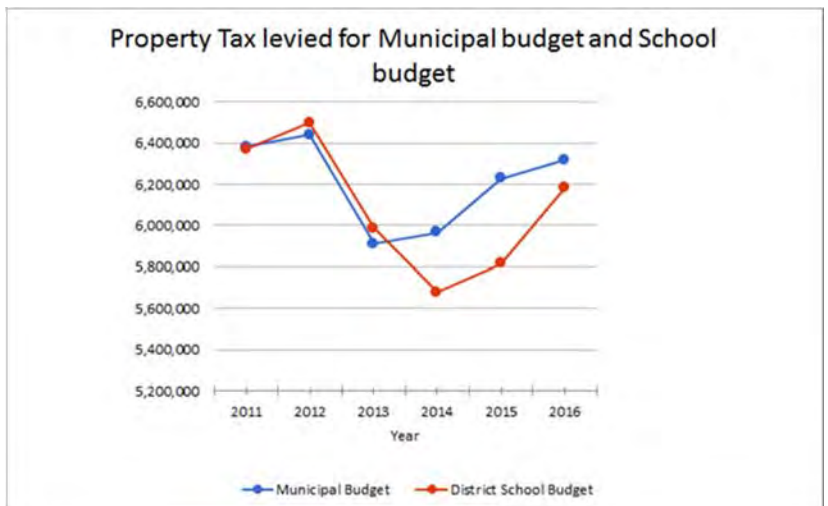


Figure 30: Property Tax + Budgets

School Budget

For the school budget, the composition of revenues is shown in Figure 29. From this graph, it can be observed that the state sources are the highest contributor to the revenues for the school budget. This graph also indicates that the school budget was barely impacted by Sandy as there is no drastic change in any of the federal sources, state sources, or local sources revenues. The heavy reliance on the state sources can explain why the school budget wasn't significantly impacted.

Property Value

Sandy had a significant impact on the average residential property value of homes in Union Beach. The average residential property value declined after the storm and has been steadily rising since 2013. Figure 31 shows the impact of the storm on the average residential property value.

Figure 31: Market Value of Property

Future Scenarios

Introduction

A fiscal impact analysis was completed for three different floods with various expected recurrence times, including 100 years, 500 years, and Sandy. Adjusting the total end number of housing units (including the extent to which owners repair their property) affects property values, total population, total school enrollment, and the amount of employees. These factors influence the municipal and school expenditures and revenues, also known as the overall net fiscal impact on the town. In order to quantify the results and predict the outcome for the municipality, calculations included the following data and assumptions.

Assumptions

Pre-scenario Net Fiscal Impact (State of New Jersey Department of Community Affairs - Property Tax Information - Abstract of Ratables)

- In 2016, the total citywide assessed property value was $505,397,800. The median residential property was $211,47, and commercial property assessment was $328,960. In 2016, the general tax rate in Union Beach was 2.789%. The municipal purpose tax, school district tax rate, and county rate were 1.249%, 1.223% and 0.317, respectively (NJ Department of Community Affairs, Abstract of Ratables, 2017).
- In 2016, the district school budget was $15,225,422, and the expected average daily enrollment was 628 pupils (NJ Department of Community Affairs, Abstract of Ratables, 2017).

Residents and non-residents generate 87.05% and 12.95% of the town's revenues and expenditures, respectively. However, all of the health and human services and park and recreation are covered by residents. The shares of revenues and expenditures generated by residents versus nonresidents were calculated using the assessed property values and number of residential parcels. Overall, this assumes the ratio of generated revenues and expenditures of each group to be constant.

Population (United States Census Bureau-2015 AS 5-year Estimate)

- In 2015, Union Beach had 4,679 residents (*United States Census Bureau, 2016)*
- In 2015, the employed population in Union beach was 2,809 (*United States Census Bureau, 2016*).
- In 2015, there were 2,130 housing units, of which 2,009 were occupied (1,694 were owner-occupants and 315 were renters). An additional 121 units stood vacant (*United States Census Bureau, 2016*).

Lost Units (Source: "Who Live in New Jersey: A Quick Guide to New Jersey Residential Demographic Multipliers")

It was assumed that the number of housing units lost would be proportional to the percentage of units in each bedroom class. Using David Listokin's Multiplier Guide, the change in population and school enrollment numbers were calculated.

Revenues and Expenditure (Union Beach Borough 2016 Audit)

- Revenue and expenditure data was collected from the 2016 Audit, published by the Union Beach Borough
- The revenues accounted for "sticky expenditures", thus if there was a negative change in residents, local employees, or school age children, the change in cost for the municipality only decreased by 50%
- All residents created equal revenues and expenditures for the town
- All workers created equal revenues and expenditures for the town

Assumptions for Options of Home Owners After a Storm

It is assumed that individual home-owners and business-owners will choose the most logical option after a storm based on personal motives, such as the owner's income, the availability of a state funds for a buyoff, the cost of flood insurance, future risk predictions, and, of course, the degree to which the house is damaged or destroyed. Options considered in this fiscal analysis include elevating, selling as is/government buyout, completing minimal repairs, abandoning the house, or repairing to pre-storm conditions. These statistics, which were obtained after Sandy, have been extrapolated for future predictions of various degree of floods.

Parcel Data for Various Storm Surges

Since the outcomes for owner options are assumed to be proportional to the number of parcels within the floodplain of varying storm sizes, the amount of residential and commercial parcels that would choose one of the four options are quantified for each uncontrolled scenario based on the number of parcels within each flood zone. Parcel metadata was downloaded from the New Jersey Department of Environmental Protection. Floodplain metadata was downloaded from FEMA. Residential and commercial data was extracted from the layers based on the intersecting floodplains.

All Parcels in 2016 *(Abstract Ratable)*:

- Total Parcels in 2016: 2,312
- Commercial Parcels in 2016: 2,046
- Residential Parcels in 2016: 50

100-year flood:

- Total Parcels within floodplain: 2,302
- Commercial Parcels within floodplain: 70
- Residential Parcels within floodplain: 2,184

500-year flood:

- Total Parcels within floodplain: 2,577
- Commercial Parcels within floodplain: 94
- Residential Parcels within floodplain: 2,450

Sand-equivalent flood:

- Total Parcels within floodplain: 2,313
- Commercial Parcels within floodplain: 65
- Residential Parcels within floodplain: 2,064

Methodology and Assumptions Used for Quantifying Owner Decisions (Union Beach Borough Strategic Recovery Planning Report)

Table 13 shows the percentage of homes that would chose each outcome for each storm intensity/frequency. The methodology and assumptions for owner options are calculated by trends noted from Superstorm Sandy behavior. The same percentages for all the four options that were observed in Sandy are not taken, as it is assumed that residents would have built back better after Sandy and, therefore, they would be better prepared for a storm that would hit the town in 2018. The methodologies and assumptions are listed below:

1. **Elevated**

Methodology: The Union Beach Borough Strategic Recovery Planning Report (T&M, *2014)* reported that 103 of homes within the floodplain were elevated post-Sandy. Compared to the number of parcels within the storm surge, this equates to 5% of houses with in the flood area.

2. **Sold by Owner**

Methodology: MOD IV data identified 44 homes (2% of homes within Sandy's surge) that were sold in Union Beach between November 2012 and December 2013.

3. **Minimal Repairs**

Methodology: A parcel count for minimal repairs was calculated by differentiating between parcels within each flood zone. It was assumed that parcels within each flood zone would complete minimal repairs if they were not in a flood zone of a greater frequency. For example, Figure 33 identifies all parcels within a 500-year flood zone, but not within a 100-year flood zone. It was assumed that the identified parcel would only complete minimal repairs in the occurrence of a 500-year flood event.

4. **Abandon**

Methodology: As per the Union Beach Borough Strategic Recovery Planning Report (T&M, *2014)*, 430 houses were demolished, destroyed, or listed for evacuation after Sandy, which is 20.8% of the houses in the floodplains. Union Beach received 272 demolition permits in 2012, 2013, and 2014, equating to 13% of the homes within Sandy's surge area (New Jersey State Department of Community Affairs, 2016). It was assumed that the reconstructed houses are built stronger than before and a smaller percentage of homes would be abandoned in future storms

5. **Repair to Pre-Storm Conditions**: The remaining percentage of damaged houses are assumed to rebuild to pre-storm conditions.

Table 13

	Baseline (2016)	100 Year Flood	500 Year Flood	1,000 Year Flood
Inputs				
Number of homes that will be elevated	0%	1%	2%	3%
Number of homes sold at 60% of value (50% occupancy)	0%	1%	1%	2%
Number of homes that will not be rebuilt (abandoned)	0%	6%	10%	15%
Number of homes reassessed at 60% of value	0%	7%	10%	15%
Total Percent Affected	0%	15%	23%	35%

Methodology and Assumptions Used for Calculating Assessed Property Value (Union Beach MOD IV Data)

1. **Elevate**: Assessed value of Elevated Houses increases by 37 %

Methodology: A sample of six houses was randomly selected from the MOD IV tax data. The elevations of these houses were verified using street view of Google maps. From the MOD IV website, the assessed value of these homes for 2012/2013 was noted, as well as the assessed value of each of the homes after they had been elevated. The increase in the assessed value of each of the homes was calculated and an average of 37% was derived for the sample.

2. **Sold by Owner / Government Buyout**: Assessed value of properties sold "as is" decreased by 35% (sold at 65 % of assessed value).

Methodology: A sample of seven houses was selected from the MOD IV data of houses that were sold at the end of 2012 and in the beginning of 2013. The percentage of the sales price to the assessed value was calculated for each of these homes. The average of these percentages was calculated to be 65% of the pre-storm value.

3. **Minimal Repairs**: Assessed value decreases by 20%.

Methodology: A sample of seven houses was selected from the MOD IV data. Only those properties were selected whose assessed values for 2013 did not decline *drastically* from pre-Sandy. The difference between the assessed value of these homes between 2012 and 2013 was calculated and the percentage in decline of the assessed value was calculated. The average drop in assessed value was calculated to be 20%.

4. **Abandon**: Assessed value decreases by 100% and the town must pay $2,500 to demolish it.

5. **Repair to Pre-Storm Conditions**: Assessed value does not change.

Methodology for Calculating Fiscal Impacts of Generated Scenarios

An input-output (IO) model was created in order to analyze the financial impact Union Beach would encounter if confronted with a 100-year, 500-year, or Sandy-equivalent flood. The inputs for running the model included:

1. The parcels included in each flood zone
2. The percentage of homeowners that would choose each of the five available options and the change in assessed value
3. Union Beach's 2016 budget details including general revenues, property tax revenues, total revenues, and total expenditures
4. The characteristics of Union Beach's residential assessed values
5. 2016 census data including owner-occupied and renter-occupied housing units and the percentage of housing units in each bedroom class (0-1 bedrooms, 2 bedrooms, 3 bedrooms, 4-5 bedrooms)

Using Listokin's Multipliers, per capita results were calculated based on assumptions for each scenario. The linear relationship between housing units or size, population (total and students), and budget changes allowed for the calculation of revenues and expenditures and change in school budget by per capita. The calculated outputs of the model included:

1. The Net Fiscal Impact on the Municipal Budget (Change)
2. The Net Fiscal Impact on the Municipal Budget (Absolute)
3. The Net Fiscal Impact on School District

Results were double checked by comparing the calculated "New Total Revenues" 2016 baseline to the actual 2016 revenues reported in the 2016 Borough Audit. The actual municipal appropriations for 2016 were reported as $10,244,045 compared to the calculated $10,701,282 (Robert A Hulsart and Company. (2016).

Results

100 Year Flood Scenario

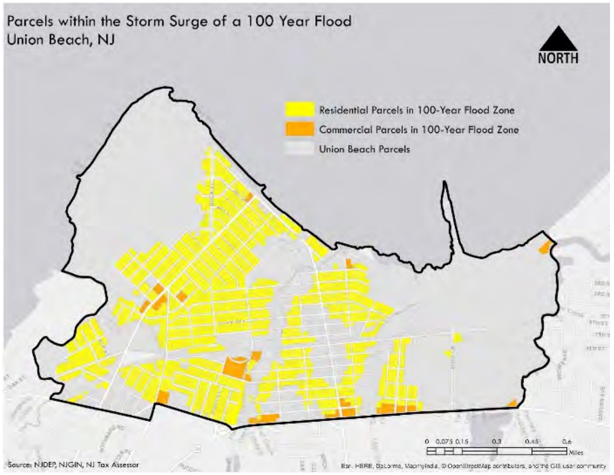


Figure 32: 100 Year Flood Scenario

Inputs	Baseline (2016)	100 Year Flood
Net Fiscal Impact on Municipal Budget (Change)		
Change in Total Revenues	$0	-$574,095
Change in Expenditures	$0	-$1,942
Net Fiscal Impact on Municipal Budget	**$0**	**-$572,153**
Net Fiscal Impact on Municipal Budget (Absolute)		
New Total Revenues	$10,702,282	$10,128,187
New Total Expenditures	$9,507,957	$9,506,016
Net Fiscal Impact on Municipal Budget	**$1,194,324**	**$622,171**

For a 100-year flood there would be a surplus of $622,170 on the entire budget, and it would be $572,153 less than the surplus of the baseline surplus for the 2016 budget.

500 Year Flood Scenario

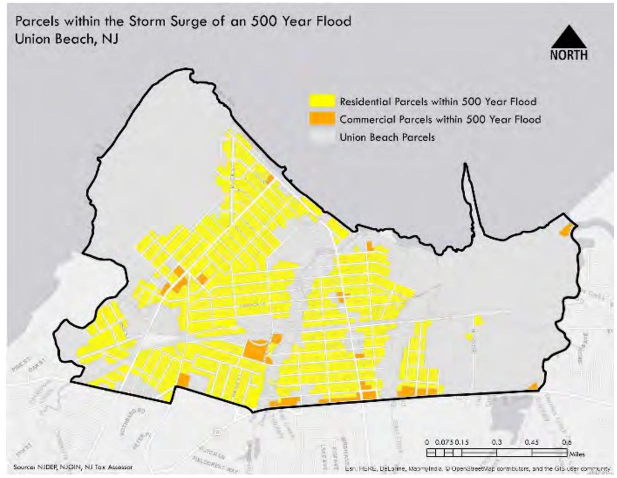


Figure 33: 500 Year Flood Scenario

Inputs	Baseline (2016)	500 Year Flood
Net Fiscal Impact on Municipal Budget (Change)		
Change in Total Revenues	$0	-$1,035,102
Change in Expenditures	$0	-$9,240
Net Fiscal Impact on Municipal Budget	**$0**	**-$1,025,863**
Net Fiscal Impact on Municipal Budget (Absolute)		
New Total Revenues	$10,702,282	$9,667,179
New Total Expenditures	$9,507,957	$9,498,718
Net Fiscal Impact on Municipal Budget	**$1,194,324**	**$168,461**

For a 500-year flood there would be a surplus of $168,461 on the entire budget, and it would be $1,025,863 less than the surplus of the baseline surplus for the 2016 budget.

Sandy-Equivalent Flood Scenario

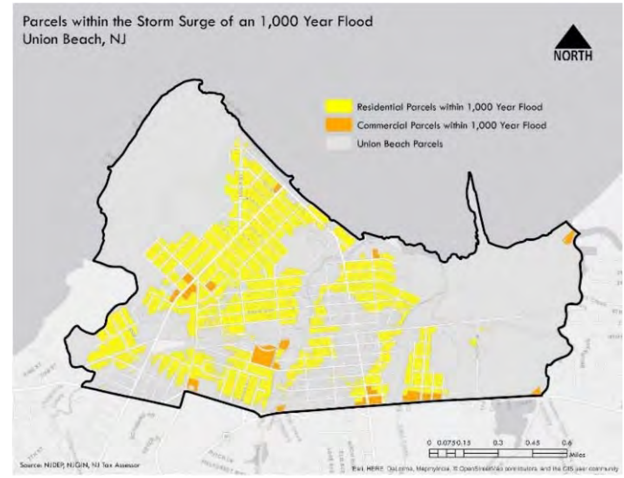


Figure 34: 1,000 Year Flood Scenario

Inputs	Baseline (2016)	1,000 Year Flood
Net Fiscal Impact on Municipal Budget (Change)		
Change in Total Revenues	$0	-$1,292,233
Change in Expenditures	$0	$13,706
Net Fiscal Impact on Municipal Budget	**$0**	**-$1,305,939**
Net Fiscal Impact on Municipal Budget (Absolute)		
New Total Revenues	$10,702,282	$9,410,048
New Total Expenditures	$9,507,957	$9,521,663
Net Fiscal Impact on Municipal Budget	**$1,194,324**	**-$111,615**

For a Sandy-equivalent flood there would be a deficit of $111,615 on the entire budget, and it would be $1,305,939 less than the surplus of the baseline surplus for the 2016 budget.

Green Infrastructure

Overview

Infrastructure across Union Beach is limited in scale because of a similarly limited tax base and relatively small service area. However, the challenges addressed by that infrastructure, in particular the network of drains, pipes, sewers, and other water-moving and water-storing infrastructure, are not so limited. In fact, as was made painfully clear during Sandy, and frustratingly apparent during regular tide and rain events, Union Beach is significantly burdened by water.

Traditional 'grey' infrastructure is so called because it recalls the color of cement. The Army Corps project will rely on groins, levees, and other constructed 'hard' barriers to the water. The functionality of such infrastructure degrades from the moment it is completed, and the maintenance costs begin to rise from the start. The existing storm drains and sewers throughout Union Beach comprise its stormwater management infrastructure.

'Green' infrastructure is so called to recall the color of growing plants. According to the EPA, green infrastructure utilizes, "Systems and practices that use or mimic natural processes to infiltrate, evapotranspirate, or reuse stormwater on the site where it is generated." (EPA, 2017) By incorporating living things into the design of a space – creating/enhancing their habitat and planning around their behavior – the maintenance costs for green infrastructure should not increase over time (as do those for grey infrastructure), and the functionality of the system increases as that life becomes more firmly established. Additionally:

Green infrastructure has the advantage of being decentralized, and therefore, has minimal disturbance on the built environment, has lower capital investment demand in the short-term, and brings numerous additional benefits to the urban environment. (Mankiewicz and Morin, 2017)

The wetlands at Conaskonk point have been acting as a green edge, absorbing water and wave energy. These wetlands protect property while providing habitat for local flora and fauna. However, any and all planted (or at least unpaved) surface in Union Beach contributes to the slowing or storage of stormwater, and so serves a function. The functions provided by soils, plants, and animals are known collectively as 'ecosystem service'. Green infrastructure incorporates and enhances ecosystem services as a way of augmenting or improving upon those services provided by traditional grey infrastructure.

According to the US Geological Survey of soils within Union Beach, a plurality (more than 40%) of soils are moderately to very poorly drained, and experience frequently flooding and ponding, with a minority (less than 20%) being well to moderately drained soils not vulnerable to flooding or ponding. Fortunately, Union Beach's limited development means that only a small amount of land (less than 2%) is classified as "urban land" – that being land covered by pavement, concrete, buildings, and other structures. This means the majority of the surface is still available. This lack of development is an opportunity for green infrastructure as, "…surface area of cities is the critical parameter for incorporating and exchanging matter and energy: water, nutrients, pollutants, light and heat." (Mankiewicz and Morin, 2017) More surface area means more opportunity.

The undeveloped status of the majority of the land, particularly around the wetland 'edge' at Conaskonk Point and along both Flat Creek and East Creek offer opportunities to absorb, transport, and store stormwater and tidal flooding. These areas also contain a significant percentage of the vacant land available in Union Beach, and so are idea locations for the implementation of green infrastructure.

Suitability Analysis of Union Beach for Green Infrastructure

Identifying areas within Union Beach that are suitable for green infrastructure is an important part of the report's recommendations. This analysis included important variables that are good indicators of spaces and locations that are well suited for green infrastructure. The analysis variables included soil type, proximity to streams, distance from homes, elevation, and placement within the flood zone. The following analysis was created and executed using ARCGIS 10.5.

Variables Used

Soils: Soils are an important factor when planning for green infrastructure because they dictate factors such as infiltration rate, infiltration capacity, and groundwater recharge.

Proximity to streams: Depth to groundwater and water table are important factors to consider when planning the construction of green infrastructure. Due to a lack of accurate water table depth in Union Beach the distance from stream was used as a surrogate for this measure. Distance used as a baseline is 250 feet from a stream in all directions.

Elevation: Elevation plays an important role in the movement of water, collection of water, and determining areas of tidal influence. This makes areas that are both very low and very high suboptimal locations for the placing of green infrastructure.

Flood zone: Flood zone and water velocity have an effect on the type and extent of possible flooding, which impacts where green infrastructure would be most effective in reducing flooding.

Methodology

GIS and AutoCAD data were collected from Natural Resources Conservation Service Soil Web Survey, National Hydrography Dataset, US Geological Survey, United States Army Corps of Engineers, Federal Emergency Management Agency, and the United States Department of Agriculture. This data includes shapefiles and raster data such as soil surveys, streams and waterbodies, building footprints, flood hazard areas, and Elevation Digital Elevation Model (DEM) at 1-meter resolution, respectively.

All of the collected data was projected at New Jersey State Plane NAD83 and converted to raster data with a resolution of 1 meter. Following this, all data was reclassified to reflected the suitability strength of the data (Ranging on a scale from 1 -5, with 1 being least suitable and 5 being the most suitable). For features such as distance from homes and proximity to streams, we calculated the Euclidean distance to or from the respective features. Euclidean distance is calculated from the center of a cell to the center of each of the surrounding cells within the area of interest, Union Beach.

The following are the values allocated for the variables and the reasoning for the attribution:

Soils: Soils were classed according to permeability and the hydric classification of the soils. All soils are classified as 1 (least suitable) with the exception of Elkton loam which is classified as a 4 (highly suitable).

Proximity to streams: Distance is classified based of the Euclidean distance. Higher suitability is given to areas that are at least 250 feet away from streams while other locations received a rating of 2 or 1 as they approached streams.

Elevation: Elevation in Union Beach ranged from -2 feet below sea level and 7 feet above sea level. Highly suitable areas (4 & 5 rating) are considered between 1.5 feet and 4 ft. Areas of low elevation are mostly coastal and found unsuitable for green infrastructure and areas at highest elevation are considered to be less effective in capturing water.

Flood Zones: Zone AE areas are considered areas that are highly suitable (classified as 5) since they have a 1% chance of flooding every year and are also out of the VE zone. Areas within the VE zone are considered as less suitable (Classified as 2) and water is not included as a possible area.

Weighted Average

The last step is to calculate the output including these four variables. A weighted average calculation is used to give certain variables higher weights than others in determining suitability. The weights given the four variables are as follows (out of 1); Elevation-.225, Soils-.15, Flood Hazard-.4, and Distance from streams-.225.

Results

The resulting calculations provide us with the map (Figure 35) which highlights suitability ranging from least suitable to most suitable. A few suitable areas identified are Brook Avenue, Scholer Park, and Chingarora Street. We have identified a number of proposals based on this analysis.

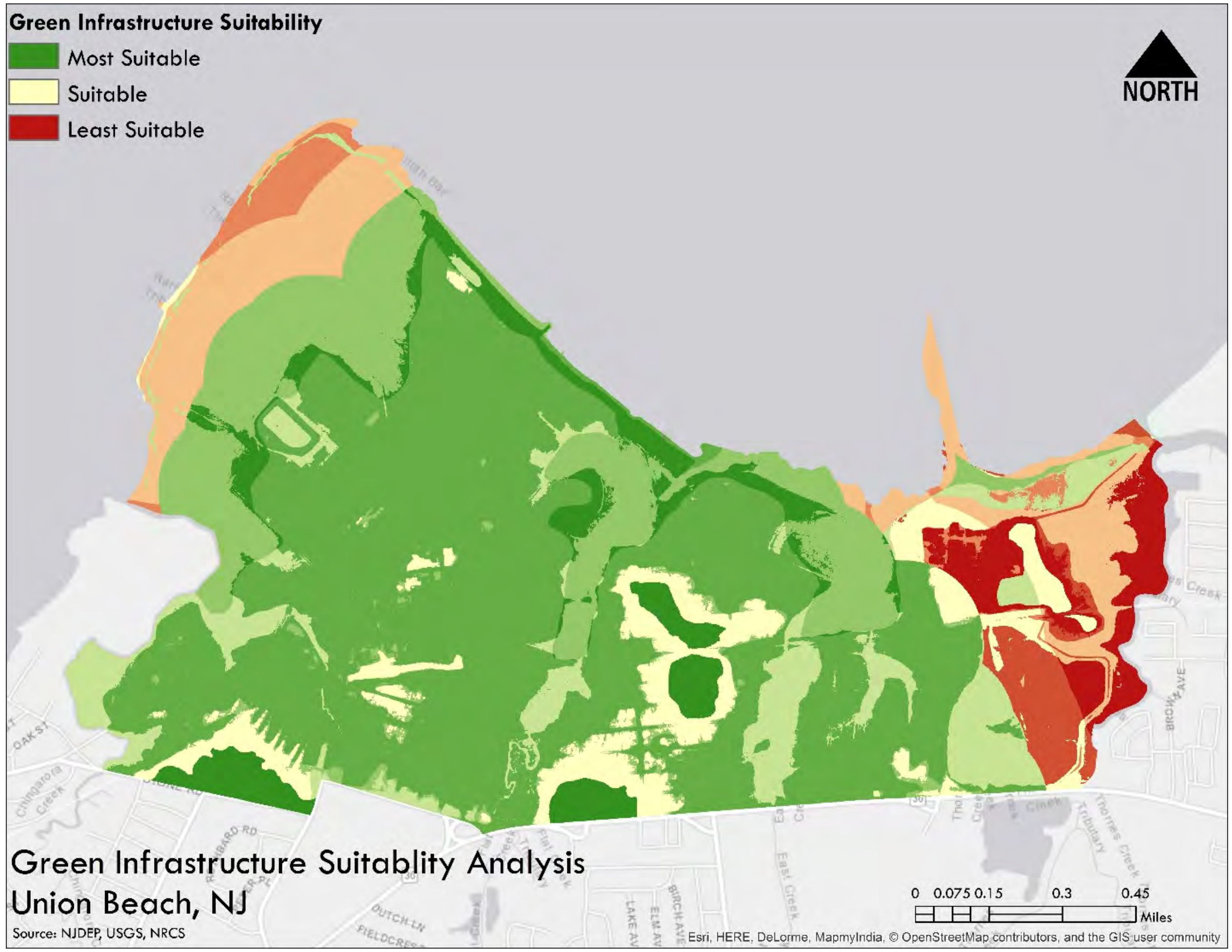


Figure 35: Green Infrastructure Suitability

Proposal Components

Wetlands and Living Shorelines

Living shorelines are one of many nature-based approaches for protecting and enhancing shorelines. These techniques bridge together engineering advances and ecological understanding to protect shorelines and vital infrastructure, create or restore natural habitats, and provide ecosystem services (Bilkovic et al., 2017). Additional benefits from living shorelines are erosion reduction, improved marine habitat, improved water quality, and the creation of filtration areas for runoff and groundwater.

In complement the Brook Avenue and the Army Corps of Engineers project, we propose the integration of a living shoreline which consists of the creation of wetlands to increase protection and habitat creation (Temmerman and Kirwan 2013; Edward et al. 2011; Shepard et al., 2011) (Figure 36). The creation of tidal wetlands along the northern portion of Union Beach provides the opportunity for natural storm water mitigation as well as ecological enhancement. The creation of tidal wetlands in the northern portion of Union Beach may be able to aid with the abatement of nuisance flooding experienced by residents on Front Street during high tides, thus improving current conditions. The creation of tidal wetlands will also promote habitat areas used for fish and feeding grounds for marsh birds, both of economic value for commercial fishing and eco-tourism (Tourism Economics 2016).

Offshore Breakwater

In addition to living shorelines and wetlands, we propose to include an offshore breakwater approximately 3000 feet from the shoreline that attaches to an already existing headland between Keansburg and Union Beach. Offshore breakwaters dissipate wave energy before it reaches the coastline (Zidan, Rageh, Sarhan, & Esmail, 2012). Including this feature adds an additional layer of protection to the proposed dune along Front Street as it will reduce erosion rates (Zidan, Rageh, Sarhan, & Esmail, 2012). Beach goers will also experience calmer waters at the Union Beach shorefront.

Deployable Floodwall

To further reduce costs of the Army Corps project, it is also proposed that deployable floodwalls be included in certain regions. These barriers can be removed following a flood event, potentially restoring views that would otherwise be blocked by a permanent wall. Typically, these walls are lower in cost than permanent levees or flood walls, but a proper flood warning system needs to be in place to ensure their proper deployment. (US Army Corps, NJDEP, 2015).

Interior Levee Removal

Examining the Army Corps project further, interior levees are observable in the southeastern section portion of the town. It is proposed that these levees be removed and the homes in this region be elevated by traditional elevation methods. We believe this is an effective protection strategy given the quantity of homes in that region. To our knowledge, most of the homes being protected by these interior levees are already elevated, and it, therefore, is possibly less costly to elevate the remaining structures than build new levees.

Rain Gardens

The final component of our proposal uses the suitability analysis, which identified favorable locations in Union Beach, to install green infrastructure. It is proposed that rain gardens be installed in regions identified as 'Most Suitable' by the suitability analysis. The primary purpose of rain gardens is to collect stormwater runoff from impervious surfaces such as roofs, driveways, or parking lots (Teague, Daniels, Pennington, & Brown). These gardens can also have environmental benefits by attracting local wildlife like birds and butterflies (Teague, Daniels, Pennington, & Brown). Since the current Army Corps project's focus is storm surge, the inclusion of rain gardens in favorable areas will supplement the project well by reducing runoff amounts.

These proposed components come at a price and Table 14 summarizes some of these estimated costs. These values were found in the North Atlantic Coast Comprehensive Study, a report put together in 2015 by the U.S. Army Corps of Engineers. The report was put together following Hurricane Sandy to help address vulnerabilities in the North Atlantic coastal region and was intended to be used by local communities to address their flood risk and plan for the future. The cost estimates presented in the table were developed for projects with a 50-year project life (U.S. Army Corps of Engineers, 2015).

Table 14: Estimated Costs of Proposals

Component	Construction (Labor, Materials)	Annual Average Maintenance
Wetland	$565,000/acre	$26,900/acre
Deployable Floodwall	$5,500/ft.	$250/ft.
Offshore Breakwaters	Varies	Varies
Living Shoreline	$1,400/ft.	$70/ft.
Elevated Homes	Varies	Varies

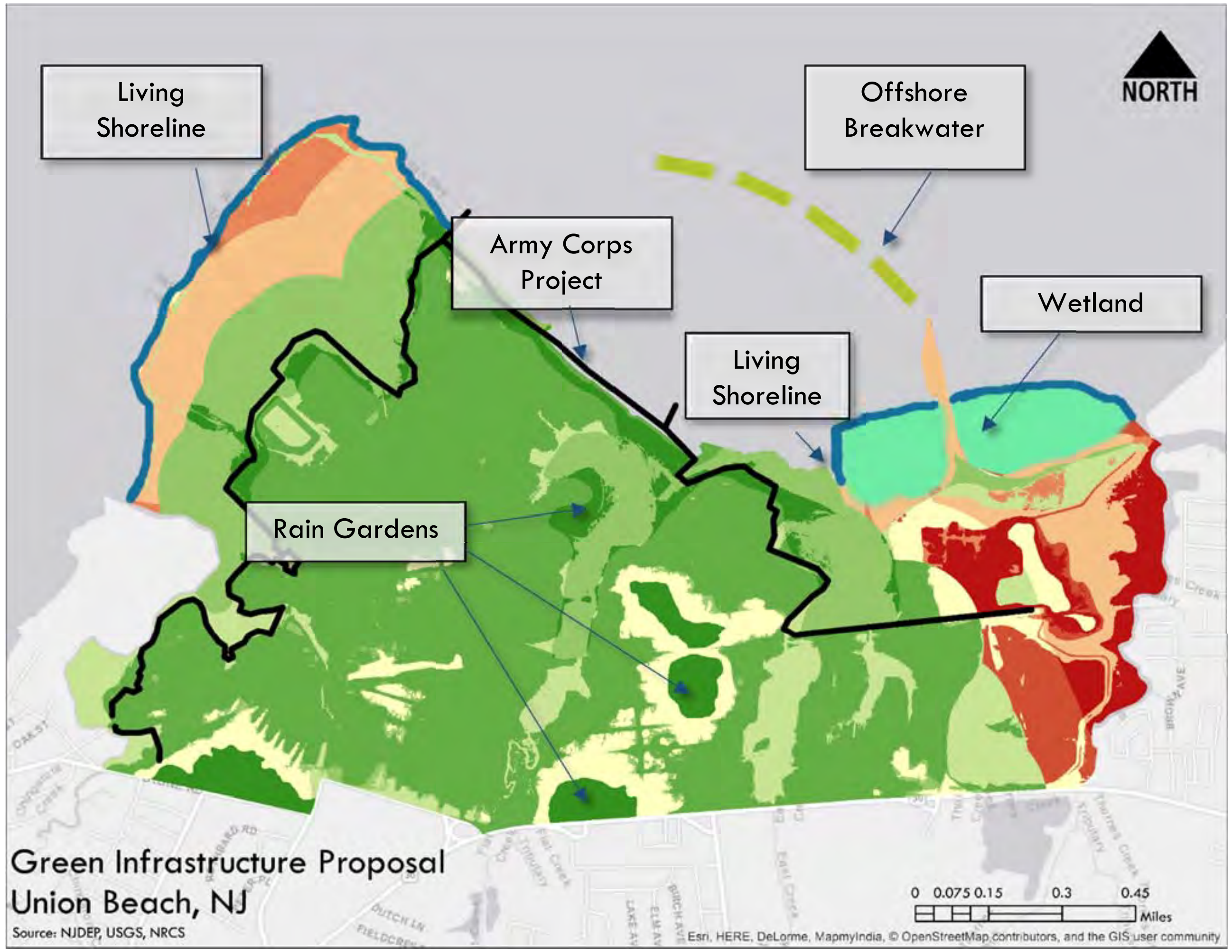


Figure 36: Green Infrastructure Proposal

Additional Recommendations

DPW Project

This redevelopment project includes the construction of age-restricted housing. The purpose of this project is to increase the availability of housing for the Borough's ageing population. Since this site is located in the 100-year flood zone, as shown in Figure 37, the design of the structure will be raised above the first floor elevation.

Due to the physical limitations the elderly may face, the raised nature of the structure may pose problems in the event of a natural disaster. Unlike the Brook Ave project, the DPW project is not contingent on the completion of the Army Corps project. Therefore, if the DPW project is completed before the Army Corps project, the seniors in this location are vulnerable to the effects of flooding. Due to this limitation, it would be advantageous to relocate this project to a tract of land identified for development in the Borough's Commercial Corridor plan. Relocating along Highway 36 would place this vulnerable population further away from the 100-year flood zone. The housing would also be closer to a major highway which is convenient for emergency service access. The Borough Fire Department is also located nearby.

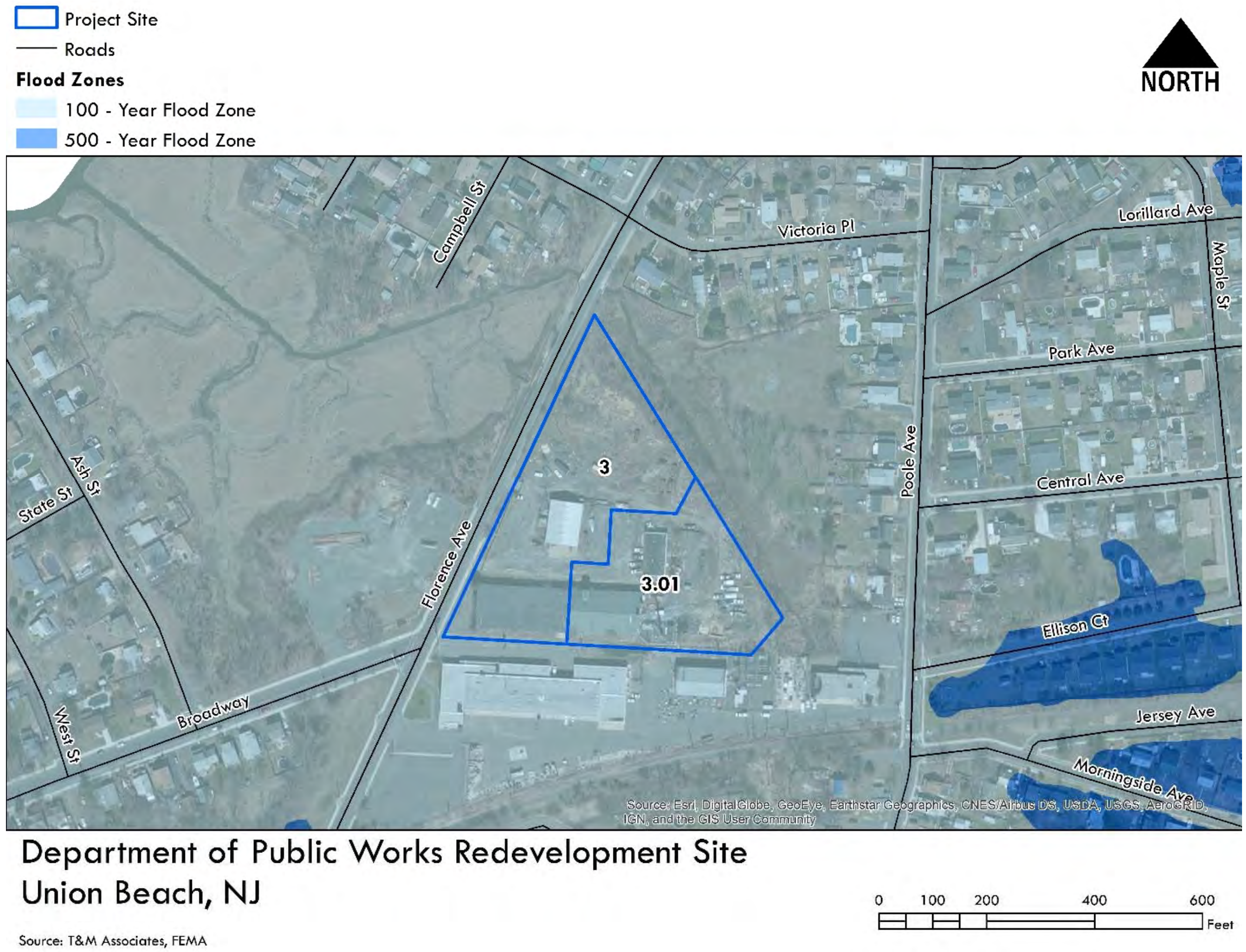


Figure 37: DPW Project Limitations

If relocating is not an option, ensuring that all utilities are raised above the first floor would help prevent power outages if a storm were to occur.

Commercial Development on Front Street

The top right image is a historical photograph of Front Street from the 1930s. Front Street has traditionally been the center of commercial activity for the Borough. Financial troubles associated with the great depression prevented the retention of commercial activity on the waterfront.

Today, the American Legion bar and restaurant (bottom) is one of the few remaining commercial establishments on Front Street. Not only is this a popular location for community gatherings, but its raised design makes the structure resilient to flooding.

Waterfront Rendering

Figure 38: Waterfront Rendering

From our observations and discussions with residents, we have noticed the strong connection the people of Union Beach have with the shorefront. Therefore, given the results of the line of sight analysis and the presence of vacant, unused lots along Front Street, we propose to expanding commercial development to the waterfront. Elevated commercial development can be erected in these vacant lots on Front Street. These establishments can feature ocean facing balconies and would supplement the already raised American Legion. Raised development on Front Street would allow residents to view over the proposed dune to the New York City skyline, and ultimately revitalize the shorefront of Union Beach.

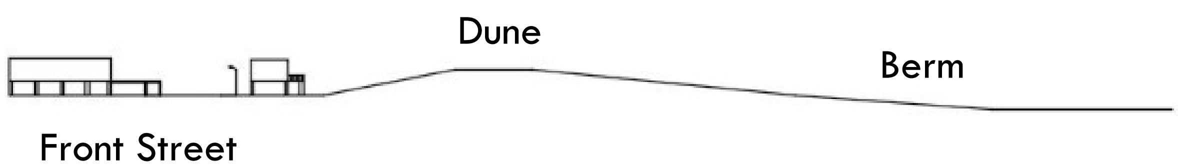


Figure 39: Section View of Rendering

Community Rating System

The Community Rating System (CRS) is a voluntary program created by the National Flood Insurance Program (NFIP). This system recognizes community efforts beyond minimum NFIP standards by reducing flood insurance premiums for the community's property owners. Communities must submit proof of the resilience measures they adopt. Points are earned for each measure they adopt, and more points yields greater discounts on flood insurance premiums. For example, Union Beach recently upgraded from a level 8 to a level 6 by submitting documents verifying that vulnerable buildings were raised above minimum required elevation levels. Currently Union Beach is at a level 6. Table 15 shows that a level 6, highlighted in yellow, earns a 20% discount on flood insurance. In order to increase to a level 5, highlighted in blue, and receive a 25% discount, Union Beach must earn 454 more points.

Table 15: CRS Points

Class	Discount	Points Needed
1	45%	4,500 +
2	40%	4,000 - 4,499
3	35%	3,500 - 3,999
4	30%	3,000 - 3,499
5	25%	2,500 - 2,999
6	20%	2,000 - 2,499
7	15%	1,500 - 1,999
8	10%	1,000 - 1,499
9	5%	500 - 999
10	0%	0 - 499

Goal: Class 5

2,500 Points

Current Level: Class 6

2,046 Points

There are many ways Union Beach can earn more points, but a few with the greatest potential are outlined herein Table 16. The residents who participated in the focus group indicated that they would be eager to help their community become more resilient in the face of future flooding. One way that residents can be directly involved in the CRS is by becoming part of a Program for Public Information (PPI). Activity 330 is Outreach Projects, and a PPI can be created to help promote outreach projects. A PPI must be composed of at least 5 people, 3 of which must be non-local government stakeholders like residents or local business owners. Union Beach already earns 60 points with their current outreach projects. However, just creating a PPI can earn 80 more points, and existing outreach projects can earn more points just by being carried out by a PPI.

Union Beach can also create additional outreach projects for repetitive loss properties or specific tools for use after a flood event. The total potential points for completing Activity 330 is 350 points, so Union Beach could earn up to 290 more points with the help of resident involvement and a PPI.

Activity 620 is Levee Safety, and this is worth up to 235 points. Union Beach currently has no levees, and thus earns no points for this activity.

Table 16: CRS Recommendations

Subject	Current Points	Action	Max. Potential Points
Outreach projects	60	Program for Public Information (PPI)	350
Levee	0	Emergency Levee Breach Plan	235
Map Information Service	30	Add details like erosion risks	90
Natural Floodplain Functions Plan	0	Develop a green infrastructure plan	100
TOTAL	90		775

The Army Corps of Engineering plan includes levees, so Union Beach could earn 235 points for creating an emergency levee breach plan.

Activity 320 is Map Information Service, for which Union Beach already earns 30 points. This activity is worth 90 points, so 60 more points could be earned if maps distributed to residents included not just flood zones but also additional risks like areas of high erosion or endangered species. Activity 350 is Flood Protection Information, and one part of this activity includes creating a Natural Floodplain Functions Plan. This plan would describe suitable locations for green infrastructure and suggest how green infrastructure could be implemented. Union Beach currently earns zero points for this activity, but creating a Natural Floodplain Functions Plan can earn up to 100 points. **Combined, these four suggestions alone could earn up to 685 points, and Union Beach only needs 454 points to achieve the next level of discounts.** There are numerous other CRS actions Union Beach could take to raise their score as well (National Flood Insurance Program Community Rating System Coordinator's Manual, 2017).

Conclusion

Similar to the rest of New Jersey's coastal communities, Union Beach will continue to face risks from sea level rise, storm surge, and flooding events. There seems to be an overall acceptance of this future, and a general consensus to take action from the town's leadership and from individual residents. However, based on the proposed redevelopment projects, we observed a strong dependence on the U.S. Army Corps of Engineers project being completed. Conversely we also heard a lack of confidence from some of the residents about the completion of the project within their lifetimes.

As a result, we saw an opportunity to incorporate additional components such as green infrastructure, nature-based defenses, and breakwater systems to supplement the original Army Corps design. This would ensure that the proposed project not only withstood storm surge, but additional hazards. These hazards include nuisance flooding, which would serve residents better in the long run by reducing damages, promoting social and economic well-being, increasing resilience, and in turn, reducing recovery time following a storm.

Union Beach has a unique opportunity ahead, it can learn from the collective experiences of coastal communities around New Jersey, take preventative measures to reduce future risks, damages, and losses from storms and flooding, and serve as a model for implementing nature based defenses, planning for coastal calamities, and set the bar higher for towns across the state.

This report identifies several ways that risks and vulnerabilities can be considered. By collaborating across academic programs and including input and perspectives from various stakeholders, our studio was able to get a glimpse of the complexities a vulnerable coastal community faces. It is our hope that Union Beach will be able to consider, expand upon, and build on parts of our report to keep Union Beach at the forefront of coastal resilience.

Table of Figures

References

Bilkovic et al. (2017) Living Shorelines: The Science and Management of Nature-Based Coastal Protection. CRC Press

Burket, W. H. (1998) Images of America: Union Beach. Charleston, South Carolina: Arcadia Publishing.

Chandra Putra, Handi. Real property market responses to coastal flooding. Retrieved from https://doil.org/doi:10.7282/T3Z89G7W

Climate-ADAPT. (2015). Storm surge gates/flood barriers. Retrieved from Climate-ADAPT: http://climate-adapt.eea.europa.eu/metadata/adaptation-options/storm-surge-gates-flood-barriers/#success_factors

Edward, B.B. et al. (2011) The value of estuarine and coastal ecosystem services. Ecological Monographs (2), 169.

FEMA. (2007). Chapter 5 - Barriers. In Selecting Appropriate Mitigation Measures for Floodprone Structures.

FEMA. (2017, December 14). National Flood Insurance Program: Flood Hazard Mapping. Retrieved from https://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping

Kopp, R.E., A. Broccoli, B. Horton, D. Kreeger, R. Leichenko, J.A. Miller, J.K. Miller, P. Orton, A. Parris, D. Robinson, C.P.Weaver, M. Campo, M. Kaplan, M. Buchanan, J. Herb, L. Auermuller and C. Andrews. 2016. Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel. Prepared for the New Jersey Climate Adaptation Alliance. New Brunswick, New Jersey.

Levin, M. J., Kim, K. J., Morel, J. L., Burghardt, W., Charzynski, P., & Shaw, R. K. (2017). *Soils within Cities Global approaches to their sustainable management - composition, properties, and functions of soils of the urban environment*. Stuttgart: Schweizerbartsche, E.

Listokin, D. (2006, August). How Lives in New Jersey? A Quick Guide to New Jersey Residents. Retrieved from http://nj.gov/state/planning/publications/177-who-lives-quick-guide.pdf

Miller, K. G., Kopp, R. E., Horton, B. P., Browning, J. V., Kemp, A. C. (2013) A geological perspective on sea-level rise and its impacts along the U.S. mid-Atlantic coast. Earth's Future. 1, 3-18.

National Flood Insurance Program Community Rating System Coordinator's Manual (2017). Retrieved December 18, 2017, from FEMA website: https://www.fema.gov/media-library-data/1493905477815-d794671adeed5beab6a6304d8ba0b207/633300_2017_CRS_Coordinators_Manual_508.pdf

New Jersey Department of Community Affairs. (2016). Demolition Permits Yearly Summary Data. Retrieved from http://www.state.nj.us/dca/divisions/codes/reporter/demo_permits.html

NJ Association of County Tax Boards. (2017). Assessment Records Search. Retrieved from: http://njactb.org/

NJ Department of Environmental Protection. (n.a.). Office of GIS.

NJ Department of Community Affairs. (2017). Property Tax Information, Retrieved from www.nj.gov/dca/divisions/dlgs/resources/property_tax.html.

Robert A Hulsart and Company. (2016). Borough of Union Beach Audit 2016. www.ubnj.net/ubnj/Administration/Financial%20Information/.

T&M Associates. (2014, April) Union Beach Borough Strategic Recovery Planning Report.

Retrieved from http://www.state.nj.us/dca/divisions/lps/SRPRs/Union%20Beach%20SRPR.pdf

Teague, K., Daniels, M., Pennington, J., & Brown, M. (n.d.). *Rain Gardens and Stormwater*. University of Arkansas.

Temmerman, S. and Kirwan, M.L. (2015) Building land with a rising sea. Science 349, 588-589.

United States Census Bureau. (2016). American FactFinder Community Facts. Retrieved fromfactfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t#none.

U.S. Army Corps of Engineers. (2015). *North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk*.

US Army Corps of Engineers - New York District. (2017). Raritan Bay and Sandy Hook Bay, New Jersey Hurricane Sandy Limited Reevaluation Report for Coastal Storm Risk Management.

U.S. Army Corps of Engineers Philadelphia District; New Jersey Department of Environmental Protection;. (2015). *Delaware River Basin Comprehensive Study - Interim Feasibility Study for New Jersey: Flood Risk Management Measures*.

U.S. Geographical Survey. NRCS.

Zidan, A., Rageh, O., Sarhan, T., & Esmail, M. (2012, December). Effect of Breakwaters on Wave Energy Dissipation (Case Study: Ras el-Bar Beach, Egypt). *International Water Technology Journal, 2*.