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BEVERLY CITY, NJ

# COASTAL VULNERABILITY

## ASSESSMENT REPORT



NEW JERSEY  
RESILIENT  
COASTAL  
COMMUNITIES  
INITIATIVE

Prepared for the City of Beverly by the Delaware Valley Regional Planning Commission; funded by the National Oceanic and Atmospheric Administration for the New Jersey Resilient Coastal Communities Initiative, managed by the New Jersey Department of Environmental Protection Office of Coastal and Land Use Planning



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# Executive Summary

Located along the Delaware River in Burlington County, Beverly City has historically been susceptible to the effects of coastal flooding (i.e., flooding along the tidal portions of the Delaware River shoreline and other tidal waterways), and the combination of rising tidal waters and increasing frequency of extreme weather events will continue to increase the risk of flooding events in the city over time.

In this project, Beverly City staff worked with the Delaware Valley Regional Planning Commission (DVRPC) to conduct a coastal vulnerability assessment (CVA), in which participants reviewed and prioritized future risks to the city from the combined effects of storm surge and sea level rise. The CVA used 2100 sea level rise projections (3.3 feet) in combination with a model that shows the depth and extent of storm surge from a Category 2 storm if it were to strike at high tide and at an angle and direction that maximized the amount of surge.

The CVA project team reviewed the impact of this “CVA scenario” on 15 assets in Beverly. Assets include properties, infrastructure, or natural resources that are of high value to the community and/or facilities and populations that might be particularly vulnerable to extreme events (see Table 1). The project team determined whether each asset would get flooded using the previously described flooding scenario, what would happen to the asset if it were to be flooded, and the consequences to the city if the asset were damaged or unable to function during a flood.

**Table 1:** Breakdown by Type for All Analyzed Assets

Asset Category	Count
Utility	4
Open Space	3
Transportation/Evacuation Route	2
Vulnerable Population	2
Institutional/Cultural/Government	2
Emergency Facility	2
<b>Total Number of Assets</b>	<b>15</b>

Beverly’s assets vary in their degree of vulnerability under the projected flood scenario described, although the analysis revealed five assets that Beverly should consider of high concern (Table 2).

**Table 2:** List of Asset Types Identified as High Concern

Asset Category	Count
Utility	3
Transportation/Evacuation Route	1
Open Space	1

The five assets of high concern include the city's municipal wastewater treatment facility (a utility asset), its sea walls along the Delaware River (utilities, specifically flood control structures), a storm drain at the intersections of Penn Street and Magnolia Street (utility), cul-de-sac roads that do not provide residents an alternative means of egress (transportation and evacuation routes), and publicly owned open space that is slated to be used for residential or mixed-use development (open space).



# Beverly CVA

## Introduction

The municipal CVA is a tool to help communities plan for flooding along their coastlines and tidal waterways and prioritize flood mitigation strategies, enabling them to better manage and recover from these floods. Every level of government—federal, state, and local—has a role in planning for stressors and threats likely to afflict its citizens. However, municipalities that have the tools to understand, predict, and prepare for the natural disasters that occur within their borders are arguably best poised to assist their constituents in reducing potential harms associated with climate hazards and extreme weather events.

The CVA assesses the degree to which a community’s “assets” (its properties, infrastructure, natural resources, and populations) will be affected by flooding from projected sea level rise and storm events. For those assets that are affected, the CVA analyzes the consequences that their temporary or long-term loss poses to the community. With this assessment, communities will be better informed to make decisions about land use planning, flood mitigation, sea level rise adaptation, infrastructure maintenance, capital improvements, and post-disaster recovery.

On August 28, 2015, Beverly City met with DVRPC, the region’s Metropolitan Planning Organization, to begin the CVA process. The project team used a CVA methodology created by Sustainable Jersey within the New Jersey Resilient Coastal Communities Initiative, a program run by the Office of Coastal and Land Use Planning in the New Jersey Department of Environmental Protection (NJDEP). NJDEP and Sustainable Jersey developed the methodology to help municipalities prepare for sea level rise and likely increases in the frequency of extreme storm events.

## Beverly’s Location

Beverly City encompasses 0.78 square miles in Burlington County, New Jersey. Located along the tidal Delaware River, Beverly will feel the effects of coastal sea level rise. At the same time, it will be affected by the more frequent and stronger storms anticipated in the northeastern United States. The combination of rising tidal waters, increasingly severe coastal storms, and more extreme precipitation events will increase the risk of flooding in the city over time.

The inland locations of several important facilities, including Beverly’s municipal building, public works facility, emergency operations facility at Firehouse No. 1, Hope House Fire Station No. 2, communications substations, fiberoptic vault, library, and local retirement home (Beverly Commons), protects them from coastal flooding. However, flooding from the Delaware River still poses a risk to several neighborhoods, especially to new construction and building rehabilitation projects planned as part of the city’s waterfront redevelopment strategy.

## Historical Flooding in Beverly City

Like other communities in New Jersey, Beverly City is susceptible to extreme precipitation events and potential flooding. The participants in the CVA commented that Beverly City already experiences regular flooding along the Delaware River, which is subject to tides of between eight and ten feet in this area that occasionally seep behind the city’s sea walls. These “sunny day” flood events are expected to increase with sea level rise.

According to CVA participants, Hurricane Irene (August 2011), Tropical Storm Lee (September 2011), and Superstorm Sandy (October 2012) were the storms that caused the most significant flooding in recent history. These storms caused flooding along the city's waterfront and neighborhoods farther inland, with Lee in particular saturating normally free-draining soils and causing groundwater seepage into homes. The city has a high water table relative to the surrounding area, and it is already strained with handling stormwater flow that comes downstream from Delanco Township and Edgewater Park Township, as well as from a county-owned pump station located south of the city.

To the knowledge of the CVA participants, the city has not faced a catastrophic—i.e. a “100-year”—flood event in recorded history. Communities north of the head-of-tide at Trenton along the Delaware River have experienced numerous devastating floods since the beginning of the 20th century, with eight major floods having occurred since 1996. However, the impacts of these floods were experienced from Trenton northward, where the river is not tidal and the water is confined to a narrower channel. While hydrographic data was not gathered for Beverly City for this report to confirm or deny this assertion, CVA participants indicated that the highest water levels experienced in Beverly were those associated with Hurricane Irene, Tropical Storm Lee, and Superstorm Sandy. The National Oceanic and Atmospheric Administration's (NOAA's) Burlington City tide gauge, which is located about three miles upstream of Beverly City along the Delaware River, shows that Superstorm Sandy had a maximum flood height of about 7.7 feet above mean sea level.

## Beverly City's Coastal Vulnerability

### Why a CVA is Relevant to Beverly City

The combination of sea level rise and increases in the intensity and frequency of coastal storms caused by climate change will introduce new vulnerabilities in Beverly that the city will need to address.

Since 1900, the sea level has risen approximately one foot in the tidal Delaware River.<sup>1</sup> Climate change will continue to cause an accelerating rate of sea level rise and increases in the intensity of severe storm events in the coming decades. The following is a summary of the expected coastal and riverine flooding changes in New Jersey, assuming global greenhouse gas emissions trends continue as they are today.

### Sea Level Rise

In New Jersey, the most recent sea level rise central estimate (meaning that the estimate has a 50 percent probability of being met or exceeded) is 1.4 feet from current sea levels by 2050, and 3.4 feet from current levels by 2100 assuming current rates of emissions continue.<sup>2</sup>

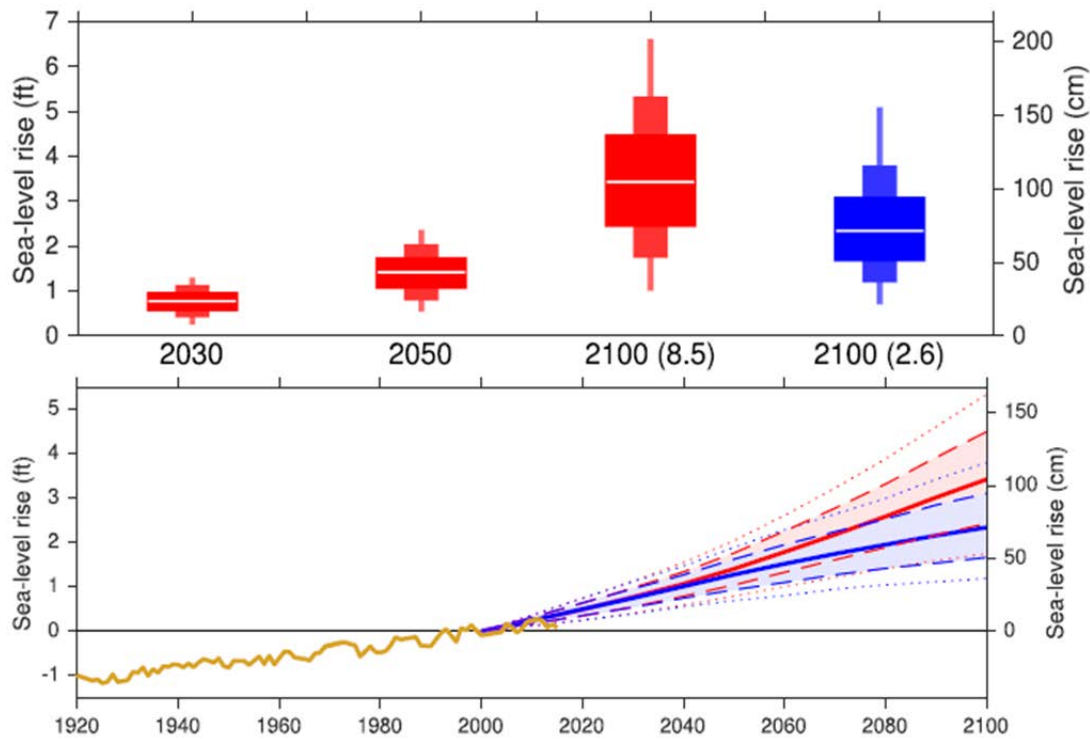
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<sup>1</sup> Radley Horton et al., “Ch. 16: Northeast,” in *Climate Change Impacts in the United States: The Third National Climate Assessment*, ed. J. M. Melillo, T. C. Richmond, and G. W. Yohe (U.S. Global Change Research Program, 2014), 373, accessed January 9, 2017, [pubs.giss.nasa.gov/docs/2014/2014\\_Horton\\_ho06500e.pdf](https://pubs.giss.nasa.gov/docs/2014/2014_Horton_ho06500e.pdf).

<sup>2</sup> R. E. Kopp et al., *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, NJ: Rutgers University, October 2016), 2.

Figure 1 shows sea level rise projections for New Jersey at Atlantic City in 2030, 2050, and 2100. In the top chart, the box-and-whisker plots indicate sea level rise projections. In 2030 and 2050, the projections are the same for the low- and high-emissions scenarios (Representative Concentration Pathways [RCP] 2.6 and 8.5, respectively). In 2100, the red box-and-whisker plot indicates the sea level rise projection for the high-emissions scenario (RCP 8.5), and the blue box-and-whisker plot indicates sea level rise projections for a low-emissions scenario (RCP 2.6).

**Figure 1:** Sea Level Rise Projections for New Jersey in 2030, 2050, and 2100



Source: Kopp et al., 2016

The white line across the middle of each box-and-whisker plot denotes the 50th percentile value (the value that has a 50 percent probability of occurring). For example, in 2050, the white line is located at 1.4 feet. Looking above the white line, again for 2050 as an example, there is a 33 percent chance that sea level rise will be between 1.4 and 1.8 feet, a 12 percent chance that sea level rise will be between 1.8 and 2.0 feet, and a 4 percent chance that sea level rise will be above 2.0 feet. The same probabilities exist for three sets of sea level rise values below the white line of the box-and-whisker plot.

In the bottom chart, the gold-colored line indicates observed tide-gauge heights. Solid red and blue lines are the 50th percentile projection for the high-emissions (RCP 8.5) and low-emissions (RCP 2.6) scenarios, respectively. Dashed lines are 17th–83rd percentile projections, and dotted lines are 5th–95th percentile projections, with blue and red shading showing the ranges for, and distinguishing between, the low- and high-emissions scenarios.

The data presented in this report are the result of research conducted in 2016 by the New Jersey Climate Adaptation Alliance Advisory Committee, a consortium of respected climate researchers led by a team at Rutgers University.<sup>3</sup>

Scenes from the aftermath of severe coastal storms, such as Superstorm Sandy, demonstrate the potential adverse impacts of storm surge and coastal flooding on the basic functioning of municipalities, their businesses, and their residents. While coastal storms can strike at any time, sea level rise will exacerbate their impacts. Absent any changes in storms, a two-foot rise in sea level, which New Jersey is likely to experience by 2100, would more than triple the frequency of dangerous coastal flooding in the region.<sup>4</sup>

### Coastal Storms and Storm Surge

Flooding from storm surge occurs when winds associated with strong coastal storms drive water onto land. This is the exact process that produced extreme flooding on the Atlantic Coast of New Jersey during Superstorm Sandy. The tidal Delaware River did not experience the same levels of storm surge during Superstorm Sandy, but it could have happened if the storm had taken a different track.

Unlike sea level rise, storm surge is a temporary condition. However, storm surge can happen at any time, and the potential height of water pushed onto land in the Delaware River region from a strong storm is much greater than the projected amount of sea level rise. For example, storm surge heights during Superstorm Sandy exceeded 10 feet in some parts of northern New Jersey and New York, three times the median amount of projected sea level rise by 2100.

While the future frequency and intensity of coastal storms cannot be predicted with certainty, the warming in the atmosphere and oceans associated with climate change is likely to increase the intensity of coastal storms, particularly in the latter part of the 21st century.<sup>5</sup>

### Riverine Flooding

While this report focuses primarily on coastal flooding, riverine flooding cannot be ignored. It poses an even greater threat for some neighborhoods in Beverly City, including the area along Railroad Avenue and Manor Road, which includes such critical municipal facilities as the Beverly Edgewater Park Emergency Squad building, the Beverly City Elementary School, and the American Legion building. The area around Bridgeboro Road in Edgewater Park Township also floods; although it is outside Beverly's borders, flooding at this location has the potential to block egress from the city along its Broad Street evacuation route.

Beverly currently uses the Federal Emergency Management Agency's (FEMA's) 100-year floodplain map (or "Flood Insurance Rate Map" [FIRM]) to evaluate the threat of riverine flooding. The city's FIRM is so called because it shows the flooding expected (based on historical patterns) from a storm that has a 1 percent chance of occurring in any given year.

The city should continue to use this map for that purpose but at the same time should recognize that the frequency of storms with heavy downpours is projected to increase as a result of climate change.<sup>6</sup> As

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<sup>3</sup> Ibid.

<sup>4</sup> Horton et al., 374.

<sup>5</sup> NOAA, "Geophysical Fluid Dynamics Laboratory," in *Global Warming and Hurricanes: An Overview of Current Research Results*, accessed March 17, 2017, [www.gfdl.noaa.gov/global-warming-and-hurricanes/](http://www.gfdl.noaa.gov/global-warming-and-hurricanes/).

<sup>6</sup> Horton et al., 374.

products and models become available to project the spatial extent of this evolving threat, they should be evaluated by city officials.

## Current Preparedness for Flooding

### Land Use

Fortunately for Beverly, the majority of assets in the city are located inland, away from its waterways and at a sufficiently high elevation to avoid widespread damage. Furthermore, much of the land that is predicted to flood in future decades, which is concentrated to the northwest of the city along the Delaware River, is open space (see Figure C3 in Appendix C). This open space is predominately wetland habitat, which is likely to be more resilient to flooding than the city's built environment and in fact protects inland neighborhoods from experiencing the full force of a coastal flood.

### Infrastructure Projects

Beverly City has employed several infrastructural strategies to manage coastal flooding along the Delaware River, including constructing sea walls along the river, elevating key infrastructure at the municipal wastewater treatment plant, and purchasing portable equipment. The city conducted a study to determine the volume of stormwater being pumped into and through the city by the Burlington County Pump Station, which helped the city determine its stormwater system's risk to being incapacitated by upstream flow. Beverly City is working with Burlington County to tie drainage systems together in order to reduce stormwater backup and give the total drainage system more redundancy. The city has also studied flooding effects at one of its most vulnerable assets, its wastewater treatment plant, and there is a protocol in place for preparing for floods at this facility.

The city would like to do more, but it is challenged to balance its annual municipal budget, making the act of investing in new or updated infrastructure a goal that must be deferred.

### Emergency Operations Procedures

Guided by the city's FEMA-approved hazard mitigation plan, Beverly officials and staff feel prepared for flood emergencies. Officials and emergency response managers have multiple means of city-wide communication available. Beverly uses the Swift911 emergency notification system, which enables communications through phone, text, or email and for which residents have to register. The city also uses NJ Register Ready, a county-wide registration program for residents with limited mobility or other impairments that would make emergency evacuation more challenging. The city has the capacity to evacuate residents, but to date, evacuation has not been needed. A few residents voluntarily self-evacuated in preparation for Hurricane Irene and Superstorm Sandy. City staff has also informally provided elderly residents with extra assistance, going door-to-door and helping them find shelter.

Beverly's Office of Emergency Management website contains information on disaster planning and links to the National Severe Storms Laboratory's Severe Weather 101 Guide, Ready.gov's basic disaster supplies list, the National Hurricane Center's hurricane preparedness resources, home emergency and disaster safety information from Improvenet, and flood protection advice for homes from Redfin Real Estate. The website also lists city staff and official contact information.

## Vulnerable Populations

Beverly City has a population of approximately 2,569 (2015 5-Year American Community Survey [ACS]), and a density of 3,294 residents per square mile. There are several populations that may need additional assistance in the event of a storm, but as indicated in the “Current Preparedness” section above, the city continues to demonstrate its desire to ensure that all citizens are given the assistance they need before, during, and after storms.

### Households in Poverty

Beverly has a comparably larger proportion of low-income residents that may lack resources to prepare for, respond to, or recover from an emergency. The city’s poverty level in 2015 was 15.0 percent, which was above the state average of 10.5 percent and the county average of 6.25 percent within the same time period.<sup>7</sup> Several properties owned by the Beverly Housing Authority, which are home to low-income residents, are located within the area that is predicted to flood.

### Residents with a Disability

In 2015, 17.8 percent of residents reported having a disability, which was substantially higher than the state and county percentages of 10.3 percent and 11.0 percent.<sup>8</sup> These residents may have particular mobility and medical care needs in an evacuation.

### Homeowners and Renters

In 2015, 68.7 percent of residents reported owning their homes, which is lower than the 76.5 percent reported by Burlington County residents but higher than that reported in New Jersey (64.5 percent).<sup>9</sup> Renters have less ability to repair their homes following a disaster, so while the majority of the city’s residents, as homeowners, are more secure in this regard, there is still a substantial portion of households that, as renters, are more at risk of displacement following a severe storm.

### Limited English Speakers

In 2015, 3.0 percent of Beverly City residents reported that they spoke English “not well” or “not at all,” which is higher than that reported for Burlington County (1.7 percent), although not for New Jersey (6.3 percent).<sup>10</sup> This population may need additional outreach to enable them to understand threats associated with incoming flooding, what is required for them to prepare, what resources are available to avoid harm, and what assistance can help with recovery from these events.

### Seniors

In 2015, 18.1 percent of Beverly City residents were elderly, which is relatively lower than the state and county percentages of 20.2 and 21.0 percent.<sup>11</sup> Nevertheless, as with residents with a disability, seniors may also have particular mobility and medical care needs in an evacuation.

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<sup>7</sup> U.S. Census Bureau, “B17017: Poverty Status in the Past 12 Months by Household Type by Age of Householder,” 2011–2015 ACS 5-Year Estimates.

<sup>8</sup> U.S. Census Bureau, “B18101: Sex by Age by Disability Status,” 2011–2015 ACS 5-Year Estimates.

<sup>9</sup> U.S. Census Bureau, “B25044: Tenure by Vehicles Available,” 2011–2015 ACS 5-Year Estimates.

<sup>10</sup> U.S. Census Bureau, “B16004: Age by Language Spoken at Home by Ability to Speak English for the Population 5 Years and Over,” 2011–2015 ACS 5-Year Estimates.

<sup>11</sup> U.S. Census Bureau, “B01001: Sex by Age,” 2011–2015 ACS 5-Year Estimates.

## Carless Households

Approximately 4.1 percent of households in Beverly City did not own cars in 2015, which is higher than the county's reported value (1.5 percent) and the state's value (2.4 percent).<sup>12</sup> Carless households face challenges in evacuating before a storm by relying on alternative modes of transportation. However, the majority of residents (95.9 percent) have cars and thus more options to evacuate before an emergency.

CVA participants noted that low-income residents, elderly residents, and residents with physical disabilities are scattered through the community rather than clustered in an area predicted to be prone to coastal flooding, with the exception of those living in several properties owned by the Beverly Housing Authority. As a result, the city does not need to evacuate large neighborhoods of highly vulnerable residents. And while Beverly has relatively larger numbers of at-risk populations to assist before, during, and after a storm, the city has the procedures mentioned previously in place to help them.

## Scenarios

The flood scenario used in this CVA shows the result of storm surge generated by a Category 2 storm plus sea level rise projection of 3.3 feet by 2100.<sup>13</sup> Storm surge was modeled using NOAA's SLOSH (Sea, Lake, and Overland Surge from Hurricanes) model and shows what would happen if a Category 2 storm were to strike the Delaware Bay at an angle that would maximize storm surge at high tide. In other words, this is a "worst case scenario" for a Category 2 storm in the tidal Delaware River. **This flooding scenario will be described in this report as the "CVA scenario."**

Notably, the inundation resulting from the combined sea level rise and storm surge depicted in the CVA scenario closely resembles the 1 percent/100-year flooding extent. Figure 2 demonstrates this similarity in the northwest corner of Beverly City. FEMA uses the 1 percent scenario in its FIRMs, and Beverly uses these maps for planning purposes. Because the extent of flooding from sea level rise in 2100 during a Category 2 storm is similar to the extent of the city's FEMA floodplain, the authors determined that the CVA scenario was not overly pessimistic or of such a low probability as to not warrant modeling. Furthermore, the storm surge heights expected in a modeled Category 2 storm are certainly possible, as was experienced in northern New Jersey during Superstorm Sandy.<sup>14</sup> Since storm surge heights associated with a Category 3 or Category 4 storm are less likely, the authors of this report determined that these are not scenarios for which municipalities should focus their planning efforts.

Flood depths were determined using a baseline elevation derived from Light Detection and Ranging (LiDAR) data.<sup>15</sup> The storm surge modeling and the baseline elevation layers were developed state-wide by NJDEP and layered on maps developed by DVRPC. The maps for this study are in Figure 2 and Appendix C.

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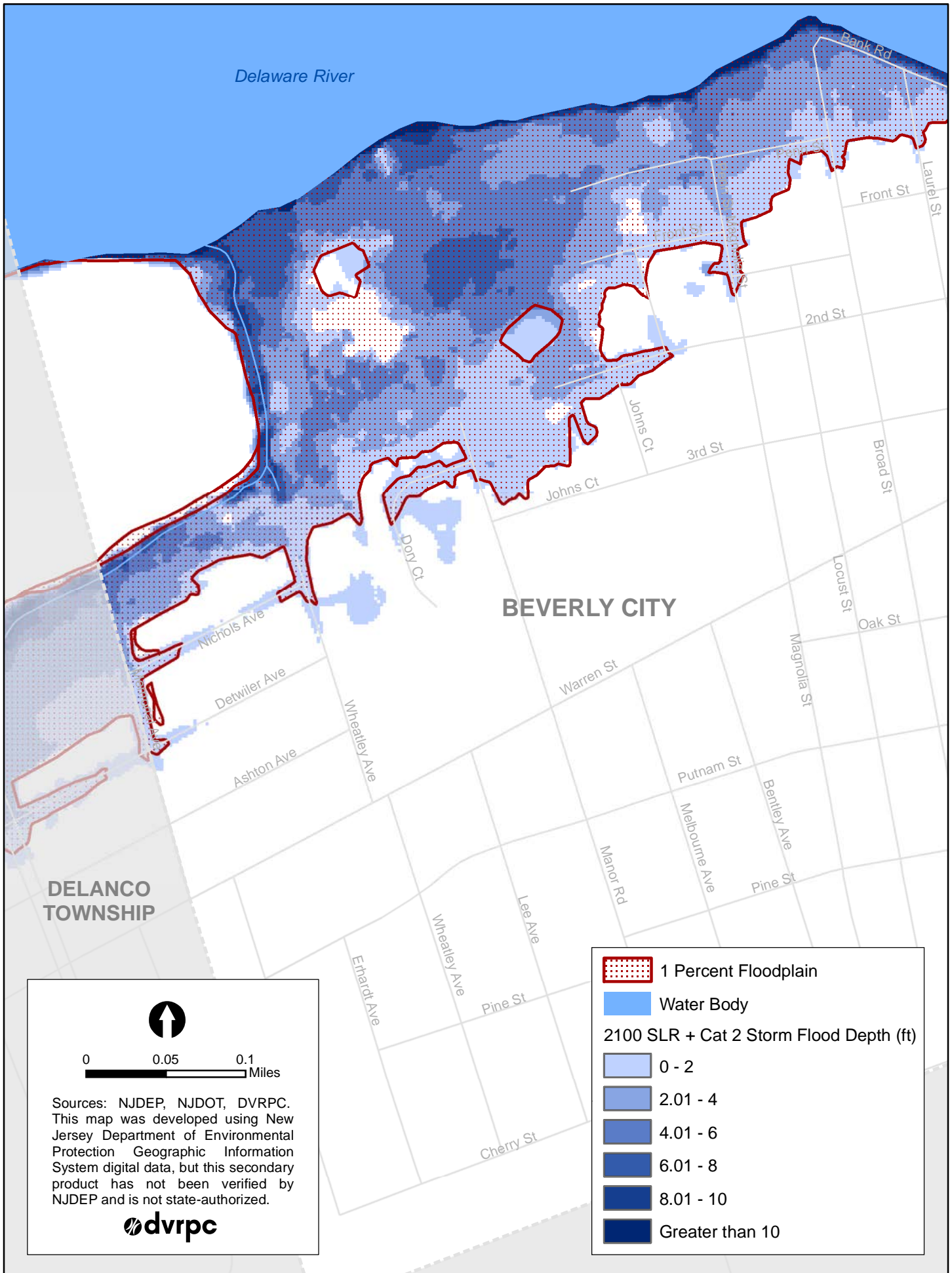
<sup>12</sup> U.S. Census Bureau, "B25044: Tenure by Vehicles Available," 2011–2015 ACS 5-Year Estimates.

<sup>13</sup> The 3.3-foot figure was from a report produced by the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel that predates the current report. The 3.3-foot figure was already built into the maps and models by the time the report with the 3.4-foot median estimate was produced.

<sup>14</sup> The storm surge experienced in Sandy Hook in northern New Jersey during Superstorm Sandy was approximately 8.5 feet above mean higher high water. This height is commensurate with what the SLOSH model would predict for a Category 2 hurricane striking the area. Sandy was not technically a hurricane when it made landfall in New Jersey, but the storm's large wind field and low pressure generated a storm surge that would normally be associated with a Category 2 hurricane according to predictive modeling.

<sup>15</sup> Note that the projected flood events used in this assessment were generated by several models prepared by state and national agencies and professionals, and are suitable for planning purposes. However, due to the uncertainty of projections and accuracy of certain types of data, the maps should not be the sole resource for conducting site-specific analyses.

Figure 2: Northwest Corner of Beverly City and 1 Percent Floodplain





## Assessing Vulnerabilities

### Methodology

On August 28, 2015, DVRPC staff met with Beverly City staff (listed in the Acknowledgments section) to discuss the city's past vulnerabilities to flooding. On January 28, 2016, the group convened a second time to discuss the city's critical assets and conduct the CVA. This group examined the vulnerability of 15 "assets," which are properties, infrastructure, or natural resources that are owned by the city or have high value to the community, as well as vulnerable populations located within the city. The assets are evaluated using a three-step process:

1. Community assets are identified, mapped, and compared with maps of flooding for selected flood scenarios to determine if they will be exposed to flooding or not.
2. The sensitivity of individual assets is determined. *Sensitivity* is shorthand for the impact of flooding on an asset. For example, a flooded basketball court will be relatively unimpacted after floodwaters recede, while paper documents in a repository will likely be permanently destroyed if they were exposed to flooding. While this is a clear-cut example, the sensitivity of many types of assets, such as a downtown building or shopping center, is challenging to determine with much specificity.
3. The consequence is determined by the potential effects on the community from temporary, long-term, or permanent damage to each individual asset.

### Identifying and Mapping Community Assets

The CVA relies on Geographical Information Systems (GIS) maps to locate and analyze community assets and flood hazards. Community assets are identified among three categories—Built Environment, Natural Environment, and Vulnerable Populations—and are plotted using GIS. DVRPC mapped assets and plotted them against the CVA scenario to determine whether they would be exposed to flooding.

### Evaluating Asset Sensitivity and Vulnerability

*Sensitivity* is the degree to which an asset may become affected by predicted floodwaters. *Vulnerability* is the product of exposure and sensitivity. If an asset is exposed to flooding *and* it is sensitive to flooding, then it is vulnerable. The level of vulnerability is thus a function of the level of sensitivity of an asset. In other words, an asset that is exposed to flooding and is highly sensitive to flooding would be highly vulnerable, while an asset that is exposed and moderately sensitive would be moderately vulnerable. Assets that are not exposed are not vulnerable, regardless of their sensitivity.

For each asset, vulnerability was categorized as insignificant, low, moderate, or high. A description of the categories can be found in Appendix B. When there was insufficient information to determine the exact vulnerability ranking for an asset, a range was used.

### Evaluating the Consequences of Asset Damage

*Consequence* is the effect on the community if an asset is temporarily or permanently damaged or impaired by flooding. Consequence is ranked as insignificant, minor, moderate, or high for each asset. A description of the meaning of each ranking can be found in Appendix B.

## Analysis and Findings

Beverly’s CVA examined 15 assets, which were listed by type in Table 1 (page 1).

The CVA indicates that most assets in Beverly will not likely sustain many significant impacts from the combined effects of a Category 2 storm surge and sea level rise in 2100. Beverly has a high elevation relative to its tidal waterways, and development is mostly located inland on these higher elevations, which increases the resiliency of its assets to flooding. As mentioned previously, much of the area that is predicted to flood is open space. Nevertheless, there are some assets in Beverly that are vulnerable to potential flooding.

### Assets of High Concern

Five of the assets examined by this CVA were determined to be assets of high concern. These assets are the most vulnerable to flooding of the total examined and have the greatest consequences to the city should they become damaged.

Table 3 shows the vulnerability and consequences ratings for those assets. The highest vulnerability and consequences ratings belong to the city’s wastewater treatment plant. Two sets of assets, the city’s sea walls and its storm drain, are highly vulnerable, but the consequences of their damage are limited to several neighborhoods. Several cul-de-sac streets are intrinsically not vulnerable, but their flooding could make evacuation difficult for some homeowners. The flooding at the western end of Penn Street could restrict access to the wastewater treatment plant. The publicly owned parcels along the Delaware River are not at risk presently, but any new construction on them could become highly vulnerable. For the full asset matrix, see Appendix A.

**Table 3:** Overview of Assets Identified as High Concern

Assets of High Concern				
Asset Name	Asset Category	Exposure (Flood Depth)	Vulnerability	Consequences
<b>Cul-de-Sac Streets near Wetland</b>	Transportation (Streets)	2nd St: 0–2.8 ft Dory Ct: 0–1.6 ft Front St: 0–3.0 ft Johns Ct: 0–0.5 ft Penn St: 0–4.3 ft	Low	High for Penn Street; Minor for other roads
<b>Municipal Wastewater Treatment Facility</b>	Utility (Wastewater Treatment Plant)	2.9–4.6 ft	High	High
<b>Publicly Owned Planned Residential Parcels</b>	Open Space and Habitat (Open Space)	0–4.0 ft	Insignificant with current use; Insignificant to High with proposed use(s)	Insignificant with current use; Minor with proposed use(s)

Assets of High Concern				
Asset Name	Asset Category	Exposure (Flood Depth)	Vulnerability	Consequences
Sea Walls	Utility (Flood Control Structure)	3.0–11.1 ft	High	Minor
Storm Drain	Utility (Stormwater Conveyance Structure)	0–4.0 ft	High	Minor

**Cul-de-Sac Streets near Wetland**

Several roads near the drainage channel and dredge spoils in the northwest part of the city are dead ends or cul-de-sacs. As such, they do not provide an alternative means to evacuate in the event of the flooding projected in the CVA scenario. Projected flood exposure in these areas ranges from 0.5 feet to 4.3 feet. The upper range of those depths would slow or prevent egress from multiple households during storms, some of which (particularly along Dory Court and Johns Court; see Figure 3) already regularly flood. Fortunately, flood depths on the parcels *along* these streets are expected to be minimal in the CVA scenario, and the city can further minimize risk by helping residents evacuate before major storms.

Flooding at Penn Street was assigned a high consequences rating because at over four feet, it could prevent municipal staff from reaching the wastewater treatment plant in order to resolve flood-based damages to the plant.

**Figure 3:** The Cul-de-Sac at John’s Court



Source: Google Maps, September 2013

## Municipal Wastewater Treatment Facility

Located on the waterfront, this asset treats wastewater for both Beverly City and Delanco Township (Figure 4). The facility currently experiences flooding during storms, and the parcel on which it is located will face greater depths—between 2.9 and 4.6 feet—in the CVA scenario. The city has determined that flood depths as low as one foot could impede the functioning of the plant, as floodwater could reach the facility’s chlorine contact tanks, make contact with wastewater that has not completed the chlorination process, and potentially carry that untreated wastewater out onto the property and downstream. Additional problems include flooding of homes and streets. With flood depths of between two and four feet, the plant would lose both primary and emergency power. The closure of the plant would affect the entire city and neighboring Delanco Township.

The city is aware of the plant’s vulnerabilities, has already studied the effects of flooding on the plant, and has a protocol in place for preparing for floods. Staff have mounted the plant’s transformers above expected flood heights and purchased portable diesel pumps to address more frequent nuisance flooding.

While the city has plans for additional improvements, these upgrades are expensive, and with many residents delinquent on their sewer bills—CVA participants reported being \$87,000 below expected income in 2016—any improvements to the plant will require external funding.

**Figure 4:** Beverly City Wastewater Treatment Facility



Source: Google Maps, September 2013

## Publicly Owned Planned Residential Parcels

Beverly City owns two parcels adjacent to the Delaware River (Figure 5), which it plans to develop as residential or mixed-use. Up to four feet of flooding is anticipated on the parcels in the CVA flooding scenario. When the parcels are developed, the new construction may be highly vulnerable, depending on the developer's choice of site plan and building design. The city plans to require parking on the first floor and use the baseline NJDEP rules for construction in a floodplain.

**Figure 5:** A View of Beverly's Waterfront Parcels from the Northeast



Source: Google Maps, September 2013

## Sea Walls

Beverly owns two sea walls along the Delaware River that protect inland properties by preventing soil erosion.

**Figure 6:** Sea Wall at Van Sciver Street



Source: City of Beverly, May 2013

Both sea walls may face flood depths of up to 11.1 feet in the CVA scenario, but the walls are already subject to being overtopped during storm events. They also experience minor structural damage from riverine flooding. If the sea walls were damaged or destroyed, their loss could cause further erosion along the coast. Erosion could damage Veterans Drive, Van Kirk Street, and Van Sciver Street (Figure 6). Neighborhoods behind the walls would be affected, although it is unlikely that serious damage to buildings would occur, as they are set back from the waterfront.

### Storm Drain

One of the city's storm drains, located at the intersection of Penn Street and Magnolia Street (Figure 7), is projected to receive up to four feet of water in the CVA scenario. This drain currently gets backed up during storms, causing additional flooding in the blocks surrounding it. Increased flooding would further impede its ability to function, yielding additional flooding upstream in neighborhoods adjacent to the storm sewer system, most notably low-income properties in the Beverly Housing Authority development.

**Figure 7:** Storm Drain at Penn and Magnolia Streets



Source: Google Maps, September 2013

A full table showing the exposure, sensitivity, and consequences of all assets can be found in Appendix A of this report. Appendix C shows a map of all listed assets superimposed with the CVA scenario.

### Municipal Assets of Lower Risk

The remaining (lower-risk) assets are fairly evenly distributed among the categories of Institutional/Cultural/Government, Emergency Facility, Open Space/Habitat, Vulnerable Populations, Utility, and Transportation. Five of these assets, including the Beverly City Elementary School; fire department; police department; St. Joseph's School/Beverly City School District business office; and Beverly Commons, a retirement home, are not in areas likely to flood.

The most vulnerable of the municipal assets not listed as areas of high concern are the Beverly Housing Authority-owned properties located in a flood-prone area. Of the 19 buildings managed by the Authority, seven may become entirely flooded, but with relatively low depths. Six buildings will likely not be flooded, but

egress from the parcel may be made difficult by flooding of approximately one foot on sidewalks. An additional six buildings will likely be out of harm's way, and egress will not be a concern.

While the assets in the Park/Open Space category are in flood-prone areas, the consequences for their flooding are considered minor.

Table 4 combines the vulnerability and consequences rating to show the overall risk rating for all assets not considered to be of high concern. Six assets are considered to be “out of harm’s way” because they are not predicted to be exposed to flooding in the CVA scenario. The remaining four assets were assigned to the minor or moderate risk categories.

**Table 4:** Breakdown of Remaining Assets by Degree of Risk

Rating	Number of Assets
Out of Harm’s Way	6
Minor Risk	1
Moderate Risk	3
<b>Total</b>	<b>10</b>

## Recommendations for Beverly’s Assets

Because not many of its assets are vulnerable in the CVA scenario, Beverly does not need to implement many adaptation measures immediately. However, action is particularly important for the assets considered to be of high concern. The asset-specific recommendations below are derived from DVRPC’s introductory meeting and CVA session with Beverly City. Recommendations are organized by degree of importance.

### Cost-Benefit Analysis for Protecting the Wastewater Treatment Facility

Because of the wastewater treatment facility’s vulnerable location on the Delaware River, and its importance to Beverly City and Delanco Township, the facility is a high-priority project for protecting. The city has already conducted studies and undertaken initial work to protect components of the facility or move them out of harm’s way. Ultimately, however, the entire wastewater treatment facility can only be protected by creating a berm around it or by moving it inland and out of harm’s way. These two options are long-term projects that require substantial planning and funding to execute. The city’s first step toward determining the preferable option is to conduct a cost-benefit analysis to determine which option yields better results for the community.

### Site Planning

Beverly City owns two parcels along the Delaware River that are planned for residential or mixed-use development. These parcels are in the floodplain and are highly susceptible to flooding in the CVA scenario; new construction may face flood levels of up to four feet.

Beverly is aware that these parcels have experienced flooding in the past, and the city plans to require that the developers of these parcels place parking areas on the first floor of any future buildings in order to elevate occupied floors above the base flood elevation. Otherwise, they plan to use the NJDEP’s existing rules for

construction in a floodplain. However, these rules may not sufficiently protect against the floods anticipated in the CVA scenario.

The city should further reduce risk on these parcels by requiring the following:

- construction only on the southern half of the lots, which are projected to receive less flooding;
- incorporation of durable materials that can handle floods on the first floor; and
- elevation of essential building systems four feet above ground level at the site, which could include electrical systems; plumbing systems; heating, ventilating, and air conditioning systems; or any specialized equipment or equipment that is expensive or that takes a long time to replace.

To keep anticipated tax rates while reducing flood risk on the two parcels in the long term, Beverly could also subdivide each parcel into two lots: a northern lot that will have more exposure to flooding and a southern lot that will have less exposure. The city could then develop the two southern lots while permanently preserving the two northern lots as open space, park land, or as a waterfront promenade. These northern waterfront parcels would serve as an amenity for Beverly City residents while reducing the risk of flood damage to future development.

These strategies, in combination with the “Zoning Strategies” recommendation discussed below, will help provide additional protections for development on these parcels.

### Ascertain the Structural Vulnerability of Assets

Beverly’s sea walls and several Beverly Housing Authority-owned properties are projected to be vulnerable to flooding from sea level rise and coastal storms. However, the sensitivity of these structures to flooding depends on variables that the city has yet to measure or document. Beverly should determine the sensitivity of these assets to flooding conditions predicted in the CVA scenario in order to determine their true degree of vulnerability.

### Partnerships with Other Entities

Beverly City should partner with Delanco Township, Burlington County, and neighboring municipalities to address three flooding issues in Beverly:

- Because Delanco uses Beverly’s wastewater treatment facility, Delanco should be involved in efforts to protect it from future flood hazards as described above.
- Burlington County owns a pump station that contributes additional volume to Beverly’s storm sewer system. Accordingly, actions to address this problem should involve the county.
- Development in upstream municipalities exacerbates excessive stormwater runoff and flooding in Beverly. Beverly and its neighbors should work together to mitigate stormwater runoff in their watershed. NJDEP’s Office of Stormwater Management could be a resource in establishing a partnership.

### Land Conservation

Beverly City should work with the landowner of the wetland habitat that is predicted to receive the majority of the city’s floodwaters to preserve it as open space or recreation space. Green Acres, Blue Acres, the Nature



Conservancy, the Trust for Public Land, and the New Jersey Conservation Foundation are potential sources of funding for acquisition or easements.

## Outreach and Assistance for Residents in Cul-de-Sacs or Dead-End Roads

As mentioned previously, there are several roads in the city that have dead ends or cul-de-sacs that may be affected by flooding. The city should prioritize outreach for flood preparedness and disaster assistance to the residents living along those streets, particularly those in the properties owned by the Beverly Housing Authority. The city could also work with residents of these streets to ensure that the residents have emergency plans so that they can evacuate the area as necessary. The city could assign “block captains” as liaisons to educate their neighbors on risks, work with the city to help residents evacuate before severe storms, and reach out to new residents in the neighborhoods at risk.

## General Recommendations

The general recommendations below are organized by degree of importance within each subcategory. They are derived from the Getting to Resilience reports written by the Jacques Cousteau National Estuarine Research Reserve (JCNERR).<sup>16</sup> JCNERR wrote these reports for municipalities that completed the Getting to Resilience questionnaire, which is a set of questions posed to municipalities about their past and ongoing work to plan for and respond to coastal flood hazards. The reports offer recommendations based on the municipality’s responses to the questionnaire.

### Planning

#### Incorporating Coastal Hazards in Plans and Regulations

Beverly should include information discussed in the CVA, particularly the flood projections and depths caused by sea level rise and storm surge, in municipal plans and ordinances. These documents may include (but are not limited to) the municipal master plan, all hazards mitigation plan, emergency response plan, zoning ordinance, subdivision and land development ordinance, and stormwater management ordinance. For example, Worcester County, Maryland, created a comprehensive plan that incorporates coastal hazards throughout the entire document.<sup>17</sup>

#### Long-Range Planning for Coastal Flooding

Beverly should begin a community-wide planning process to prepare for the long-term effects of storm surge and sea level rise at time scales that extend beyond the standard 20- or 25-year planning horizon. This process will help the community prepare for the gradual, but steadily increasing, rates of sea level rise expected in the ensuing decades. Actions may include decisions to avoid long-term capital investments in areas that may be affected by sea level rise in 30 or 50 years.

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<sup>16</sup> New Jersey Resilient Coastal Communities Initiative, *Case Studies*, accessed November 1, 2017, [www.prepareyourcommunitynj.org/case-studies/](http://www.prepareyourcommunitynj.org/case-studies/).

<sup>17</sup> Worcester County, Maryland, *The Comprehensive Development Plan*, March 14, 2006, [planning.maryland.gov/PDF/OurWork/CompPlans/Worcester/06\\_CMP\\_Worcester.pdf](http://planning.maryland.gov/PDF/OurWork/CompPlans/Worcester/06_CMP_Worcester.pdf).

## Capital Improvements Plan or Hazard Mitigation Plan

Beverly should incorporate flood mitigation projects into a municipal capital improvements plan or hazard mitigation plan. In doing so, the city can add these projects to an existing “funding pipeline” and make it easier for these projects to be funded and implemented.

## Regulations

### Zoning Strategies

Zoning ordinances can be used in a variety of ways to protect community assets against flooding. For example, zoning ordinances can be used to regulate setbacks from rivers and streams, increase base flood elevations for buildings, and set requirements for stormwater management. In particular, Beverly could create a zoning overlay in floodplain areas, or update the existing zoning code, to require new construction, renovations, and/or flood-sensitive building systems to be elevated above the flood heights predicted in the CVA scenario.

### Building Codes

By updating the building codes that regulate building design, construction, and landscaping, Beverly can improve the ability of structures in flood-prone areas to withstand future floods.

## Programs and Projects

### Buying Out Floodplain Properties

The most effective way to reduce losses from flooding is to acquire improved flood-prone properties, both land and structures, demolish or relocate the structures, and restrict future development on the land with a conservation easement. Repetitive loss properties that are also threatened by future sea level rise should be a priority for potential buy-outs. In cases of properties where unimproved portions of the parcel are expected to be flooded, an easement rather than a fee simple acquisition may be more appropriate.

### Restoring Floodplain Parcels to Natural Conditions

Beverly City should return any properties within flood-prone areas that were acquired through Blue Acres or other land conservation programs to natural floodplain conditions. As a municipality nears buildout, and Beverly is no exception, there are increasingly limited areas of land left that still perform natural floodplain functions. Returning lands to natural floodplain functions can be accomplished by restoring wetlands, planting natural vegetation, reducing sediment compaction, and creating a more natural elevation profile. Funding for this type of project is often available through FEMA grant programs.

### Stormwater Management

Because Beverly has a low elevation and relatively flat terrain, stormwater drainage is a problem for the city and will continue to be so as sea level rise causes the base water level in the Delaware River to increase over time. Beverly should maximize the capture, storage, and infiltration of stormwater in locations outside of the flood zone to alleviate localized flooding and ponding. Green stormwater infrastructure, and other

infrastructure that uses living plants to treat stormwater onsite, is an excellent approach to improving stormwater management and limiting minor flooding during less severe rainfall events.

### Community Rating System

Because several residential neighborhoods in Beverly are located in the FEMA floodplain and may experience significant, potentially damaging floods in the CVA scenario, Beverly should consider participating in FEMA's Community Rating System program to help reduce these property owners' flood insurance premiums. By participating in this voluntary program, Beverly will also have the opportunity to improve its floodplain management practices and make its floodplains safer.

### Living Shorelines

The city should consider living shorelines as an alternative to hard shore protection structures in efforts to restore, protect, and enhance the shoreline and its environment. Living shorelines use natural stabilization techniques that rely on vegetative plantings, organic materials, and sand fill or a hybrid approach combining vegetative plantings with low rock sills or living breakwaters to keep sediment in place and reduce the erosive impact of wave energy.

### Disaster Preparedness

#### Regional Emergency Management Coordination

Beverly should develop formalized emergency management practices with Burlington County and neighboring municipalities. Some examples could include coordinating evacuation and re-entry routes, creating large-scale outreach initiatives, or expanding available sheltering options and amenities.

#### Continuity of Operations Plan

A continuity of operations plan is separate from an emergency operations plan and ensures that essential municipal functions continue to be performed before, during, and after a wide range of emergencies. The continuity of operations plan can help Beverly prioritize essential facilities, equipment, vital records, and other assets for protection. It can also help reduce or mitigate disruptions to operations and facilitate decision making during an emergency. The Borough of Avalon has a sample plan.<sup>18</sup>

#### Evacuation Plan

Beverly should create an evacuation plan that documents its evacuation protocol before and during disasters. Information that could be added to the plan includes which of its existing evacuation routes could be flooded and where, the necessary time frame to evacuate residential neighborhoods, and conditions (if any) that would spur a lane reversal in order to evacuate a greater volume of residents from the municipality.

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<sup>18</sup> The Borough of Avalon, *Continuity of Operations/Continuity of Government (COOP/COG) Plan*, April 15, 2009, [www.prepareyourcommunitynj.org/media/27952/Avalon\\_COOP\\_COG.pdf](http://www.prepareyourcommunitynj.org/media/27952/Avalon_COOP_COG.pdf).

## Action Plan for Riverine Floods

Several neighborhoods in Beverly receive riverine flooding during storms, in addition to the coastal/tidal flooding discussed in this report. By drawing upon its knowledge of past storms and topographical information, Beverly should create an action plan that identifies (1) the type of storms that create flooding at vulnerable locations, (2) steps for staff and community members to take to prepare for and respond to similar storms in the future, and (3) resources available for addressing the anticipated problems.

## Community Emergency Response Team (CERT)

Beverly should consider creating a local CERT program. CERT programs can provide volunteer support to first responders, provide assistance to victims, help to organize volunteers at disaster sites, and collect disaster information to support first responder efforts. For small municipalities with limited staff, CERT teams are particularly useful and can help cut costs. See <https://www.fema.gov/community-emergency-response-team> for more information.

## Municipal Organization

### Historic Recordkeeping

Beverly should collect and maintain an easily accessible record of historic storms. Residents' and municipal staff members' photographs and accounts of these events, especially ones that were not documented by state and federal agencies, are useful tools that can be used to plan for future storms. These records may identify past surge extents, conditions that caused amplification of storm damages, and vulnerable areas not shown by mapping.

## Outreach

### Program for Public Information (PPI)

A PPI can help organize Beverly's outreach practices on flood hazards. A PPI is a researched, organized, and implemented program for public outreach that includes assessing the community's information needs; formulating messages; identifying means of conveying the messages; and implementing, monitoring, and evaluating the program. The National Flood Insurance Program's Community Rating System provides guidance on establishing a PPI, as well as information on outreach projects.<sup>19</sup>

This is a significant project, and the city may want to partner with other organizations or entities that have experience in educating residents on flood hazards, particularly those that can offer translation services from English to other major languages spoken in the city.

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<sup>19</sup> National Flood Insurance Program, Developing a Program for Public Information for Credit under the Community Rating System of the National Flood Insurance Program, 2014, [crsresources.org/files/300/developing\\_a\\_ppi\\_for\\_credit\\_under\\_the\\_crs\\_2014.pdf](https://www.fema.gov/crsresources.org/files/300/developing_a_ppi_for_credit_under_the_crs_2014.pdf).

## Public Presentations

Beverly should hold annual presentations for residents, business owners, and other groups to discuss flood hazards. By continuing to emphasize the importance of planning for flooding, the city can set an example that disaster readiness should be maintained, even in relatively “quiet” times. A PPI can ensure that these presentations are effective. Publicized and recorded presentations can reduce the need for numerous one-on-one meetings with constituents.

Topics can include but are not limited to discussing the science behind storm surge; defining base flood elevations, flood zones, and flooding risk; providing updates on changes to FEMA’s flood maps; sharing information on evacuation routes; providing recommendations for renovating a structure in the floodplain to better withstand floods; and discussing actions that can be taken to reduce flood insurance rates. Presentations could be accompanied by information on the municipality’s special needs database and/or flood warning systems to get more residents registered.

## Information on Floodplains

Beverly City should conduct regular outreach to residents about the natural and beneficial functions of floodplains. Preserving floodplain areas as open space or for only recreational uses is an effective strategy for reducing—if not eliminating—risks of damage or injury from floods. A continued outreach effort focused on the positive aspects of floodplains is part of a long-term strategy for getting residents to understand and support converting more of the city’s floodplain areas into open space. A white paper written by the National Association of Floodplain Managers has more information on the topic.<sup>20</sup>

## Coastal Hazard Disclosure Policy

Beverly should create a consistent coastal hazard disclosure policy that is used by all lenders and real estate agents when speaking with potential buyers about buildings located in flood-prone areas. Disclosure of known flood, erosion, or other coastal hazard risks at the time of property transfer is an important educational effort consistent with the “No Adverse Impact”<sup>21</sup> concept. Some states, such as Florida and California, have disclosure requirements. If a disclosure is required for property in a flood or coastal hazard area, the seller is required to notify potential buyers of the risks, and the risks can be factored into the purchase decision. If there is a berm, sea wall, or other protective structure on coastal property for sale, a disclosure policy could also require that prospective buyers be made aware of the issues surrounding such structures, particularly the need for monitoring and maintaining them. This type of policy can help sellers avoid transferring known adverse impacts that become unpleasant surprises to buyers.

## Packaged Flood Preparedness Outreach Materials

By packaging flood-preparedness materials to residents in anticipation of future floods, Beverly could save time and energy leading up to, during, and after a flooding event as outreach will already have been prepared for dispersal. The outreach should cover evacuation routes, safety procedures, shelter locations, recovery

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<sup>20</sup> Association of State Floodplain Managers, *Natural and Beneficial Floodplain Functions: Floodplain Management—More than Flood Loss Reduction*, September 16, 2008, [www.floods.org/PDF/WhitePaper/ASFPM\\_NBF%20White\\_Paper\\_%200908.pdf](http://www.floods.org/PDF/WhitePaper/ASFPM_NBF%20White_Paper_%200908.pdf).

<sup>21</sup> Association of State Floodplain Managers, *No Inverse Impact (NAI)*, accessed November 1, 2017, [www.floods.org/index.asp?menuID=460](http://www.floods.org/index.asp?menuID=460).

operations, procedures for entering a flooded building, steps for getting a permit for repairs, substantial damage rules, flood protection opportunities during repairs, and information on grants.

## Resources and Funding Opportunities

### Federal Programs: Flood Hazards

#### FEMA: Flood Mitigation Assistance Grants

The Flood Mitigation Assistance Grants Program provides funding to states, municipalities, and other groups for projects or plans that reduce or eliminate the long-term risk of flood damage to structures insured under the National Flood Insurance Program. The funds for this grant program are disbursed through states. Beverly should contact the New Jersey State Hazard Mitigation Officer ([www.state.nj.us/njoem/](http://www.state.nj.us/njoem/)) if it is interested in applying. More information is available at [www.fema.gov/flood-mitigation-assistance-grant-program](http://www.fema.gov/flood-mitigation-assistance-grant-program).

#### FEMA: Hazard Mitigation Grants

The Hazard Mitigation Grant Program helps communities implement hazard mitigation measures following a presidential major disaster declaration. The funds for this grant program are disbursed through states. Beverly should contact the New Jersey State Hazard Mitigation Officer ([www.state.nj.us/njoem/](http://www.state.nj.us/njoem/)) if it is interested in applying and has an eligible project. More information is available at [www.fema.gov/hazard-mitigation-grant-program](http://www.fema.gov/hazard-mitigation-grant-program).

#### FEMA: Pre-Disaster Mitigation Grants

The Pre-Disaster Mitigation Grant Program assists states, municipalities, and other groups in implementing a sustained pre-disaster natural hazard mitigation program to reduce overall risk from future hazards while reducing reliance on federal funding in future disasters. This program awards planning and project grants and provides opportunities for raising public awareness about reducing future losses before disaster strikes. The funds for this grant program are disbursed through states. Beverly should contact the New Jersey State Hazard Mitigation Officer ([www.state.nj.us/njoem/](http://www.state.nj.us/njoem/)) if it is interested in applying. More information is available at [www.fema.gov/pre-disaster-mitigation-grant-program](http://www.fema.gov/pre-disaster-mitigation-grant-program).

### Federal Programs: Community Support

#### Partnership for Sustainable Communities

This partnership between the U.S. Department of Housing and Urban Development (HUD), the U.S. Department of Transportation, and the Environmental Protection Agency provides grants to help communities create vibrant, healthy neighborhoods that provide more housing options, economic opportunities, and efficient transportation while reinforcing existing investments. The program website includes grant offerings from each of these agencies. More information is available at [www.sustainablecommunities.gov/partnership-resources](http://www.sustainablecommunities.gov/partnership-resources). Information about the grants available in this program is also posted on [www.grants.gov](http://www.grants.gov).

#### HUD: Community Development Block Grant Program

Burlington County receives funding from the federal Community Development Block Grant Program for developing viable urban communities with an emphasis on assisting low-income persons. Funding may be used to meet urgent needs where conditions pose a threat to the health or welfare of the community.

Examples of projects funded include reconstruction of affordable housing after a flood, or the redevelopment of public access along waterways to include Americans with Disabilities Act (ADA) access. More information is available at [www.co.burlington.nj.us/258/Block-Grant-Program](http://www.co.burlington.nj.us/258/Block-Grant-Program).

#### U.S. Economic Development Administration: Economic Adjustment Assistance Program

This program provides financial assistance to communities experiencing gradual or sudden adverse economic changes, including but not limited to those caused by federally declared disasters. More information is available at [www.eda.gov/funding-opportunities/](http://www.eda.gov/funding-opportunities/).

### Federal Programs: Infrastructure

#### U.S. Army Corps of Engineers: Emergency Streambank and Shoreline Protection

This program funds the construction of streambank and shoreline protection projects to reduce erosion risks for structures, including highways, municipal water supply systems and sewage disposal plants, churches, hospitals, schools, nonprofit public services, and known cultural sites. More information is available at [www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Flood-Risk-Management/Section-14/](http://www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Flood-Risk-Management/Section-14/).

#### U.S. Army Corps of Engineers: Small Flood Risk Management Projects

This program funds construction or improvement of flood control works, levees, floodwalls, impoundments, or pumping stations; flood proofing; relocation of structures; or flood warning and preparedness systems. The Corps of Engineers oversees planning, design, and construction of flood risk management projects in coordination with the project sponsor. More information is available at [www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Flood-Risk-Management/Section-205/](http://www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Flood-Risk-Management/Section-205/).

### Federal Programs: Open Space and Natural Resources

#### U.S. Army Corps of Engineers: Aquatic Ecosystem Management and Restoration

This program provides financial and technical assistance to restore degraded aquatic ecosystems to a more natural condition. More information is available at [www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Ecosystem-Restoration/Section-206/](http://www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Ecosystem-Restoration/Section-206/).

#### U.S. Army Corps of Engineers: Project Modification for Improvement of the Environment

This program offers financial and technical assistance for planning, engineering, design, and construction of projects to restore ecosystems that have been degraded by a previously constructed Corps of Engineers project. Projects typically involve environmental restoration of aquatic, floodplain, and upland areas. More information on this program is available at [www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Ecosystem-Restoration/Section-1135/](http://www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Ecosystem-Restoration/Section-1135/).

#### U.S. Army Corps of Engineers: Snagging and Clearing for Flood Control

This program provides financial and technical assistance to reduce flood damages by clearing and excavating channels, as well as constructing embankments in some instances, using materials from the clearing operation. More information is available at [www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Flood-Risk-Management/Section-208/](http://www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Flood-Risk-Management/Section-208/).

## State Programs: General Assistance

### NJDEP Bureau of Flood Control

The Community Assistance Program Unit in NJDEP's Bureau of Flood Control offers a range of floodplain assistance to municipalities. This unit offers assistance with floodplain issues (in person or on the phone), floodplain ordinance and floodplain map creation and adoption, solving problems on development within Special Flood Hazard Areas, Community Rating System applications and compliance, flood mapping, and disaster response. The unit also offers regular workshops on floodplain-related topics. More information on this program is available at [www.nj.gov/dep/floodcontrol/about.htm#management](http://www.nj.gov/dep/floodcontrol/about.htm#management).

### NJDEP Coastal Management Program

The New Jersey Coastal Management Program is part of the National Coastal Zone Management Program and provides resources for sustainable and resilient coastal community planning, and climate change planning. Their technical assistance offerings include contractor assistance, direct municipal grant programs, and funding for the implementation of living shorelines or other nature-based mitigation projects. The available resources are updated regularly. For more information, contact the Coastal Management Office ([www.state.nj.us/dep/cmp/czm\\_contact.html](http://www.state.nj.us/dep/cmp/czm_contact.html)).

## State Programs: Flood Relief and Control

### NJDEP Shore Protection Program

This cost-share program provides grants to protect property and infrastructure from coastal storm damage, erosion and shoreline migration, and sea level rise. Funds can be used for the protection, stabilization, restoration, or maintenance of the shore, including monitoring studies and land acquisition. Projects must be consistent with the New Jersey Shore Protection Master Plan and Coastal Zone Management Program. Project areas must be affected by normal tidal cycles and be located on public or private property that has legal, perpetual easements assigned to the state for public access and use. More information is available at [www.nj.gov/dep/shoreprotection/funding.htm](http://www.nj.gov/dep/shoreprotection/funding.htm).

### NJ Office of Emergency Management Public Assistance Program

This program was developed to assist public entities in New Jersey with getting federal funding for repairs, restorations, reconstruction, or replacement of public facilities or infrastructure damaged by a disaster. The program coordinates damage and needs assessments in response to expected or actual emergency situations as part of the Federal Disaster Assistance Program. The funds available differ for each community in each declared disaster area. More information is available at [ready.nj.gov/programs/public-assistance-program.shtml](http://ready.nj.gov/programs/public-assistance-program.shtml).

## State Programs: Open Space Preservation and Management

### NJDEP Blue Acres Program

In 2009, New Jersey passed an act to authorize bonds for the acquisition of lands in the state's floodways for recreation and natural resources protection. Twenty-four million dollars are available for acquiring properties that have been damaged by storms, may be prone to incurring damage from storms or storm-related flooding,



or protect other lands from such damage. All Blue Acres acquisitions must be from willing sellers. More information is available at [www.nj.gov/dep/greenacres/blue\\_flood\\_ac.html](http://www.nj.gov/dep/greenacres/blue_flood_ac.html).

#### NJDEP Community Stewardship Incentive Program Grant

This program provides grants to local governments and shade tree commissions to help implement a comprehensive community forestry management plan. Grant categories include resiliency planning, hazard mitigation, and reforestation and tree planting. More information is available at [www.state.nj.us/dep/parksandforests/forest/community/grants-csip.html](http://www.state.nj.us/dep/parksandforests/forest/community/grants-csip.html).

#### NJDEP Green Acres Program

The Green Acres Program provides low-interest loans and grants to municipal and county governments to acquire open space and develop outdoor recreation facilities. Green Acres works with local governments from grant application through project completion. All land funded under this program must be open to the public. More information is available at [www.nj.gov/dep/greenacres/local.html](http://www.nj.gov/dep/greenacres/local.html).

#### NJDEP Green Communities Grant (Community Forest Program)

This program assists local governments in developing Community Forestry Management Plans that guide communities in establishing and maintaining urban and community forests. Funding is provided through the U.S. Department of Agriculture Forest Service Urban and Community Forestry Program. More information is available at [www.nj.gov/dep/grantandloanprograms/nhr\\_gccg.htm](http://www.nj.gov/dep/grantandloanprograms/nhr_gccg.htm).

### State Programs: Contaminant Mitigation

#### NJDEP Hazardous Discharge Site Remediation Fund

This program provides grants to municipalities, counties, and redevelopment entities for investigating and remediating contaminated sites identified as areas in need of redevelopment, and for remediating contaminated sites located in a designated Brownfield Development Area. Applications are available online or may be obtained by request from NJDEP. More information is available at [www.nj.gov/dep/srp/finance/hdsrf/](http://www.nj.gov/dep/srp/finance/hdsrf/).

#### NJDEP Technical Assistance Grants

Technical Assistance Grants provide funding to nonprofit community groups to improve the community's understanding of the environmental conditions at a contaminated site and remediation processes. The bulk of the funding must be used to hire an independent Licensed Site Remediation Professional as a technical advisor to help interpret and comment on site documents. The grant funds are available to community groups during the Remedial Investigation phase and the Remedial Action phase of remediating a contaminated site. Local governments have to partner with an eligible nonprofit organization to make use of these funds. More information is available at [www.nj.gov/dep/grantandloanprograms/sr\\_techassist.htm](http://www.nj.gov/dep/grantandloanprograms/sr_techassist.htm).

## State Programs: Water Quality Protection

### NJDEP and New Jersey Environmental Infrastructure Trust (NJEIT) Environmental Infrastructure Financing Program

This program, funded through both NJDEP and NJEIT, provides low-interest loans for constructing water quality protection facilities, including for wastewater treatment and stormwater and nonpoint source pollution management. The Financing Program also provides loans for such activities as open space land purchase and conservation, contamination remediation, and well sealing. More information is available at [www.nj.gov/dep/grantandloanprograms/sr\\_techassist.htm](http://www.nj.gov/dep/grantandloanprograms/sr_techassist.htm) and [www.njeit.org/](http://www.njeit.org/).

### NJDEP Nonpoint Source Pollution Control Grants (319 Grant Program)

The Nonpoint Source Pollution Control Grants Program provides grants to reduce water quality impairment through nonpoint source pollution control projects. More information is available at [www.nj.gov/dep/grantandloanprograms/eps\\_nspc.htm](http://www.nj.gov/dep/grantandloanprograms/eps_nspc.htm).

### Rutgers University Cooperative Extension Water Resources Program

The Water Resources Program is a specialized program at Rutgers Cooperative Extension that identifies and addresses community water resources issues. Their projects and programs currently include agricultural watershed planning and implementation, green infrastructure education and construction, impervious cover reduction, municipal stormwater management, community training on water quality issues, rain garden and rain barrel workshops, and watershed planning and implementation. More information is available at [water.rutgers.edu/](http://water.rutgers.edu/).

### Water Quality Restoration Grants Program

The money from this grant program is available for watershed restoration projects that address stormwater runoff from nonpoint sources. Eligible projects include green infrastructure that reduces stormwater runoff in communities with aging combined wastewater-stormwater infrastructure; and projects that improve suburban stormwater management systems, help agricultural operations reduce nonpoint source pollution, implement water quality improvements in the Raritan River and Delaware River and Bay watersheds, construct living shorelines, improve water quality in coastal lakes, and promote environmental education. More information is available at [www.state.nj.us/dep/wms/bears/npsrestgrants.html](http://www.state.nj.us/dep/wms/bears/npsrestgrants.html).



# Appendix A



## Coastal Vulnerability Assessment Matrix Vulnerability of Structures, Properties, and Populations in a Category 2 Storm in 2100

### Sea Level Rise (SLR) Projections

YEAR	SLR FROM PRESENT
Present	-
2050	+ 1.4 ft
2100	+ 3.3 ft

### TOP AREAS OF CONCERN

Asset Name	Asset Type	Asset Description	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
Cul-de-Sac Streets near Wetland	Transportation (Streets)	Several roads within the city have dead ends or cul-de-sacs that do not provide an alternative means to evacuate in a flood: Dory Ct., Johns Ct., Penn St., Front St., and 2nd St.	Dory Ct. will be flooded with up to 1.6 ft of water, the cul-de-sac portion of Johns Ct. with up to 0.5 ft, Penn St. with up to 4.3 ft at the wastewater treatment plant, Front St. with up to 3 ft at the Beverly Housing Authority buildings, and 2nd St. up to 2.8 ft. However, some homes along Dory Ct. and Johns Ct. are already affected by flooding, and the waters from storm surge and sea level rise may cause worse flood conditions.	Extended periods of flooding, high-velocity floods, or flooding that parallels a road can cause erosion of roadway infrastructure. Most roads, however, are not substantially affected by being temporarily overtopped by water. The city should examine the potential damages from the more extreme depth projections closer to the waterfront.	Low	The flooding of these streets slows or prevents egress from multiple households during a storm and may prevent access to the wastewater treatment plant. If the potentially affected residents are evacuated prior to a storm, the consequences to those households will be small; however, reduced access to the wastewater treatment plant could reduce the speed at which the city could make repairs to flood-damaged infrastructure, which could make it harder to repair when the flood waters recede.	High for Penn St.; Minor for other roads
Municipal Wastewater Treatment Facility	Utility (Wastewater Treatment Plant)	Located on the waterfront, west of Magnolia St. Treats wastewater for Beverly City and Delanco Township.	The asset currently experiences storm-related flooding and will face greater depths in this scenario. In this scenario, the entire property may become flooded, with depths of between 2.9 and 4.6 ft.	The city has determined that flood depths as low as 1 ft at the plant have caused problems. At this point, water could flood the chlorine tanks and make contact with wastewater that has not completed the chlorination process. At 2 to 4 ft of flooding, the plant would lose emergency and primary power, and flooding out would occur for buildings, control panels, and motors. Waste could not be treated at that point.	High	The closure of parts of the wastewater treatment plant after a flood would affect the entire city, plus Delanco Township. Repairs to systems that were damaged in the flood could take multiple weeks or months, during which time the city would have to find other means to treat wastewater for businesses and homes, which could be costly.	High
Publicly Owned Planned Residential Parcels	Open Space and Habitat (Open Space)	Two parcels located between Broad St., Cooper St., and Front St. along the waterfront and behind a sea wall. They are currently vacant, but the city plans to develop them as mixed-use or residential.	The parcels and any planned structures, particularly to the north of the sites, may experience flood depths of up to 4 ft. More than half of the larger, western parcel will likely be flooded, and less than half of the smaller, eastern parcel will likely be flooded.	The city will require that developers of these parcels put parking on the first floor and otherwise use NJDEP rules for construction in a floodplain. The potential height of the flooding in this scenario needs to be compared with the NJDEP regulations. More information is needed on the proposed site plans for the two parcels and proposals for the design of the structures.	Insignificant with current use; Insignificant to High with proposed use(s)	The consequences of the flooding of these parcels to the city are currently insignificant. Once constructed, while flooding may make some of the individual homes or businesses vulnerable, flood damages to these properties would be less likely to affect the city as a whole.	Insignificant with current use; Minor with proposed use(s)
Sea Walls	Utility (Flood Control Structure)	Beverly City has two publicly managed sea walls that protect the coastal land adjacent to them from erosion. One is located at the end of Van Kirk St., and one is located at the end of Van Sciver St.	The sea walls may face between 3.0 and 11.1 ft in flood depths.	The walls are currently subject to structural damage from riverine flooding. The additional impact from a Category 2 storm plus sea level rise may increase the rate at which the structures degrade.	High	Failure of the sea walls from flooding could cause erosion and a possible landslide. The neighborhoods behind them would face some flooding, but structures will not likely be affected.	Minor

**TOP AREAS OF CONCERN (CONTINUED)**

Asset Name	Asset Type	Asset Description	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
Storm Drain	Utility (Stormwater Conveyance Structure)	A storm drain located at the intersections of Penn St. and Magnolia St.	The storm drain at Penn and Magnolia Sts. will likely be covered by about 4 ft of flood water.	The storm drain already gets backed up near the shoreline during storms. Increased flooding from storm surge and sea level rise will likely further impede its ability to function during storms.	High	When the storm drain does not function properly, it currently causes additional flooding in the blocks surrounding the street intersections where it is located. The intersection of Magnolia St. and 2nd St. has been observed to receive the most flooding. Additional flooding would most substantially affect the residents living in the Beverly Housing Authority-owned properties near the Penn St. and Magnolia St. intersection. While flooding may make some of the individual homes more prone to damage, damages to these properties would be less likely to affect the city as a whole.	Minor

**BUILT ENVIRONMENT**

Beverly City Elementary School	Institutional/Cultural/Government	Public elementary school located at 601 Bentley Ave.	The asset is out of harm's way in this scenario.	-	Insignificant	N/A	N/A
Evacuation Routes	Transportation (Evacuation Routes)	The city's designated evacuation routes include Manor Rd. south to Cherry St., Broad St., and Cooper St.	Manor Rd. and Broad St. are already prone to riverine flooding. Flooding from sea level rise and storm surge may worsen these flood conditions; in this scenario, Manor Rd. north of Johns Ct. may be flooded by up to 1.3 ft, Broad St. north of Front St. may be flooded by up to 5.4 ft, and Cooper St. north of Front St. may be flooded by up to 1.3 ft.	Extended periods of flooding, high-velocity floods, or flooding that parallels a road can cause erosion of roadway infrastructure. Most roads, however, are not substantially affected by being temporarily overtopped by water. The city should examine the potential damages from the more extreme depth projections on Broad St., closer to the waterfront.	Low	Because the projected flooding extent in this scenario only affects a few blocks of each evacuation route, only a small number of households will be affected by flooding of these routes. If the potentially affected residents are evacuated prior to a storm, the consequences to those households will be small.	Minor
Fire Departments	Emergency Facility (Fire Department)	Two fire companies serving Beverly City. Beverly Fire Co. (Station 1) is located at 440 Laurel St., and Hope Hose Fire Co. (Station 2) is located at 408 Broad St.	The assets are out of harm's way in this scenario.	-	Insignificant	N/A	N/A
Police Department	Emergency Facility (Police)	Beverly City's police station, located at 446 Broad St.	The asset is out of harm's way in this scenario.	-	Insignificant	N/A	N/A
Revetment Block	Utility (Flood Control Structure)	Located between Cooper St. and Broad St. along the waterfront. They protect the coast, primarily the publicly owned planned residential parcels, from erosion.	The revetment block may face flood waters of up to 11.2 ft, which will flow over the block and reach its landward side.	As a preventative measure for coastal erosion, the revetment block is intended to withstand flooding. The revetment block's sensitivity could increase with age or under stress from particularly high floods or fast currents.	Low to Moderate	Damages to the revetment block from flooding would cause additional erosion along the waterfront, potentially eliminating Bank Rd. and parts of the publicly owned planned residential parcels.	Minor
St. Joseph's School/St. Joseph's Roman Catholic Church	Institutional/Cultural/Government	A Roman Catholic church and school (grades 1–8) that also holds the Beverly City School District Business offices. It is located at 524 Warren St.	St. Joseph's is close to the flooding extent for this scenario but will not be affected.	-	Insignificant	N/A	N/A

NATURAL ENVIRONMENT							
Asset Name	Asset Type	Asset Description	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
Riparian Open Space and Habitat	Open Space and Habitat (Habitat)	An area located to the northeast of the city along the waterfront and a small water body that originates in Delanco. It contains wooded and scrub/shrub wetlands.	In a Category 2 storm plus 2100 sea level rise scenario, the habitat may experience flooding of up to 9.5 ft, particularly along the ditch. However, typical depths will likely be less than 5 ft. However, this land already gets flooded from riverine flooding, both from the Delaware River and from inland areas.	A small portion of the open space that may face flooding is wetlands, and these wetlands are likely tolerant to the soil hydration that occurs with flooding. The majority of the land area is forested, however, and more information is needed about the tree species potentially affected, particularly those farther inland, and their tolerance of flooded soils.	Low to Moderate	Riverine flooding in this area already causes the basements of some homes to the south to flood. The added waters from sea level rise and storm surge will cause greater damage to the homes that already flood and potentially cause flooding in homes that have not previously been affected. However, the affected homes will likely still be a small fraction of Beverly City's total households.	Minor
Waterfront Park	Open Space and Habitat (Open Space)	The park is open space, previously a baseball field, that is located between Penn St. and Broad St. along the waterfront.	The park is already affected by riverine flooding. In this storm surge and sea level rise scenario, the entire park may be flooded, and by depths typically between 4 and 8 ft.	The park contains one structure, a gazebo. More information on the elevation and materials of the gazebo are required to determine whether and if it could be damaged by flood waters washing over and through it. Otherwise, the park contains grass and trees that could likely survive brief periods of flooding.	Moderate	The flooding of this park will be a temporary nuisance to residents, who will be able to use one of the city's other parks farther inland until the flood waters recede.	Minor

**VULNERABLE POPULATIONS AND HOUSING FACILITIES**

Beverly Commons	Retirement Home/ Environmental Justice Community	Senior housing with low-income units located at the intersections of Penn St. and Magnolia St., and Broad St. and Bank Rd.	The asset is out of harm's way in this scenario.	-	Insignificant	N/A	N/A
Beverly Housing Authority Properties	Economically Disadvantaged Populations	Three sites located along Penn St., Broad St., and Second St. They offer low-income housing and other assistance resources to Beverly residents. Housing is available for elderly, families, and handicapped/disabled populations.	Of the 19 buildings managed by the Beverly Housing Authority, seven may become entirely flooded with up to 2.5 ft of water but generally less than 1 ft. Six buildings will likely not be flooded in this scenario, but egress from the parcel may be made difficult by flooding of approximately 1 ft on sidewalks. An additional six buildings will likely be out of harm's way, and egress will not be a concern.	The houses that flood already use sump pumps, and the city already has a protocol in place to evacuate residents before storms. More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters. The fact that the residents of the buildings have lower incomes makes most types of recovery from floods more challenging.	Moderate	While the effect of flooding may be substantial to some of the residents of the Beverly Housing Authority, the affected homes are a small fraction of Beverly City's total households.	Minor





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# Appendix B

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## Appendix B: Vulnerability and Consequences Rating Keys

Vulnerability Rating Key	
Level	Vulnerability Rating Given Hazard Exposure and Sensitivity
Insignificant	<p><i>Exposure to Flooding:</i> This community asset is located out of harm's way.</p> <p><i>Physical/Structural Damage:</i> No physical or structural damages expected.</p> <p><i>Disruption/Impairment:</i> No disruption in function, accessibility, or development and delivery of basic services and supplies. No apparent impacts to services, typical operations, routine, or daily life.</p> <p><i>Accessibility:</i> Key staff members are able to access facilities or locations without interruption.</p>
Low	<p><i>Exposure to Flooding:</i> Majority of this community asset is located out of harm's way.</p> <p><i>Physical/Structural Damage:</i> Minor physical or structural damages expected.</p> <p><i>Disruption/Impairment:</i> Limited disruption in function, accessibility, or development and delivery of basic services and supplies. Limited impacts to typical operations, routine, or daily life, if any.</p> <p><i>Accessibility:</i> Key staff members are able to access facilities or locations with minimal interruption.</p>
Moderate	<p><i>Exposure to Flooding:</i> Significant portion of this community asset is located in harm's way.</p> <p><i>Physical/Structural Damage:</i> Moderate physical or structural damages are sustained.</p> <p><i>Disruption/Impairment:</i> Moderate level of disruption to accessibility or mobility of asset, amenity, or population. Moderate level of interruptions to development and delivery of basic services and supplies. Typical operations, routine, or daily life are moderately affected by flood hazard scenario.</p> <p><i>Accessibility:</i> Secondary evacuation and access routes available for use if or when primary systems fail.</p>
High	<p><i>Exposure to Flooding:</i> Majority of this community asset is located in harm's way.</p> <p><i>Physical/Structural Damage:</i> Severe level of harms (destruction of property, degradation of function, and/or injury) expected, resulting in high degree of loss. Asset, amenity or population is unable to withstand flood impacts.</p> <p><i>Disruption/Impairment:</i> Severe, potentially irreparable challenges faced, requiring significant changes to asset functioning and community's daily life, yielding a "new normal." Production, provision of services, or daily routine expected to sustain high degree of disruption. Significantly reduced operational capacity of community assets and amenities; long-term or permanent relocation of asset, amenity, or population.</p> <p><i>Accessibility:</i> Severe disruptions to accessibility of asset, amenity, or population, or the disruption of this asset, cause accessibility issues to other community assets. Key individuals, material supplies, core operating systems, and functioning interrupted or unavailable.</p>

### Consequences Rating Key

Level		Given Vulnerability of Assets, Rate the Magnitude or Severity of Consequences
1	Insignificant	<p><i>Injuries &amp; Fatalities:</i> Only minor injuries, if any.</p> <p><i>Property Damages:</i> Only minor property damage.</p> <p><i>Population Displacement:</i> No population displacement.</p> <p><i>Public Health:</i> Human health impacts are negligible or not measurable.</p> <p><i>Economy:</i> Little to no impacts to major and local businesses. No loss of services.</p> <p><i>Typical Operations/Daily Life:</i> No impacts or disruptions to typical operations, routine, or daily life.</p> <p><i>Environment:</i> No lasting environmental degradation.</p> <p><i>Emergency Response:</i> No adverse effects to emergency response.</p> <p><i>Hazardous Materials:</i> No increase or change in community or ecosystem exposure to toxins or hazardous materials.</p> <p><i>Municipal Budget:</i> Negligible operational costs.</p>
2	Minor	<p><i>Injuries &amp; Fatalities:</i> Minor injuries, limited in geographic scope and/or affected population(s).</p> <p><i>Property Damages:</i> Limited property in narrow affected area damaged or destroyed.</p> <p><i>Population Displacement:</i> Temporary displacement of a small portion of the population.</p> <p><i>Public Health:</i> Measurable but minor adverse human health effects and increase of disease.</p> <p><i>Economy:</i> Minor impacts to major and local businesses. Minor interruption of supply and services.</p> <p><i>Typical Operations/Daily Life:</i> Limited disruption to typical operations, routine, or daily life.</p> <p><i>Environment:</i> Minor damage or loss to habitat and species or functioning of the systems as a component of "green" infrastructure of the community. Small loss of natural resource base. Increased, but tolerable, stress on ecosystem.</p> <p><i>Emergency Response:</i> Slight decrease in emergency response times and effectiveness.</p> <p><i>Hazardous Materials:</i> Limited hazardous materials spill, manageable cleanup and remediation.</p> <p><i>Municipal Budget:</i> Additional but tolerable operational costs.</p>
3	Moderate	<p><i>Injuries &amp; Fatalities:</i> Multiple deaths or injuries possible over a broad population.</p> <p><i>Property Damages:</i> Substantial property in affected area damaged or destroyed.</p> <p><i>Population Displacement:</i> Long-term population displacement over a broader segment of the population.</p> <p><i>Public Health:</i> Human health impacts are widespread, including increased risk of the spread of communicable diseases. Extended interruption of supply and services.</p> <p><i>Economy:</i> Disruptions to major and local businesses.</p> <p><i>Typical Operations/Daily Life:</i> Operations, routine, or daily life affected such that only redundant or alternative systems can be used for an extended duration. Highly vulnerable services, businesses, and populations suffer heavy adverse impacts while less sensitive systems seek alternative arrangements.</p> <p><i>Environment:</i> Major damage or loss of habitat or functioning of the systems as a component of "green" infrastructure of the community that may be permanent with adverse impacts. Large loss of natural resource base.</p> <p><i>Emergency Response:</i> Emergency response is strained and may result in significant degradation of response effectiveness and times.</p> <p><i>Hazardous Materials:</i> Large hazardous material spill with significant risk to humans and ecosystems.</p> <p><i>Municipal Budget:</i> High operational costs straining local budgets.</p>
4	High	<p><i>Injuries &amp; Fatalities:</i> High number of deaths or injuries possible across a wide population.</p> <p><i>Property Damages:</i> Majority of property in affected area damaged or destroyed.</p> <p><i>Population Displacement:</i> Permanent and widespread population displacement.</p> <p><i>Public Health:</i> Widespread adverse and significant health impacts, possibly including spread of communicable disease.</p> <p><i>Economy:</i> Major loss of local businesses.</p> <p><i>Delivery of Services:</i> Long-term interruption of supply and services.</p> <p><i>Typical Operations/Daily Life:</i> Majority of community operations, routines, or daily life patterns intensely impacted for an extended period. Highly vulnerable services, businesses, and populations unlikely to bounce back from shock.</p> <p><i>Environment:</i> Permanent degradation of habitat and species or functioning of the systems as a component of "green" infrastructure of the community. Majority destruction of critical natural resources base.</p> <p><i>Emergency Response:</i> Need for emergency services exceeds full capacity, and/or services are degraded and not functioning.</p> <p><i>Hazardous Materials:</i> Hazardous material spill that requires multi-year clean-up and poses significant health or ecosystem risk.</p> <p><i>Municipal Budget:</i> Operational costs exceed funding and place local government into adverse long-term financial conditions.</p>

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# Appendix C

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Figure C1: Beverly City with Flooding from Sea Level Rise in 2100 and a Category 2 Storm

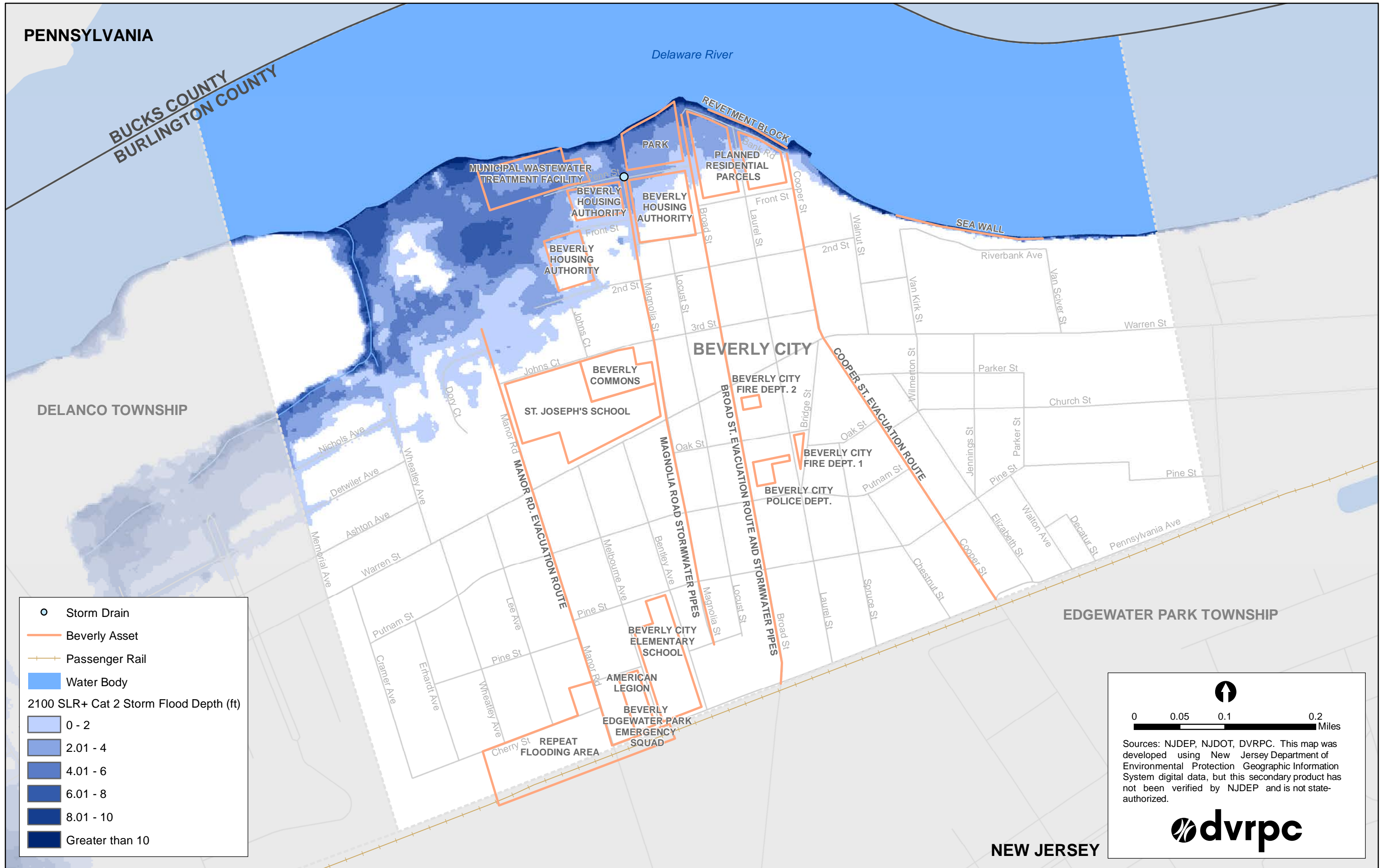


Figure C2: Beverly City with Aerials and CVA Scenario (Extent Only)





Figure C3: Beverly City with Open Space and CVA Scenario (Extent Only)





# Beverly City Coastal Vulnerability Assessment Report

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**Key Words:**

Beverly City, Burlington County, Climate Change, Coastal Vulnerability Assessment, Delaware River, Environment, Flooding, Hazard Mitigation, Municipal Planning, Natural Resources, New Jersey, Sea Level Rise, Waterfront

**Abstract:**

This report documents the coastal vulnerability assessment that the Delaware Valley Regional Planning Commission conducted with municipal staff and residents from Beverly City in 2015 and 2016. The narrative outlines projected effects of climate change in New Jersey, records Beverly's historic flooding issues and the actions taken to increase its resilience to floods, and discusses the coastal vulnerability assessment's methods, findings, and recommendations.

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