Cape May Seawall
City of Cape May
Cape May County, New Jersey

Coastal Storm Risk Management
Continuing Authorities Program Section 103

Final Integrated Feasibility Report & Environmental Assessment

August 30, 2022

U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT

Executive Summary

The U.S. Army Corps of Engineers, Philadelphia District (USACE) Cape May Seawall Integrated Final Feasibility Report and Environmental Assessment evaluates the impacts of elevating a total of 530 feet of the existing Cape May seawall at the corner of Beach and Wilmington Avenues for coastal storm risk management in Cape May City. While the Cape May Seawall Study considered the majority of the existing seawall fronting Cape May City, the detailed scope and focus of the study was to assess and identify solutions to bring the vulnerable corner at Wilmington Avenue and Beach Avenue into an equivalent level of protection against overtopping in comparison to the remainder of the structure.

The Recommended Plan for this study consists of raising the elevation of the existing stone seawall along Beach Avenue and Wilmington Avenue in the City of Cape May along its current alignment by placing a reinforced concrete cap on top of the existing stone seawall to elevation +17 feet (NAVD88) for a length of 350 feet (refer to Figure 24 and 25 for a general plan and typical section for the Recommended Plan). At this elevation, the existing stone seawall would be raised approximately 7.5 feet from its existing elevation of approximately +9.4 feet (NAVD88).

At each end of the 350 feet concrete cap, a taper will be required in order to transition from the top of the new concrete cap down to the elevation of the top of the existing stone seawall. The taper will be placed at a 12H:1V slope and span a distance of approximately 90 feet on each end of the concrete cap, bringing the total length of concrete cap to 530 feet.

The total average annual net National Economic Development (NED) benefits for the NED Plan at a FY2022 Price Level with a 2.25% Federal Discount Rate are $154,000 with a 2.0 benefit-cost ratio. The reduced average annual damages associated with the NED Plan is $301,000 with 64% residual damages under the Low (Historic) Sea Level Change (SLC) curve. The Low (Historic) and Intermediate relative SLC curves for this study area are fairly linear across the 50-year period of analysis (2020-2070) while the High RSLC curve is more exponential across the period of analysis. However, the results show that the plan formulation including economic viability and relative performance of each measure, evaluation, and recommended plan selection is not sensitive to SLC change.

The Recommended Plan concrete cap elevation of +17 feet (NAVCD88) maximizes average annual net benefits and average annual costs in comparison to the +16 feet (NAVD88) alternative with slightly reduced residual damages. Economic analyses indicate that seawall elevations of +15 feet (NAVD88) and +16 feet (NAVD88) are also justified and reasonably maximize average annual net benefits. In addition, the +17 feet (NAVD88) alternative is still the reasonably NED maximizing alternative when considering all three RSLC curve scenarios.

The construction commencement date is estimated to be June 2023 and the fully funded Total Project Cost for design and construction is $3.379 million (FY2022 Price Level escalated to FY2023) and includes a contingency of 37%. Average annual OMRR&R costs are estimated to be $34,000 which is approximately 1% of the construction cost for this project.

The landward face of the concrete cap would be textured to create a sand-looking façade so that it looks more like a natural feature and blends into the current environment. Plantings will be placed in front of the landward face of the seawall for aesthetic purposes. On the seaward side of the concrete cap, sand stockpiled during construction will be graded into the concrete cap to form a partial dune and will transition into the existing adjacent dunes. In order to stabilize the placed sand from erosion, dune vegetation will be planted. While a handrail on the seaward side for public safety is not included in the selected plan, this feature will be added during the Design and Implementation Phase and will be paid for by the non-Federal Sponsor.

Based on the data presented and continuing coordination with State and Federal resource agencies, no significant adverse environmental impacts are expected to occur as a result of the proposed action. No compensatory mitigation is required as part of the Recommended Plan. The Recommended Plan may have the potential to have a visual adverse effect on the Cape May Historic District. The USACE has signed a Programmatic Agreement (PA) with the New Jersey State Historic Preservation Office and the appropriate consulting parties to address potential impacts to the Cape May Historic District. Through the PA, the USACE will continue to work together with the consulting parties to reduce potential impacts and identify potential mitigation measures. Since the potential impacts and associated mitigation, including those associated with the Historic District, have been determined to be minor, localized and temporary, the preparation of an Environmental Impact Statement is not warranted and a Finding of No Significant Impact (FONSI) for the proposed action is appropriate.

The sole Land, Easements, Rights of Way and Relocation (LERRD) Requirements for this Project is the City of Cape May which is the one landowner within the project footprint. No Federal or State lands are within the footprint of the project. There are two Standard Estates including a temporary work area easement on approximately 0.517 acres of land (Standard Estate No.15) and a perpetual flood protection levee easement for a permanent right-of-way of approximately 0.381 acres of land (Standard Estate No.9). There are no non-standard estates proposed for the Recommended Plan.

FINAL

FINDING OF NO SIGNIFICANT IMPACT

CAPE MAY SEAWALL, CITY OF CAPE MAY
COASTAL STORM RISK MANAGEMENT
CONTINUING AUTHORITIES PROGRAM SECTION 103

CAPE MAY COUNTY, NEW JERSEY

The U.S. Army Corps of Engineers, Philadelphia District, has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. Based on when NEPA was initiated, this Environmental Assessment (EA) was developed in accordance with the applicable regulations, policies, and procedures, including USACE's NEPA regulations in Engineers Regulations (ER) 200-2-2 and the previous CEQ NEPA regulations at 40 CFR Part 1500 (NEPA Implementing Regulations). The final Environmental Assessment, for the Cape May Seawall Coastal Storm Risk Management Continuing Authorities Program Section 103 Project addresses the need for coastal storm risk management along a portion of the Cape May Seawall located in Cape May County, New Jersey.

The Final Environmental Assessment, incorporated herein by reference, evaluated alternatives to reduce storm damages in Cape May City associated with the existing seawall. In addition to a "no action" plan, four other alternatives were evaluated. These include a steel sheet pile wall, demolishing and rebuilding the existing wall, a concrete cap and nonstructural elevation/floodproofing/acquisition. The placement of a reinforced concrete cap along 350 feet of the existing seawall plus two 90-foot tapers on either side is the National Economic Development (NED) Plan and the Recommended Plan.

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the Recommended Plan are listed in the Table below:

Summary of Potential Effects of the Recommended Plan Table

	Insignificant effects	Insignificant effects as a result of mitigation	Resource unaffected by action
Aesthetics	X		
Air quality	X		

	Insignificant effects	Insignificant effects as a result of mitigation	Resource unaffected by action
Aquatic resources/wetlands			X
Invasive species			X
Fish and wildlife habitat	X		
Threatened/Endangered species/critical habitat	X		
Historic properties	X		
Other cultural resources		X	
Floodplains			X
Hazardous, toxic & radioactive waste			X
Hydrology			X
Land use			X
Navigation			X
Noise levels	X		
Public infrastructure			X
Socio-economics			X
Environmental justice			X
Soils			X
Tribal trust resources			X
Water quality			X
Climate change			X

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the Recommended Plan. Best management practices (BMPs) as detailed in the EA will be implemented, as appropriate, to minimize impacts. BMPs include a seasonal window from May 1 – August 15 for the protection of beach nesting birds. If piping plovers are present during construction, the window may be extended (March 1 – August 30) to cover their nesting season.

No compensatory mitigation is required as part of the Recommended Plan. At this time, the U.S. Army Corps of Engineers does not know if there will be any mitigation measures due to impacts on the Cape May Historic District. Through the Programmatic Agreement (PA) that has been executed, the USACE will continue to work together with the New Jersey State Historic Preservation Office (NJSHPO) and other consulting parties to reduce potential impacts and identify potential mitigation measures related to potential visual impacts to the Historic District.

Public review of the draft EA and FONSI was conducted in February, 2021. All comments submitted during the public review period were responded to in the Final EA and FONSI.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined that the Recommended Plan may affect, but is not likely to adversely affect federally listed species or their designated critical habitat. The US Fish and Wildlife Service agreed with this determination in correspondence dated June 8, 2021 and March 8, 2022.

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, the U.S. Army Corps of Engineers determined that the Recommended Plan may have the potential to have a visual adverse effect on the Cape May Historic District. A Programmatic Agreement between the USACE and the New Jersey State Historic Preservation Office has been executed to continue consultation during the design and construction phase.

This project does not entail actions that fall under the Clean Water Act of 1972, as amended, as no discharge of dredged or fill material into waters of the United States is associated with the Recommended Plan. As a result, section 404(b)(1) Guidelines (40 CFR 230) are not applicable to this project.

A determination of consistency with the New Jersey Coastal Zone Management program pursuant to the Coastal Zone Management Act of 1972 was obtained from the NJDEP in a letter dated April 26, 2021. All conditions of the consistency determination shall be implemented in order to minimize adverse impacts to the coastal zone.

All applicable environmental laws have been considered and coordination with appropriate agencies and officials has been completed.

Technical, environmental, and economic criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that implementation of the Recommended Plan will not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

20 SEP 2022

Date

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Ramon Brigantti
Lieutenant Colonel, Corps of Engineers
District Commander

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1.0 Introduction

1.1 Study Purpose, Need and Scope

The U.S. Army Corps of Engineers (USACE) Philadelphia District has prepared this integrated feasibility report and environmental assessment for the Cape May Seawall, City of Cape May, Cape May County, New Jersey, Coastal Storm Risk Management Study ("study"). It includes input from the non-Federal sponsor, local governments, natural resource agencies, non-governmental organizations, and the public. The purpose of the study is to investigate potential coastal storm risk management solutions for the City of Cape May. The need for the study is to reduce damages and risk to life, infrastructure, and property of the City of Cape May that have experienced significant flooding damages due to ocean overtopping of the existing seawall during coastal storm events. A recommendation for Federal participation in a coastal storm risk management project that is technically sound, economically justified, and environmentally acceptable is presented in this Final report.

The Federal objective for water and related land resource project planning is to contribute to National Economic Development (NED) consistent with managing and reducing risk to the Nation's environment, pursuant to National environmental statutes, applicable executive orders, and other Federal planning requirements (Principles and Guidelines [P&G], 1983). Water and related land resources projects are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective. This report: (1) summarizes the current and potential water resource problems, needs, and opportunities for coastal storm risk management; (2) presents the results of the plan formulation for water resource management solutions; (3) identifies specific details of the Recommended Plan, including inherent risks and (4) details the extent of Federal Interest and local support for the plan.

1.2 Study Authority

The authority for this project is Coastal Storm Risk Management Section 103 of the 1962 River and Harbor Act. Under this authority, USACE is authorized to plan, design, and construct small coastal storm risk management (CSRM) projects with and without specific Congressional authorization. Each project is limited to a Federal cost of not more than $10 million, including all project-related costs for feasibility studies, planning, engineering, design, and construction.

1.3 Non-Federal Sponsor

The City of Cape May has signed a Feasibility Cost-Sharing Agreement (FCSA) and is acting as the non-Federal sponsor (NFS) for the study, with a responsibility for 50 percent of the costs of the feasibility study. A non-Federal sponsor will also have to be identified for the Design and Implementation Phase as well as the Construction Phase

1.4 Study History

A determination of Federal Interest in pursuing this study was approved by the USACE North Atlantic Division on September 17, 2014. The initial appraisal of Federal interest involved reviewing existing conditions, communicating with local stakeholders, proposing a single coastal storm risk management alternative for the seawall area of Cape May, and conducting a preliminary benefit-cost analysis. A FCSA for this feasibility study was executed by USACE and the City of Cape May in May 2015.

1.5 Study Area

The study area is located in the City of Cape May, Cape May County, New Jersey (Figures 1, 2, and 3). The study area is approximately 0.8 square miles in size and covers a majority of the developed portion of the City. It is primarily composed of residential properties, however, commercial properties are predominant along the ocean front.

Figure 1: Location of the City of Cape May within the State of New Jersey.

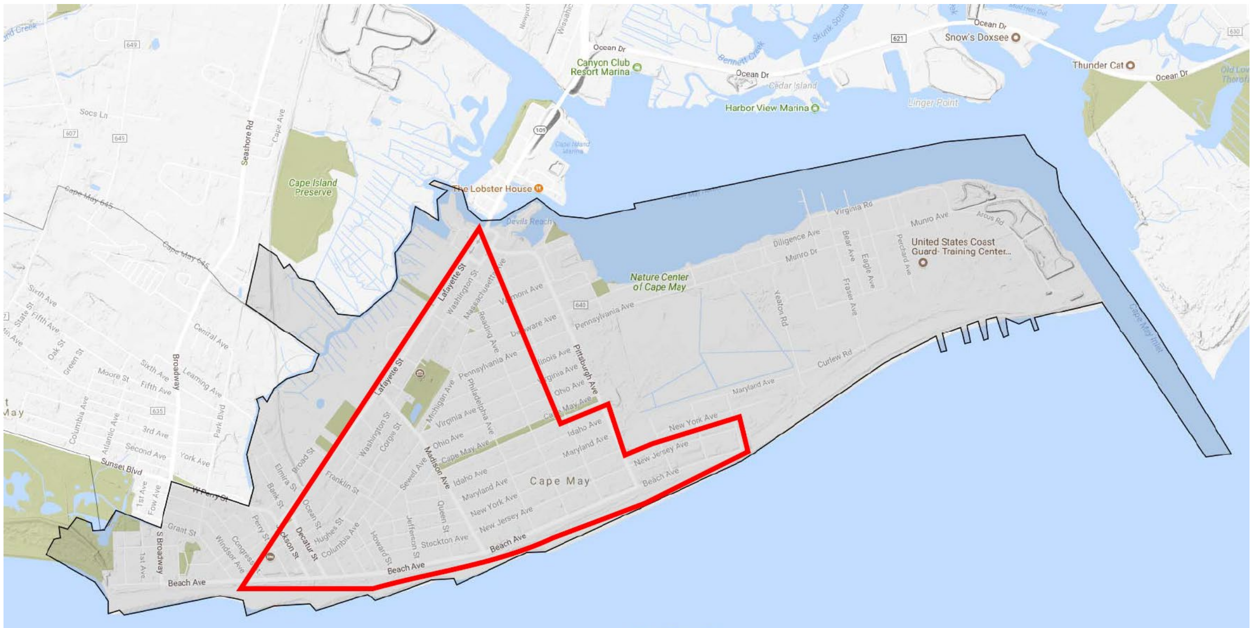


Figure 2: Municipal Boundary of Cape May City (black line) and Study Area (red line).

Figure 3: Location of the study area within the City of Cape May.

2.0 Existing Conditions

The City of Cape May is a 2.2 square mile community located at the southern tip of the mainland of New Jersey, where the Atlantic Ocean meets the Delaware Bay, approximately 70 miles southeast of Philadelphia, PA. The Atlantic Ocean is located to the south, the municipalities of Lower Township and the Borough of West Cape May are located to the west, Cape May Harbor is located to the north, and Cape May Inlet is located to the east (Figure 4). Cape May Inlet and Harbor are connected to the Delaware Bay via the Cape May Canal. Cape Island Creek is a tidal creek which connects the Harbor and a wetland complex to the west known as the Fow Tract. The eastern end of the City is occupied by the United States Coast Guard (USCG) Training Center, which occupies approximately 20% of the land area in the City. Another wetland complex known as the Sewell Tract is located on the east side of the city adjacent to the USCG Training Center.

The study area includes an area known as the Frog Hollow Neighborhood which is low-lying and particularly prone to flooding. Frog Hollow's approximate boundaries are the triangle that is formed by Beach Avenue, Madison Avenue, and Washington Street.

The year-round population of the City is approximately 3,500 residents and the summer population is typically between 40,000 and 50,000 people.

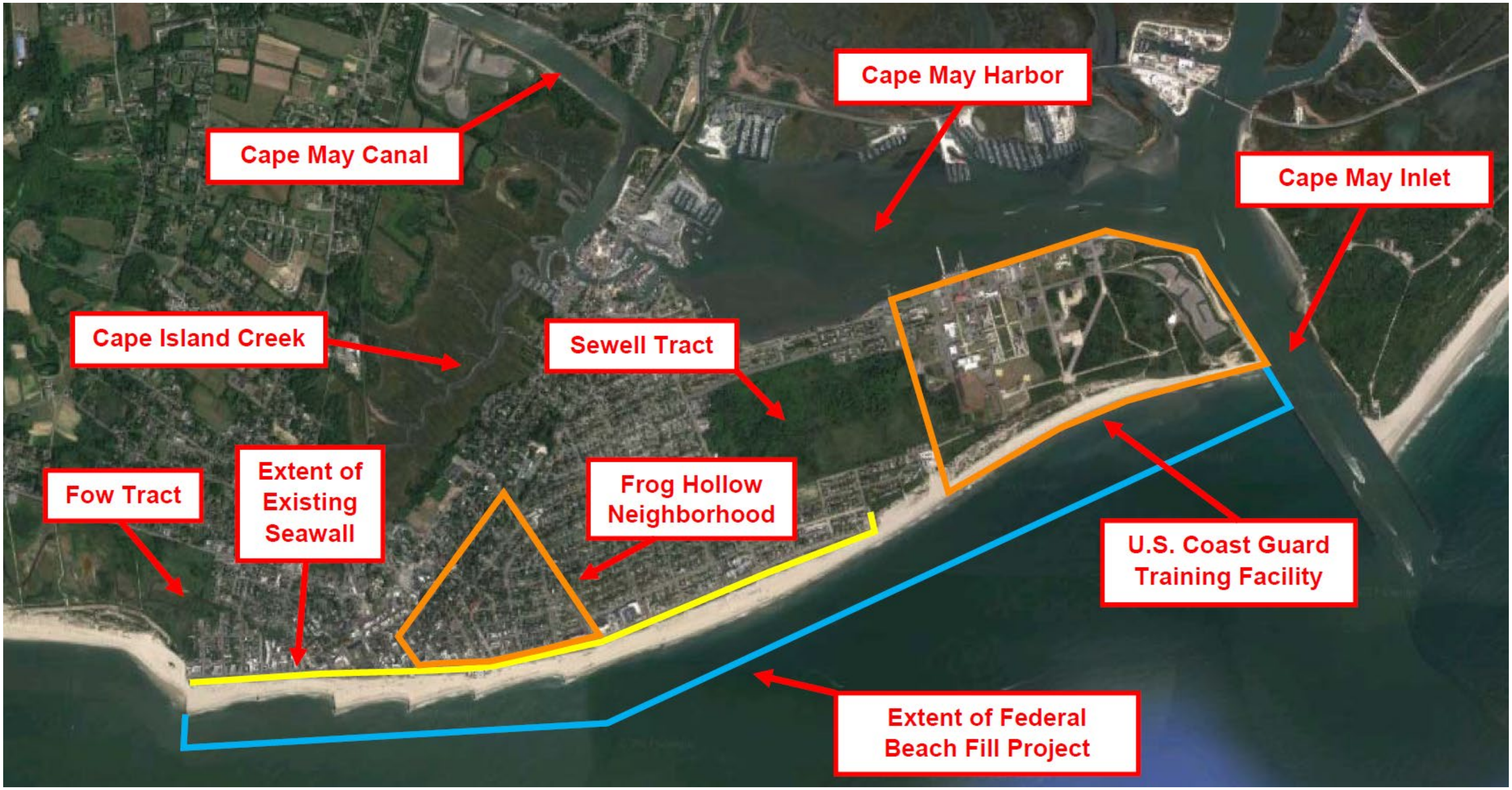


Figure 4: Features of the study area.

2.1 Topography

Historically, much of Cape May was a tidal wetland (Figure 5). Over the course of the early 1900s, the area was gradually filled for residential and Federal Government land development purposes. The topography of Cape May in the vicinity of the study area generally has the highest elevations to the west and the north (Figure 6). Along Lafayette Street, which is located between Frog Hollow and Cape Island Creek, ground elevations are approximately greater than +10 feet North American Vertical Datum of 1988 (NAVD88). The north central part of the city, in the vicinity of Illinois and Virginia Avenues, also has ground elevations which are generally greater than 10 feet. The lowest ground elevations in the city are within Frog Hollow (approximately +3 to +4 feet (NAVD88) and along Beach Avenue (approximately +5 to +6 feet (NAVD88).

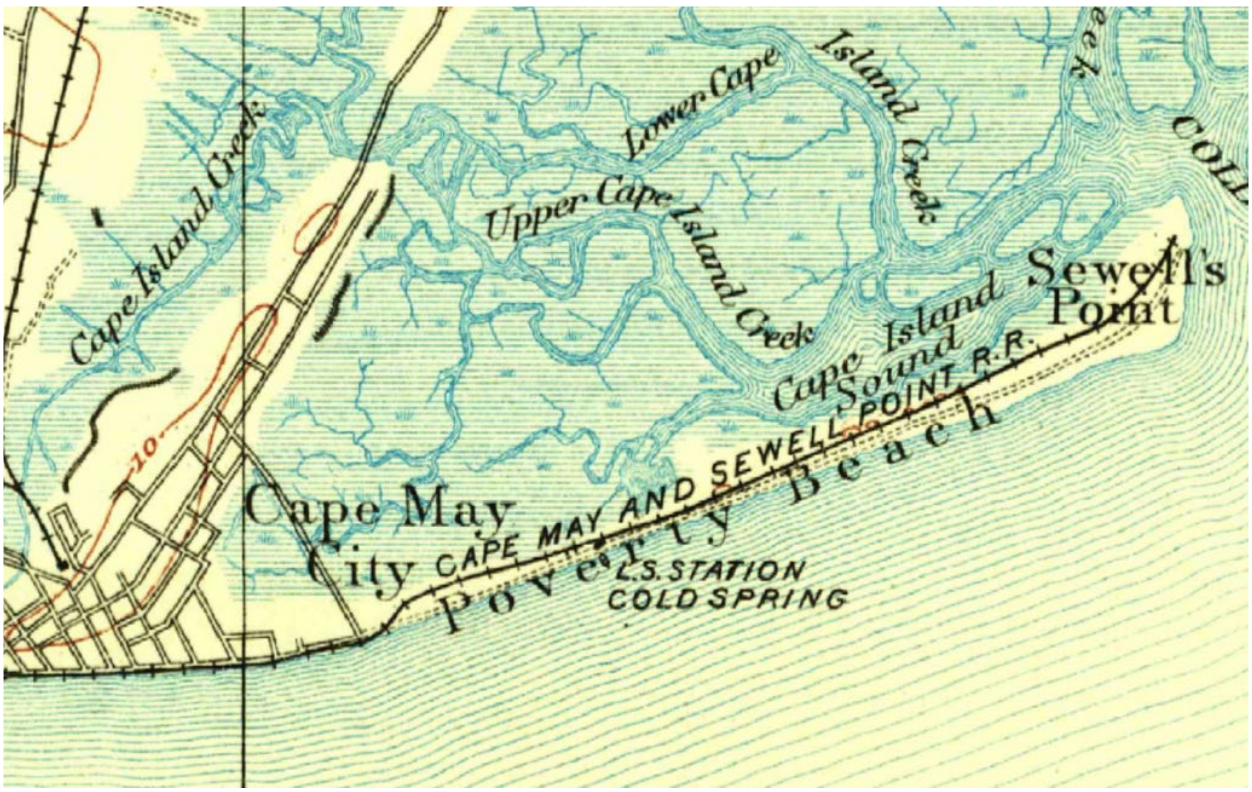


Figure 5: City of Cape May historic topographic map from 1888.

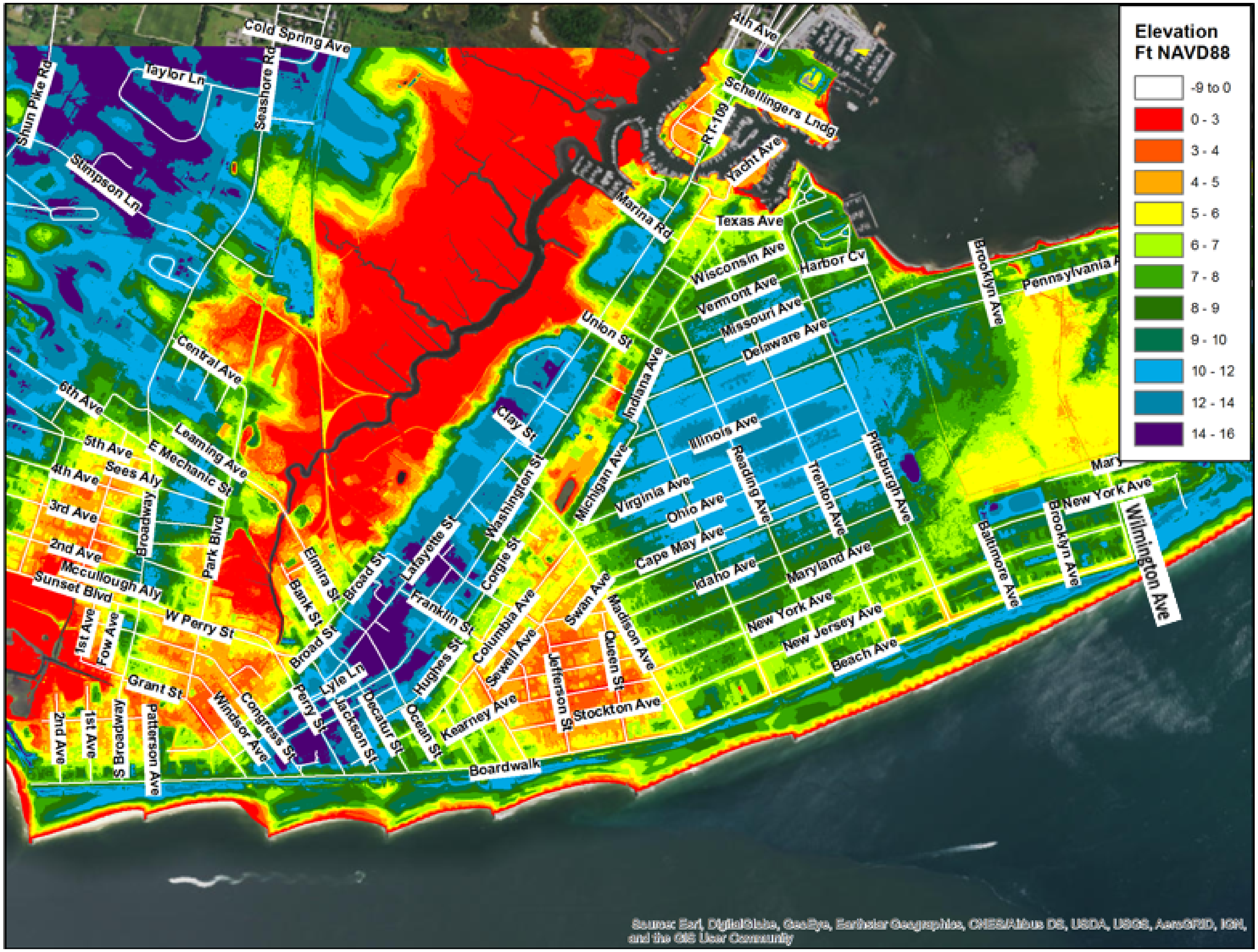


Figure 6: Topographic map of the City of Cape May.

2.2 Existing CSRM Measures

2.2.1 Existing Seawall

A timber bulkhead provided coastal storm risk management along the ocean front of Cape May through the 1960s. The existing seawall was constructed by the State of New Jersey and designed in association with the City of Cape May following the destruction of the bulkhead and boardwalk by the Ash Wednesday Storm in March of 1962. The seawall is constructed of large rocks (approximately 4 to 5 feet in diameter) with concrete grouted within the voids (Figure 7). It extends from 2nd Avenue on the west side of the City to Wilmington Avenue on the east side. From 2nd Avenue to Madison Avenue, the top of the seawall is covered by an asphalt promenade that is used for recreation (Figure 8). This length of the seawall also has a concrete retaining wall on the street side. From Philadelphia Avenue to Wilmington Avenue, the seawall does not have an asphalt promenade and has a two-foot timber bulkhead on the street side (Figures 9 and 10). Ownership and maintenance of this seawall as well as the street-side concrete retaining wall and timber bulkhead is performed by the City of Cape May.

Figure 7: Typical seawall construction from Philadelphia Ave to Wilmington Ave.

Figure 8: Existing seawall west of Madison Avenue, showing paved top with the concrete wall to the right.

Figure 9: Sections of seawall with and without asphalt promenade.

Figure 10: Existing seawall east of Philadelphia Avenue.

A survey of the seawall was performed in December 2015 to determine the variation in the top elevation along its entire length. Three point transects were collected every 10 feet on the street side, the centerline, and the ocean side. Figure 11 illustrates that the seawall has a consistent top elevation of between 9 and 11 feet (NAVD88) from 2nd Avenue to Howard Street (where Convention Hall is visible on the beach). Figures 11 and 12 both illustrate that there are some sections of the seawall that have a top elevation between 7 and 9 feet (NAVD88). Although the seawall at the corner of Beach and Wilmington Avenues appears to have a top elevation of 11 to 13 feet (NAVD88) on Figure 12, these elevations represent the top of the sand dune which has accreted on the ocean side of the wall. The actual elevation of the top of the wall under the sand is approximately 9.5 feet (NAVD88).

2.2.2 Federal CSRM Project

Coastal storm risk management is also provided along the shorefront of Cape May by a Federal beach project that extends from the west side of Cape May Inlet to the terminal groin near 2nd Avenue. Initial construction was completed in 1991 and periodic nourishment is scheduled for every 2 years. The design includes a berm and groins but does not include a dune. Any dunes that are present on the ocean side of the seawall have accreted naturally or were constructed by the City. The seawall is not located within the footprint of the Federal CSRM project.

2.2.3 Municipal Storm Water Pump Stations

There are two storm water pump stations located in the Frog Hollow area which were designed and constructed to facilitate the drainage of storm water from the low-lying city streets. The Benton Avenue Pump Station is located near the intersection of Queen Street and Benton Avenue and was constructed in the early 1980s. This station has three pumps, one electric, and two fueled by diesel. The electric pump has a 7,000 gallons per minute (gpm) capacity and each diesel pump has a 25,000 gpm capacity. Only two of the pumps can be operating at the same time, so the maximum pumping rate would be both of the diesel pumps combined at 50,000 gpm.

The Madison Avenue Pump Station is located at the intersection of Madison Avenue and Beach Avenue and was constructed in 1987. This station has two pumps, both electric, and both with individual pumping capacities of 7,000 gpm. They are designed to function in a lead/lag sequence, with the second pump operating only when the first is at maximum capacity. Both pump stations discharge storm water to the ocean.

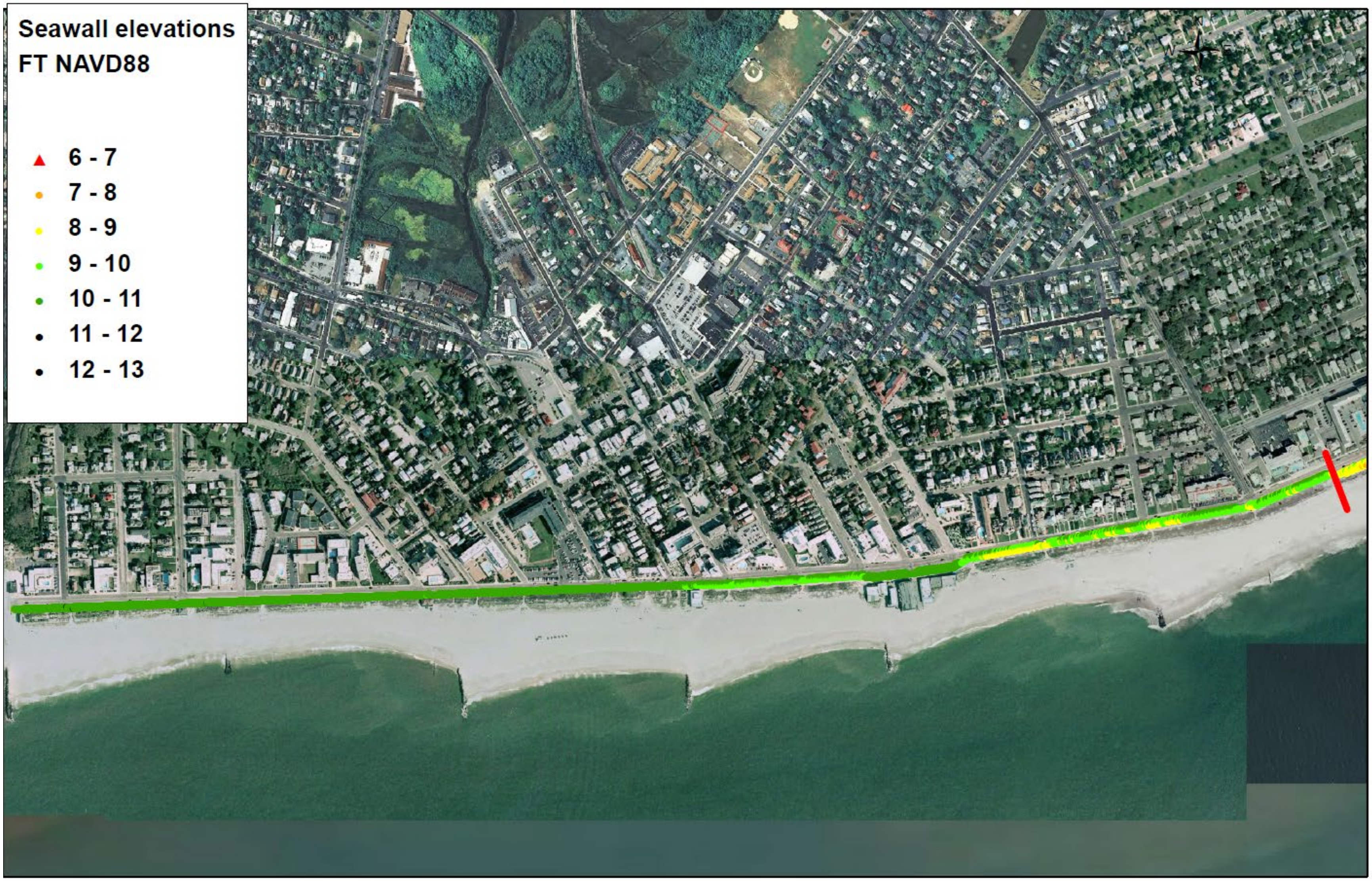


Figure 11: Elevation of top of seawall from 2nd Avenue to Madison Avenue (red line is transition from asphalt to no asphalt).

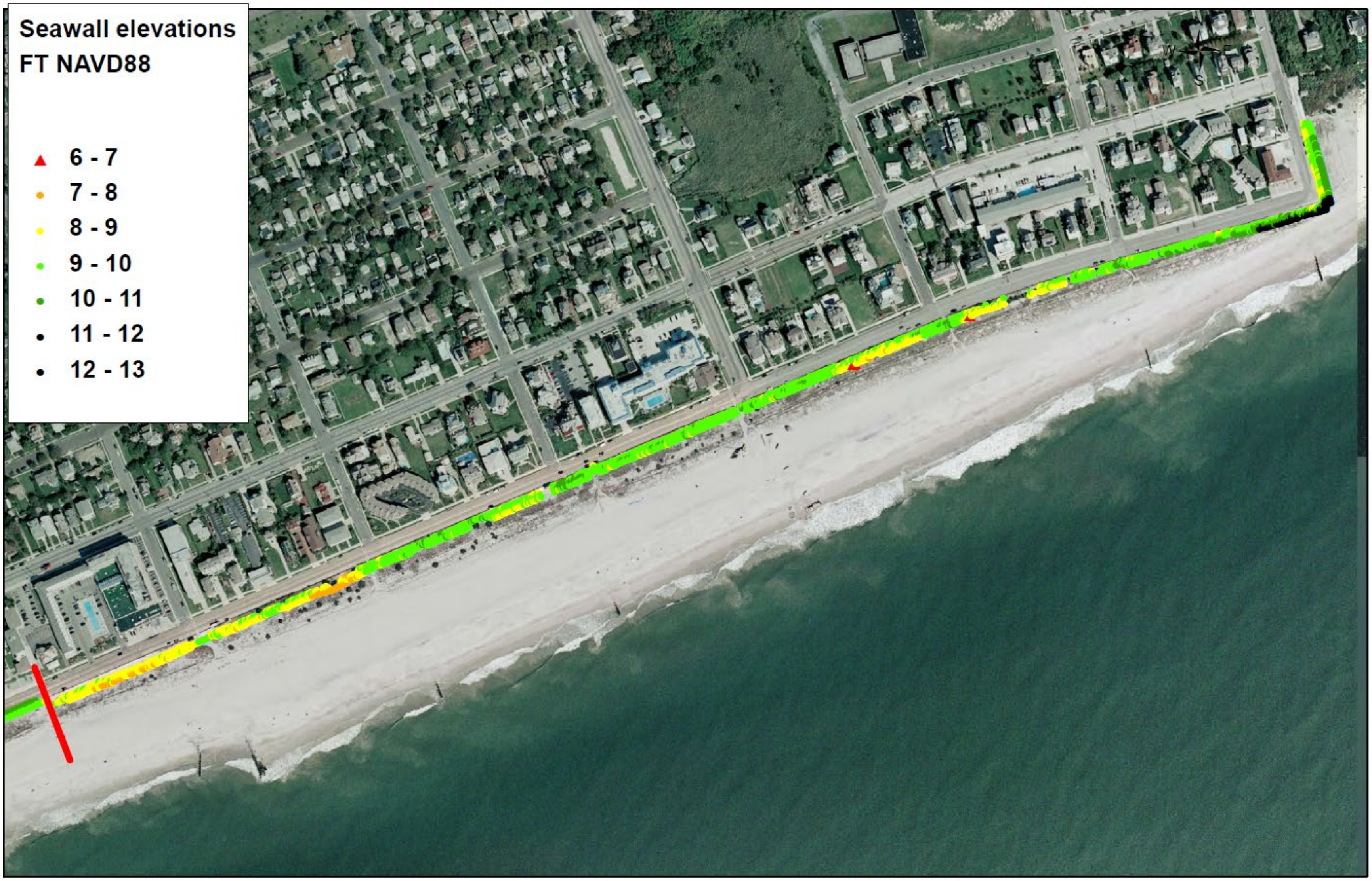


Figure 12: Elevation of top of seawall from Philadelphia Avenue to Wilmington Avenue.

2.3 Describing Storms and Flood Levels

Floods are often defined according to their likelihood of occurring in any given year at a specific location. The most commonly used definition is the "100-year flood." This refers to a flood level or peak that has a one in 100, or 1 percent chance of being equaled or exceeded in any year (i.e. 1 percent "annual exceedance probability" or "AEP"). Therefore, the 100-year flood is also referred to as the "1 percent flood," or as having a "recurrence interval" or "return period" of 100 years. In this report, "1 percent flood" is used to describe this type of event.

A common misinterpretation is that a 1 percent flood is likely to occur only once in a 100-year period. In fact, a second 1 percent flood could occur a year or even a week after the first one. The term only means that the average interval between floods greater than the 100-year flood over a very long period (say 1,000 years) will be 100 years. However, the actual interval between floods greater than this magnitude will vary considerably.

In addition, the probability of a certain flood occurring will increase as the overall period of time increases. For example, over the life of an average 30-year mortgage, a home located within the 1 percent flood zone has a 26 percent chance of being flooded at least once. Even more significantly, a house in a 10 percent flood zone is almost certain to be flooded at least once (96 percent chance) for the same 30-year mortgage. The probability (P) that one or more of a certain-size flood occurring during any period will exceed a given flood threshold can be estimated as:

$$P = 1 - \left[1 - \frac{1}{T}\right]^n$$

Where T is the return period of a given flood (e.g., 100 years, 50 years, 25 years) and n is the number of years in the period. The probability of flooding by various return period floods in any given year and over the life of a 30-year mortgage is summarized in Table 1.

Table 1: Examples of flooding by various return periods.

Return Period (years)	Chance of flooding in any given year (equaled or exceeded)	Percent chance of flooding during a 30-year mortgage
10	10 in 100 (10%)	96%
50	2 in 100 (2%)	46%
100	1 in 100 (1%)	26%
500	0.2 in 100 (0.2%)	6%

Because of the potential confusion, recent USACE guidance recommends use of the annual exceedance probability terminology instead of the recurrence interval or return period terminology. For example, the “1 percent AEP flood” or “1 percent chance exceedance flood” is a flood event that has a 1 percent chance of occurring any given year. The terms may be shortened to “1 percent flood”, as opposed to oft-referenced but confusing “100-year flood.” This report uses the short form “1 percent flood”.

It is noted that floods driven by coastal storms are influenced by changes in mean sea level. As mean sea level rises, flood levels will increase for a given storm frequency. Hence, AEP flood levels vary in time with changes in mean sea level. Analyses for this study include the impacts of future sea level rise on flood levels and evaluate flood responses to three (low, medium, and high) future relative sea level change curves.

2.4 Flooding in Cape May

Cape May has historically experienced flooding problems caused by the combined effects of elevated ocean water levels (e.g. storm surge), wave action, and heavy precipitation during tropical cyclones and nor'easters. The location of the city at the southern tip of New Jersey makes it particularly vulnerable to coastal storms which gather strength over the ocean. The most damaging coastal storm events in Cape May over the past 60 years include: the Ash Wednesday Storm in March 1962, the nor’easter in 1980, Hurricane Gloria in 1985, the Halloween Storm in 1991, the nor’easters in January and December 1992, Hurricane Irene in 2011, Hurricane Sandy in 2012, and the nor’easter in January 2016.

Ocean water levels are recorded by the National Oceanic and Atmospheric Administration (NOAA) at the Cape May, NJ Tide Gage (Station ID 8536110). This gage is located at the west end of the Cape May Canal at the Cape May – Lewes Ferry terminal. This tide gage was established in 1965 and provides the longest continuous record of coastal flooding in the area. The top ten highest water levels recorded over the period of record are listed in Table 2. No adjustment to water surface elevation has been made for sea level rise or fall in this table.

Table 2: Top Ten Highest Water Levels at Station 8536110

Rank	Elevation (Ft NAVD88)*	Date	Storm Type
1	5.96	1/23/2016	Nor'easter
2	5.87	10/29/2012	Hurricane Sandy
3	5.79	9/27/1985	Hurricane Gloria
4	5.67	10/29/2011	Nor'easter
5	5.64	10/25/1980	Nor'easter
6	5.53	12/11/1992	Nor'easter
7	5.52	1/4/1992	Nor'easter
8	5.50	3/3/1994	Nor'easter
9	5.37	8/28/2011	Hurricane Irene
10	5.25	10/14/1977	Nor'easter

*Source: NOAA/NOS, "Top Ten Highest Water Levels for long-term stations (as of 4/2018)"

Figure 13 displays the top ten highest water levels (in red) compared to the 1%, 10%, 50%, and 99% annual exceedance probability (AEP) water levels (in blue) for the Cape May tide gage. It can be seen that the top three events fall between the 1% and 10% AEP elevations, and the remainder between the 10% and 50% AEPs.

A clarification should be made that while the Cape May, NJ gauge represents back bay water levels, the Lewes, DE Tide Gage (Station ID 8557380) is more representative of ocean water levels that influence coastal overtopping and was used in the coastal analysis. Water level information for the Lewes, DE Tide Gage is provided in the Engineering Appendix.

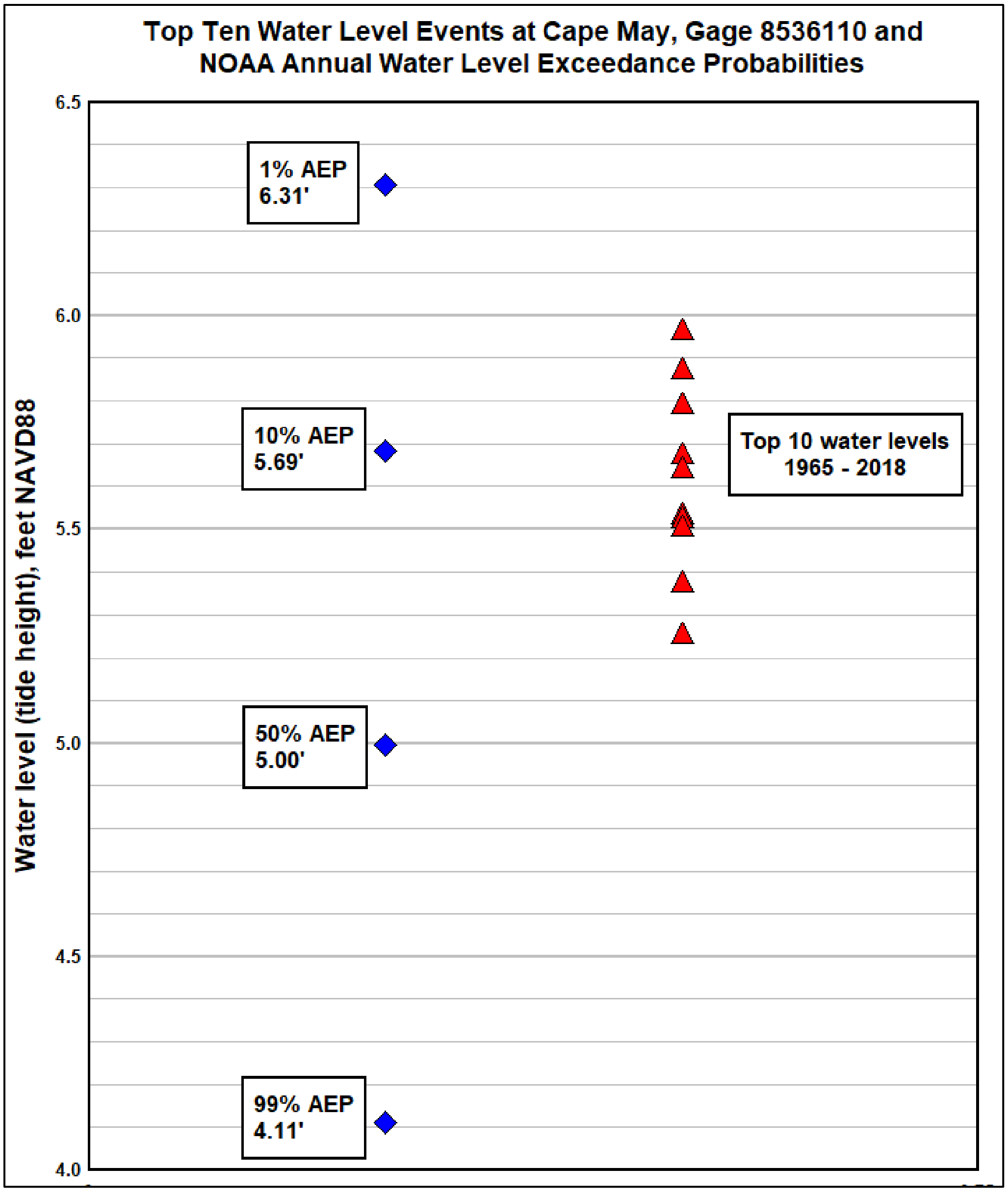


Figure 13: Comparison plot of top ten water levels and AEPS.

Figure 14 provides the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for the City of Cape May. A majority of the structures in the study area are susceptible to flooding from a 1% AEP flood event ("AE" yellow areas). The red areas ("VE") along the ocean front and the harbor are designated as an area with a 1% or greater chance of flooding and an additional hazard associated with storm waves. The green areas ("X") are designated as areas of moderate flood hazard, usually the area between the limits of the 1% and 0.2% AEP flood events.

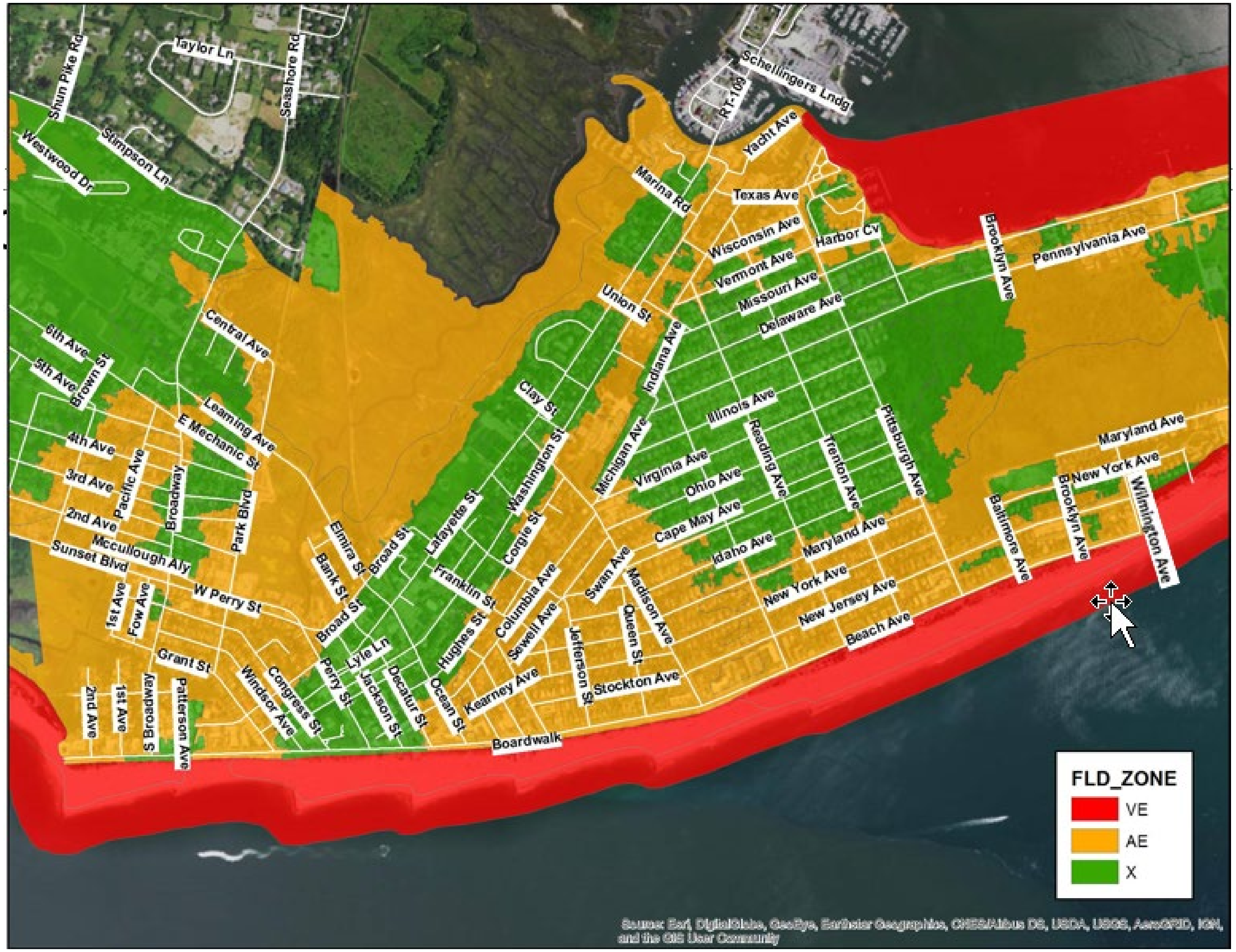


Figure 14: FEMA Flood Insurance Rate Map for the City Cape May.

2.5 Historic Coastal Storm Events

Coastal storms, both tropical hurricanes and extratropical nor'easters, have routinely resulted in flood waters entering the City of Cape May causing both physical and nonphysical damages. This includes overtopping of the existing coastal seawall, flanking from the western edge of the city, and inundation from the back bay. In recent years, four coastal storm events are the most historically relevant and their impacts are briefly synopsized in the section below.

Hurricane Sandy – October 29, 2012

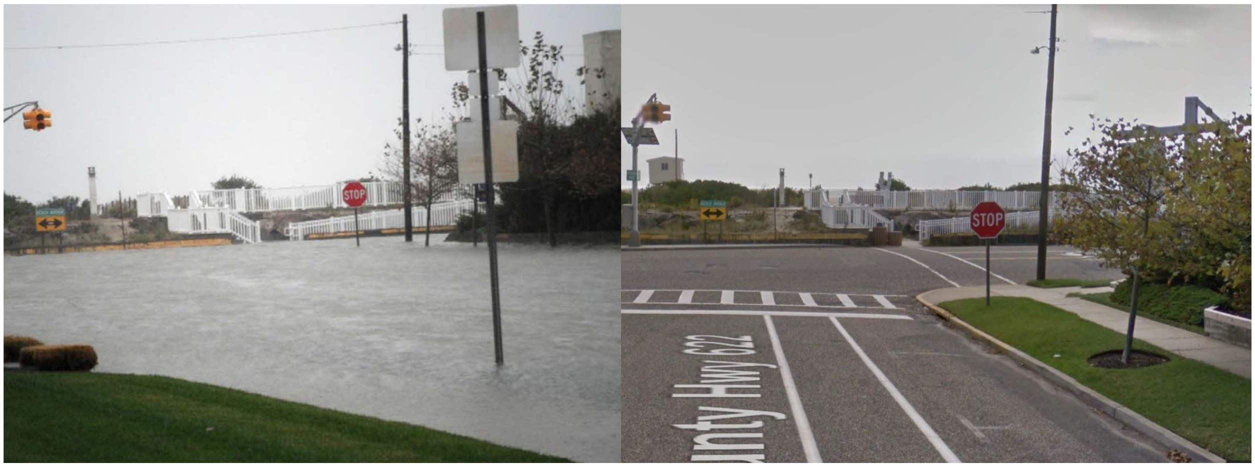
Tropical Hurricane Sandy formed in the Caribbean on October 22nd and would make landfall in New Jersey a week later. The hurricane reached Category 3 status with peak winds of 115mph. The storm resulted in an estimated $30 billion (FY2013) regional economic losses with 37 attributed deaths throughout the state. An estimated two million homes in the state of New Jersey lost power and 346,000 residential structures were damaged or destroyed. Though the City of Cape May did not receive the same intensity of coastal forces as other locations in the northern region of the state, the City was under mandatory evacuation from October 26th and received both inundation from the storm event and damage to both residential and commercial structures.

The highest water surface elevations recorded during Hurricane Sandy equated to approximately a 5% flood in the vicinity of Cape May. During the storm, the ocean overtopped the seawall in a number of locations, but primarily at the corner of Beach and Wilmington Avenues on the east end of the City. Local residents witnessed the ocean "pouring over the seawall like a waterfall" in this location during both high and low tides. Wave and tidal action from Sandy brought approximately 8,000 cubic yards of sand over the seawall at the intersection and onto Beach Avenue and adjacent residential properties. Sand deposition in some areas was approximately 8 feet high (Figure 15). The City's cleanup costs for the sand deposition were approximately $30,000.

Figure 15: Intersection of Beach and Wilmington Avenues following Hurricane Sandy.

When the ocean overtops the seawall during an event like Hurricane Sandy, Beach Avenue floods (Figure 16) and acts as a drainage channel that funnels the ocean water west into Frog Hollow, the lowest-lying part of the City. Local residents reported at least 3 feet of water in the streets of Frog Hollow during Hurricane Sandy. Local officials also reported that the pump stations in Frog Hollow were operating for approximately 48 hours straight throughout the storm. Rainfall amounts during Hurricane Sandy were relatively low for a large coastal storm (about 10 inches between 28 and 31 October 2012) and should have been adequately managed by the pump stations to keep the area free of flooding. However, the presence of 3 feet of water would indicate that the storm water system was overwhelmed by the additional input of the ocean water. If the pumping stations had failed to function during Hurricane Sandy, the flooding would have been much more significant.

In other sections of the study area, flooding reached 3 blocks north of Beach Avenue to Maryland Avenue, and as far west as Mt. Vernon Avenue, adjacent to the Fow Tract.



October 29, 2012 October 2013 (Google Street View)

Figure 16: Intersection of Beach and Pittsburgh Avenues during Hurricane Sandy (left).

According to National Flood Insurance Program (NFIP) data which was provided by FEMA to the Philadelphia District, approximately 26 structures in the study area were damaged by ocean-side flooding during Hurricane Sandy which resulted in $20 million in damages. Approximately 50 structures in the study area are classified as Repetitive Loss properties according to the NFIP. This means that they have had two or more flood claims over $1,000 paid by the NFIP within any 10-year period.

January 1992 Nor'easter – January 4, 1992 – Extratropical nor'easter that formed January 2nd along the East Coast of the United States with peak winds of 89mph. The storm resulted in flooding and elevated water levels across the Mid-Atlantic. In Cape May Point, storm waters breached the dune system resulting in significant inundation throughout the borough. Flooding in the City of Cape May resulted in inundation and sand deposits upward of 3 feet in some locations. Direct physical damages in the state of New Jersey were estimated around $45 million (FY1992) with 4,000 homes affected.

October 1991 Nor'easter – October 31, 1991 – Extratropical nor'easter also referred to as the 1991 Perfect Storm or the Halloween Storm. Forming on October 31st off the eastern Canadian coast, the nor'easter absorbed Hurricane Grace and caused significant damage to southern New Jersey with peak winds of 75mph. Direct physical damages are estimated around $75 million (FY1992) with significant reported erosion of dune and berm systems, particularly in Avalon and Cape May.

Hurricane Gloria – September 27, 1985 – Tropical Hurricane Gloria formed in the Caribbean on September 16th and would make landfall in New Jersey a week and half later. The hurricane reached Category 4 status with peak winds of 145mph. Damage estimates for southern New Jersey are not available, but overall damages from Hurricane Gloria are estimated at $900 million (FY1985) with fourteen attributed deaths. Over four million people were left without power from the storm including hundreds of thousands of New Jersey residents. Significant beach erosion was reported along New Jersey barrier islands.

3.0 Existing Environment

3.1 Air Quality

The Environmental Protection Agency (EPA) adopts National Ambient Air Quality Standards (NAAQS) for the common air pollutants, and the states have the primary responsibility to attain and maintain those standards. Through the State Implementation Plan (SIP), the New Jersey Department of Environmental Protection (NJDEP) manages and monitors air quality in the state.

The Clean Air Act requires that all areas of the country be evaluated and then classified as attainment or non-attainment areas for each of the National Ambient Air Quality Standards. Cape May County, New Jersey is within the Philadelphia-Wilmington-Atlantic City Non-attainment Area. As such, emissions from the Cape May Seawall Shoreline Erosion project must be below 100 tons of NOx and 50 tons of VOC per year. An Air Quality Conformity Determination Record of Non-Applicability (RONA) was completed and can be found in the Environmental/Cultural Support Document Appendix.

EPA is also active in addressing emissions related to greenhouse gases and their effect on the environment and climate change. Greenhouse gases include carbon dioxide, methane, nitrous oxide and fluorinated gases. In 2013, carbon dioxide accounted for 82% of the US greenhouse gas emissions. Carbon dioxide enters the atmosphere through burning fossil fuels (coal, natural gas and oil), solid waste, trees and wood products, and also as a result of certain chemical reactions (e.g., manufacture of cement). Carbon dioxide is removed from the atmosphere when it is absorbed by plants as part of the biological carbon cycle.

3.2 Terrestrial

While native vegetation is practically non-existent in most of Cape May due to extensive development in the area, the Cape May Peninsula is a geographic merging point for many northern and southern plant species. An example of this is that both the northern bayberry and southern wax myrtle can be found growing within parts of Cape May and the surrounding area.

Vegetation that is present in and around the project area is primarily understory, scrub shrub species that are typical of beach dune habitats in New Jersey. These species include American beach grass (*Ammophila breviligulata*), bayberry (*Myrica pensylvanica*), rugosa rose (*Rugosa rosa*), wax-myrtle (*Myrica cerifera*), and seaside goldenrod (*Solidago sempervirens*). The sand on top of the seawall at the corner of Beach and Wilmington Avenues is sparsely vegetated due to frequent disturbance primarily from pedestrian foot traffic, but also from wind, waves, and placement of sand by the nearby Federal CSRM project. Colonizing vegetation has not had the opportunity to take root. Sand along the seawall to the west and north is more densely vegetated since it less susceptible to the conditions mentioned above.

3.3 Aquatic

The inter-tidal zone of the Atlantic Ocean is approximately 140 feet south the seawall at the corner of Beach and Wilmington Avenues. The wetland complex known as the Sewell Tract is located approximately 0.5 miles to the north of the corner. Under normal conditions, there are no aquatic resources in the immediate vicinity of the seawall, however the ocean does overtop the seawall during large storm events.

3.4 Wildlife

3.4.1 Birds

The wetlands in the Sewell Tract provide important waterfowl staging habitat. Waterfowl that may occur within the project area include tundra swan (*Cygnus columbianus*), mute swan (*Cygnus olor*), Canada goose (*Branta canadensis*), brant (*Branta bernicla*), greater snow goose (*Chen caerulescens*), northern pin-tail (*Anas acuta*), green-winged teal (*Anas crecca*), blue-winged teal (*Anas discors*), and American black duck (*Anas rubripes*).

Great blue herons (*Ardea herodias*), black-crowned night herons (*Nycticorax nycticorax*), great egrets (*Casmerodius albus*), and snowy egrets (*Egretta* thula) occur in the shallows of tidal creeks and emergent flats in the vicinity of the project area.

Several raptors occur year-round in the project area. The northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), rough-legged hawk (*Buteo lagopus*), short-eared owl (*Asio flammeus*), and bald eagle (*Haliaeetus leucocephalus*) forage in the marshes during the winter. The osprey (*Pandion haliaetus*) is a common summer resident in the general area, foraging primarily in shallow water areas.

Neotropical songbirds also migrate in and out of the general project area in the spring and fall. These species may include the red-bellied woodpecker (*Centurus carolinus*), blue jay (*Cyanocitta cristata*), tree swallow (*Iridoprocne bicolor*), versper sparrow (*Pooecetes gramineus*), American robin (*Turdus migratorius*), and eastern bluebird (*Sialia sialis*). Other species known to inhabit the area are the savannah sparrow (*Passerculus sandwichensis*), song sparrow (*Melospiza melodia*), mourning dove (*Zenaida macroura*), gray catbird (*Dumetella carolinensis*), northern mockingbird (*Mimus polyglottos*), redwinged blackbird (*Agelaius phoenicues*), and brown thrasher (*Toxostoma *rufum*). Many of these birds remain to breed in the vast woodlands along the coast. The more common gull species observed in the area include the laughing gull (*Larus atricilla*), herring gull (*L. argentatus*), and ring-billed gull (*L. delawarensis*).

Several species of beach nesting birds may also be found along the beaches in Cape May. They include least terns (*Sternula antillarum*), black skimmers (*Rynchops niger*), American oystercatchers (*Haematopus palliatus*), and piping plovers (*Charadrius melodus*). Other beach species such as sanderlings (*Calidris alba*), sandpipers (*Calidris pusilla*), and multiple gull species also frequent the beaches in this area.

3.4.2 Mammals, Reptiles and Amphibians

A number of mammals, reptiles, and amphibians are associated with the scrub-thicket habitats, tidal marsh and urban areas and beaches in the vicinity of the study area. These species include: Fowler's toad (*Bufo woodhousei fowleri*), eastern hognose snake (*Heterodon platyrhinos*), box turtle (*Terrapene carolina*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethicus*), river otter (*Lutra canadensis*), whitefooted mouse (*Peromyscus leucopus*), eastern cottontail (*Sylvilagus floridanus*), and meadow vole (*Microtus pensylvanicus*). The red fox (*Vulpes fulva*) and white-tailed deer (*Odocoileus virginianus*) are occasional transient visitors and enter the area from neighboring uplands to forage.

The northern diamondback terrapin (*Malaclemys terrapin terrapin*) is a common reptilian species found in saltmarshes. They exclusively inhabit coastal salt marshes, estuaries, tidal creeks and ditches with brackish water, but utilize beaches, dunes, and gravelly areas above the high tide line to nest. A typical nest includes a clutch of 8-12 eggs that are laid from June to mid-July. Depending on the temperature of the soil, eggs typically hatch in 61-104 days. However, hatchlings sometimes overwinter in nests (those that were laid later in the year) and emerge the next year (in April). Emerging hatchlings immediately seek vegetation for cover to avoid predation (usually from gulls and crows). Northern diamondback terrapins are believed to be in decline based on habitat losses, barriers to nesting, excessive harvesting, mortality from becoming entrapped in crab traps, road crossing mortalities, and increases in predators such as raccoons and skunks that are often associated with urbanized environments (Conserve Wildlife Foundation of NJ, 2016). Because of these stressors and an apparent decline in the population, the northern diamondback terrapin is proposed as a “Species of Concern” in NJ, however, no formal rule has been filed to date.

3.4.3 Threatened and Endangered Species

The Federally-listed (threatened) and state-listed (endangered) piping plover (*Charadrius melodus*) and the least tern and black skimmer (both State endangered species) can be found nesting along coastal beaches near the study area. Piping plovers have been nesting on a fairly regular basis in Cape May City since 1997 and along the Coast Guard beaches since at least 1988. The project area itself generally supports suitable piping plover nesting habitat. Piping plovers nest above the high tide line on mainland coastal beaches, sand flats, and barrier island coastal beaches. Nesting sites are typically located on gently sloping foredunes, blowout areas behind primary dunes, washover areas cut into or between dunes, ends of sand spits, and on sites with deposits of suitable dredged or pumped sand. The nesting season usually begins in March when the birds arrive and can extend as late as the end of August. Shortly after hatching, the young leave the nest and begin foraging within the intertidal zone.

Food for adult plover and chicks consists of invertebrates such as marine worms, fly larvae, beetles, crustaceans, or mollusks. Feeding areas include intertidal portions of ocean beaches, ocean washover areas, mudflats, sandflats, wrack lines (organic material left behind by high tide), shorelines of coastal ponds, lagoons, and salt marshes.

The seabeach amaranth (*Amaranthus pumilus*) is a Federally-listed threatened plant. The seabeach amaranth is an annual plant, endemic to Atlantic coastal plain beaches, and primarily occurs on overwash flats at the accreting ends of barrier beach islands and lower foredunes of non-eroding beaches. The species occasionally establishes small temporary populations in other areas, including bayside beaches, blowouts in foredunes, and sand and shell material placed as beachfill. Although seabeach amaranth has not been identified in the project area, the species has recently naturally recolonized coastal sites within other portions of New Jersey, New York and Maryland.

The red knot (*Calidris canutus rufa*) is a Federally-listed threatened species. Red knots may be present in and around the Cape May area during spring and fall migration. Some birds may also be found lingering in the area through the early winter. The red knot's spring migration to this area is timed with the release of horseshoe crab eggs along the Delaware Bay coastline. This generally abundant food supply helps the red knot to increase its body weight enough to be able to continue its migration to the red knot's arctic breeding grounds.

3.5 Cultural Resources

As a federal agency the USACE has certain responsibilities for the identification, protection and preservation of cultural resources that may be located within the Area of Potential Effect (APE) associated with the proposed Cape May Seawall Project (Project). Present statutes and regulations governing the identification, protection and preservation of these resources include the National Historic Preservation Act of 1966 (NHPA), as amended; the National Environmental Policy Act of 1969; Executive Order 11593; the regulations implementing Section 106 of the NHPA (36 CFR Part 800, Protection of Historic Properties, August 2004).Significant cultural resources include any material remains of human activity eligible for inclusion on the National Register of Historic Places

(NRHP). This work is done in coordination with the New Jersey State Historic Preservation Office (NJSHPO), Tribal Nations and other consulting parties.

The City of Cape May was added to the National Register of Historic Places (NRHP) in 1970, was designated as a National Historic Landmark (NHL) by the National Park Service in 1976, and is noted as having "one of the largest collections of late nineteenth-century frame buildings left in the United States. It contains over 600 summer houses, old hotels, and commercial structures that give it a homogenous architectural character." (Carolyn Pitts, National Park Service). The City is also listed on the New Jersey Register of Historic Places.

The physical area of potential effect (APE) of the proposed undertaking is reclaimed land which resulted from the filling of coastal wetlands at the northeastern extent of the cape may peninsula directly southwest of Cape May Inlet, directly behind the Poverty Beach and Sewell Point barrier spit. Due to this being historically filled land there is a very low potential for impacting subsurface archaeological deposits. Therefore, no Prehistoric Context will be provided.

Historic Context

Cape May is found at the southern end of a peninsula and county named for Captain Cornelius Jacobus Mey, one of a group of Dutch sea captains who explored the bay in the first quarter of the seventeenth century after it was encountered in 1609 by Henry Hudson. As in other areas of the Delaware River Valley, Cape May County was inhabited in semi-permanent settlements and seasonal camps by the Lenni Lenape people. These settlements eventually grew into small whaling towns. By the end of the century the total population of the county was approximately 350 people, with no courthouse or organized town layout (Dorward, 1992).

In the first half of the eighteenth century the population grew with influxes of more whalers, but also endured heavy losses to disease. The economy was primarily agricultural supplemented with whale fishing and cedar harvesting. The period after the French and Indian War in the 1760s was one of growing prosperity in the Delaware River Valley. Philadelphia emerged from the war as the colonies' most prosperous city, with the Cape May shore being frequented as a type of resort for Philadelphians.

In 1791, Ellis Hughes sought permission from the county to operate an inn. Hughes advertised his accommodations, the Atlantic Hall, in the Philadelphia Gazette stating "extensive house rooms, with fish, oysters, crabs and good liquors" with "view of the shipping, which enter and leave the Delaware" and thus beginning the resort-style growth of Cape May County. Although growth slowed during the war of 1812, the period after the war showed a renewed interest in shore visitation by wealthy Philadelphians, arriving regularly during the summer season. During the 1830s and '40s, Cape May continued to grow to be one of the most popular summer destinations for urban vacationers, sparking a rapid growth in the number of guest accommodations, and other vacation venues.

Although growth slowed during the Civil War, post-war railroad construction shaped both the fate and the physical form of post-Civil war Cape May. Train travel made it easier and more efficient for tourists, goods and building supplies to arrive; thus, leading to a revitalization with the focus on fancier, more upscale resort accommodations and real estate ventures funded by wealthy railroad financiers. The revitalization period lasted until slowing of the national economy and eventual recession of 1873. In 1878, arson destroyed 35 acres of downtown including Congress Hall and the Columbia House and many other large hotels and boarding houses, devastating the resort economy of Cape May.

The fire of 1878 marked both the end of many of Cape May's oldest buildings and a watershed moment in the development of the resort. The rebuilding effort showed a shift in architecture toward American Queen Anne and Eastlake styles and away from the bracketed and ornamented Italianate styles that dominated Cape May from the mid-nineteenth century. At the beginning of the twentieth century, a "New Cape May" movement was stirring with a view toward a new era of development, although many newer buildings continued in the same style as the earlier structures created by the architect Stephen Decatur Button, with large porches with gingerbread trim, gables and turrets. The early twentieth century initiative had the largest and most significant effect on the physical form of the city.

Cape May began to fall out of fashion in the 1950s and '60s to other resort cities such as Atlantic City, known for its nightlife and gambling; and, to the Wildwoods, with its own distinctive "Doo Wop" architecture.

Area of Potential Effect

The USACE has defined the undertaking's APE as the construction footprint of the undertaking, as well as the visual impacts the undertaking may have on the Cape May Historic District. The USACE Project Delivery Team has defined and revised the visual impact APE several times in conjunction with the NJSHPO. However, currently the NJSHPO has not yet concurred with the visual impact APE until a full analysis has been performed. This full Visual Impact Assessment analysis cannot be conducted during this phase of the project but was addressed within the stipulations of the Programmatic Agreement as per the NJSHPO request. At this time, all parties agreed that the more natural sand treatment is the most acceptable.

3.6 Coastal Resources

A review of the Coastal Barrier Resources System (CBRS) Map did not identify any CBRS units or "Otherwise Protected Areas" within the Cape May City Seawall project area and vicinity (from https://www.fws.gov/CBRA/Maps/Mapper.html accessed on 8/27/2020).

3.7 Recreation

Recreation services provided by coastal communities are a major draw of tourism along the New Jersey Coast, which is a vital part of the State's economy. The City of Cape May and the surrounding area offers numerous recreational opportunities. The ocean side offers residents and visitors boating and beach activities such as swimming, surfing, surf fishing, sunbathing, and many other beach activities. The nearshore and offshore area offers activities such as fishing, boating, wave runners, kayaking, parasailing, and paddle boarding.

Cape May is also a well-known stopover for migrating birds and it plays a critical role within the Atlantic Flyway. The area provides crucial seasonal, migratory, overwintering, and year-round habitat for a variety of waterfowl, shorebirds, songbirds and raptors, making birding an important year-round recreational activity.

The City of Cape May has numerous crossovers along the ocean front that provide access to the beach over the existing seawall for the general public.

3.8 Noise

Sensitivity to ambient noise levels differs among land use types. For example, residential areas, libraries, schools, and churches are generally more sensitive to noise than commercial and industrial land uses. The majority of land use along the ocean front in the vicinity of the project is residential and light commercial, which generally have a higher sensitivity to ambient noise levels.

Typical noise levels on Beach Avenue are due to normal vehicular traffic, which is heaviest during the summer months. Noise from the beach would include year-round wave action. Additional noise from the beach during the summer would include various sized boats and personal watercraft such as wave runners, and beach visitors. Therefore, the existing noise level from traffic and other noise in the project area is moderate to low.

3.9 Hazardous, Toxic and Radioactive Waste (HTRW)

A review of the State Hazardous Waste Sites (SHWS) list (known contaminated sites in New Jersey) was provided by Environmental Data Resources, Inc. (EDR). This review, dated 1/25/2016 and prepared for the Delaware Avenue Continuing Authorities Program (CAP) Section 14 Study, has revealed that there are 14 SHWS sites, excluding the target property (Delaware Avenue CAP project area), within a one-mile radius of the target property for the Delaware Avenue CAP Section 14 Study (Table 3). The Cape May Seawall project site is located approximately 3,000 feet south of the Delaware Avenue CAP project area and therefore well within the one-mile radius area for the Delaware Avenue CAP Study investigation. Note that the one-mile radius of the Delaware Avenue CAP project area extends offshore of the Cape May Seawall Study Area so there is little to no concern that a SHWS site extends beyond the Delaware Avenue CAP project area radius. There are no SHWS sites at the Cape May Seawall Construction area that would be impacted. Furthermore, the current project site has been unaltered since the 1/25/2016 report, and there will be no soil removal during construction.

3.10 Socio-economics

As of the 2010 Census, there were 4,034 people in the permanent year-round population in Cape May City. Summer population increases substantially with the influx of visitors and second home usage in the town. The median income to a household in Cape May City was $33,452 in the 2010 Census, and the median income for a family was $46,250.

The tourism industry is one of the most important industries in Cape May City. Tourism generates approximately one out of every three jobs. The economy of Cape May City and adjacent coastal communities relies to some extent on a transient workforce to supply tourism industry employees, especially in the summer. Each summer tourists flock to Cape May City's beach, promenade, and restaurants for day trips and extended vacations. Cape May City and Cape May Point State Park (just south of the town) serve as a popular birding destination for tourists seeking to catch a glimpse of the migratory birds that stop along the shoreline. Birding as a tourism experience is year-round.

3.11 Visual and Aesthetic Values

The ocean is not visible from Beach Avenue on the east side of the City, from approximately Philadelphia to Wilmington Avenues. The top of the stone seawall is approximately 4 to 5 feet higher than the ground along Beach Avenue. Sand which has accreted and vegetation which has established also adds approximately 3 to 4 feet of elevation to the top of the seawall, which blocks pedestrian views of the ocean. Pedestrians must access the beach via one of the public access ramps which crossover the seawall to view the ocean. According to 2018 USACE topographic surveys, the top of the sand lying on top of the seawall at the corner of Beach and Wilmington Avenues is at an approximate elevation of 14 feet (NAVD88) (Figure 17).

Table 3: SHWS contaminated sites within 1 mile of project area

Site	Address	Status	Incident Type	Distance
1636 Delaware Avenue, Cape May	1636 Delaware Ave	Intermittent-Incident Reported 11/01/2012	Spill (Incident Source: City of Cape May Water & Sewer)*	Target Property
Yacht Harbor Marine LLC	1505 Yacht Ave	Closed	Wetlands/Stream Encroach	0.562 mi.
Island Creek Towers Condominium Assoc.	1488 Washington Street	Closed	NA	0.602 mi.
Cape May Riggins	1381 Washington Street	Closed	NA	0.603 mi.
1257 Cape May Avenue	1257 Cape May Ave	Closed	Under Ground Storage Tank (Resident)	0.625 mi.
USCG Training Center, Cape May	1 Munro Ave	Closed	Spill	0.628 mi.
1238 Wilson Drive	1238 Wilson Dr	Closed	Under Ground Storage Tank	0.705 mi.
Rosemans Boatyard	5 Rosemans Street	Closed	NA	0.727 mi.
Cape May Marine	12 Falcon Ridge	Closed	NA	0.734 mi.
Canyon Club Resort Marina	900 Ocean Dr	Closed	10 Tanks, varying contents	0.775 mi.
956 Ocean Drive	956 Ocean Dr	Closed	NA	0.843 mi.
1134 Lafayette Street	1134 Lafayette Street	Closed	NA	0.867 mi.
1101 Washington Street	1101 Washington Street	Closed	NA	0.905 mi.
Shinnecock 2	906 Schellengers Lane	Pending	Fish and Wildlife	0.586 mi.
Cape May Exxon	1149 RT 109	Open	4 Tanks (unleaded gasoline)	0.627 mi.

*This incident is listed under the target property; however, it lists the incident location as 643 Washington St, Cape May, NJ 08204.

Figure 17: View from Beach Avenue looking east toward Wilmington Avenue.

4.0 Plan Formulation

This section contains the plan formulation that was performed by the USACE Project Delivery Team (PDT) for the study. Plan formulation is used to identify a list of potential plans in order to manage coastal storm risk, and eventually recommend a selected plan. This analysis involved the establishment of plan formulation rationale, identification and screening of potential measures, and evaluation of conceptual plans to address study objectives outlined in the Corps of Engineers Planning Guidance Notebook, (1105-2-100) and the Corps Planning Manual.

The purpose of the formulation was to identify plans which are acceptable, implementable, and feasible from an environmental, engineering, economic and social standpoint. Plan formulation included input from the USACE PDT, the City of Cape May, and Cape May County. Site inspections were performed by the USACE PDT on March 24, 2014; August 20, 2015; April 6, 2016, December 1, 2016, and January 12, 2021.

4.1 Problems and Opportunities

The primary problem driving this study is overtopping of the seawall in the vicinity of Beach Avenue and Wilmington Avenue in Cape May City. This studied section of the Cape May Seawall is the “weak link” in the city’s CSRM system with storm water first cresting at this location for both high frequency and low frequency events. For low frequency events, storm inundation waters also eventually crest the rest of the seawall, flank from the western end of the city, and from the northern back bay. Given the limited scope of the study, only the “weak link” is studied and modified as part of the proposed alternative.

The USACE PDT met with City officials on April 6, 2016 to discuss flooding problems in Cape May and to visit the areas typically impacted by coastal storm flooding. Discussions focused on the source of the flooding in Frog Hollow and differentiating between floodwater intrusion through Cape Island Creek, rainfall runoff, and ocean water overtopping the seawall.

Cape Island Creek is a tidal creek which flows between Cape May Harbor and the wetlands in the Fow Tract. The direction of flow in the creek changes daily with the tide cycles. Based on topography alone (Figure 6) it appears that a low-elevation “bridge” may be present between the Creek and Frog Hollow which could convey tidal flood water into the neighborhood. However, City officials indicated that overland flow of floodwater from the Creek to Frog Hollow has never been observed, even during the record high storm surge levels of the Nor’easter of January 2016. Therefore, this pathway was ruled out as a source of flooding in Frog Hollow.

Normal rainfall events and associated runoff in Frog Hollow are adequately managed through the existing storm water system and pump stations described in Section 2.2.3. The PDT determined that rainfall alone is typically not the main source of flooding in Frog Hollow. However, rainfall can intensify flooding once ocean water has begun to overtop the seawall during large coastal storm events. The PDT concluded that seawall overtopping was the main problem which needed to be addressed.

City officials indicated that four storm events had overtopped the seawall in the last 26 years. These were the Halloween Storm of 1991 (Figure 18), the two nor’easters of 1992, and Hurricane Sandy.

Figure 18: Corner of Beach and Wilmington Avenues, Halloween Storm in 1991.

The Federal beach project was constructed by July 1991 and was in place for all of these events. In each storm, overtopping occurred primarily at the corner of Beach and Wilmington Avenues. Other isolated areas of the seawall along the ocean front may have been briefly overtopped during these storms, but the area in the vicinity of Beach and Wilmington Avenues was consistently the problematic location.

In an effort to determine why the area in the vicinity of Beach and Wilmington Avenues was the “weak spot” for flooding along the ocean front, the PDT examined recent survey profiles of the Federal beach project in conjunction with the seawall elevation survey data that was collected for this study. The PDT also discussed the Beach and Wilmington Avenues area with the USACE project manager for the Federal beach project. The project manager indicated that the area is considered an erosion “hot spot” where it is difficult to maintain sand which is placed during periodic beach renourishment cycles. Even when an additional lobe of sand has been added as a buffer at the Beach and Wilmington Avenues area, the tidal and wave forces of the ocean quickly bring the area into a linear equilibrium with the beaches to the east and west.

The PDT has concluded that the underlying condition which makes the area so vulnerable is the distance from the seawall to the ocean (Figure 19). The last two blocks of Beach Avenue angle out toward the ocean, which decreases the distance between the seawall and the ocean by approximately 300 feet compared to the rest of the ocean front in Cape May. During a storm surge event when the ocean surface is elevated, this corner is the first and most susceptible point for wave attack. Frequent encroachment by the ocean is also the reason that a dune has not accreted and become vegetated in front of the seawall as it has along the rest of the ocean front.

Figure 19: Distance from the seawall to the ocean at Beach and Wilmington Avenue Area.

Problem Statement

The people, infrastructure, and property of the City of Cape May have experienced significant flooding damages due to the ocean overtopping the existing seawall at the corner of Beach and Wilmington Avenues during coastal storm events.

Problem Definition

The flood-related damages occur due to a combination of storm surge, wave action, and tidal fluctuation during coastal storms. These conditions result in ocean water overtopping the seawall at the corner of Beach and Wilmington Avenues, inundating the low-lying areas of Beach Avenue and Frog Hollow, and damaging numerous structures within Cape May.

Secondary flood-related issues which have occurred in Cape May include:

- Infrastructure damage.
- Transportation and emergency services are disrupted.
- Residents are stranded in their homes or denied access to their homes.
- Business closures.
- Motor vehicle damages.
- Emergency management personnel are needed continuously throughout the flooding for maintaining public safety and performing rescues.
- Residential, business, and public properties require extensive post-flood debris removal and clean up.

<u>Opportunities</u>

Manage the risk of coastal storm flooding to residents, infrastructure, and property within Cape May, New Jersey, through the implementation of resilient and sustainable coastal storm risk management solutions.

4.2 Future Without-Project Conditions

Gathering information about potential future conditions requires forecasts, which should be made over the period of analysis from 2020-2070 to indicate how changes in economic, social, environmental and other conditions are likely to impact problems and opportunities. Future without project conditions in the study area have the potential to be impacted by a variety of conditions including relative sea level change (RSLC), economic factors, future development, and new rules, regulations, and studies resulting from the impacts from Hurricane Sandy. Additionally, the USACE North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS, 2015) has identified Cape May as an area which has a high risk of flood peril from coastal storms now and in the future.

Cape May will continue to be vulnerable to coastal storm flooding and will continue to experience structural damages during storms as the ocean overtops the seawall in the vicinity of Beach and Wilmington Avenues. Flooding will also continue to threaten the safety of residents and the resilience of the local economy. Expected average annual damages in the future without-project condition from 2020 to 2070 are in the amount of $725,000 (FY2022 Price Level).

Within the 50-year Federal project horizon, there is potential that local and/or regional interests will implement CSRM measures within the study area in the absence of a USACE project. In preparation for Hurricane Sandy and the nor'easter in January of 2016, the City requested permission from the State to temporarily modify the beach in an attempt to mitigate storm damage. Prior to Hurricane Sandy, small, temporary berms were constructed with beach sand in front of Convention Hall (Figure 20). Similar efforts were performed at the corner of Beach and Wilmington Avenues prior to the 2016 nor'easter. The temporary berms eroded throughout the course of the storm and the ocean eventually overtopped the seawall, although not to the same degree as during Hurricane Sandy. If the temporary berms had not been present, overtopping by the 2016 storm would likely have been more significant. Local flood-fighting efforts such as these are not reliable measures given the inherent uncertainties of staff and equipment availability, timing of the storm, evacuation status, etc. They are not intended to be a long term CSRM solution for Cape May.

Figure 20: Temporary flood fighting efforts by the City prior to Hurricane Sandy.

The Federal CSRM beach project located on the ocean side of the seawall was authorized in 1986, and therefore has approximately 20 years of project life remaining before re-authorization by Congress is required. The project has been successful in achieving its goals of addressing beach erosion and managing coastal storm risk. However, the problem of beach width and the related flooding vulnerability due to the layout of city infrastructure at Beach and Wilmington Avenues is expected to persist. The placement of additional sand during renourishment cycles has proven to be ineffective at solving this problem.

Throughout the previous decades, some residents in the study area have elevated their homes in response to frequent coastal storm damage (Figure 21). The availability of post-Hurricane Sandy grant funding has also prompted renewed interest in this opportunity. However, the first floor elevations of many structures in the study area remain, and are likely to remain, near existing grade. The large hotels along Beach Avenue have extensive first floors which are near existing grade. Elevation of these types of structures is typically costly, complicated, and achieved through demolition and rebuilding.

October 2013 (Google Street View)   December 2016

Figure 21: Recently elevated structure at the corner of Kearney Avenue and Jefferson Street in Frog Hollow.

4.3 Planning Goal and Objectives

The Federal objective of water resource planning is to contribute to NED in a way that is consistent with protecting the nation's environment pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements contained in Engineering Regulation 1105-2-100.

Goal: Manage the risk of coastal storm flooding and associated damages to the City of Cape May.

In support of the goal, the planning objectives are to:

1. **Primary Objective** - Manage the risk of coastal storm flooding from inundation to residents, infrastructure, and property in Cape May from 2020 through 2070.
   <u>*Measurement:*</u> *Estimated average annual damages, as calculated by the Hydrologic Engineering Center – Flood Damage Analysis (HEC-FDA) model*

2. **Secondary Objective** - Encourage resilient and sustainable risk management solutions for Cape May through 2070.

<u>Measurement:</u> Qualitative analysis of engineering robustness and rapidity (the speed with which functionality can be restored to a system or project after a disruption).

4.4 Planning Constraints

Constraints are items that limit the planning process and are unique to each planning study. They include planning, technical, economic, environmental, institutional, regional, and social constraints.

The following universal constraints were considered during plan formulation:

- Plans should represent sound, safe, acceptable engineering solutions.
- The plans should meet the needs and concerns of the public within the study area.
- Plans should comply with USACE regulations and all Federal environmental laws, Executive Orders, and guidance, as well as applicable state and local laws.
- Plans should be realistic and state-of-the-art while not relying on future research or development.
- Analyses are based on the best information available using accepted methodology.
- To be recommended for project implementation, benefits must exceed project costs.
- Plans should avoid detrimental environmental and social effects.
- Plans should preserve and/or enhance natural resources and existing environmental conditions.
- The needs of other surrounding regions must be considered, and one area cannot be favored to the unacceptable detriment of another.

The following study-specific constraints were considered during plan formulation:

- Plans should avoid inducing flood damages.
- Plans should be resilient considering future projections in relative sea level change.
- Any plans proposed for implementation should be of an appropriate scale and complexity for the CAP.
- Plans should not impair or substantially change the purposes or functions of the adjacent specifically authorized Federal project (per EP 1105-2-58, 8.b.)

4.5 Key Uncertainties

The following three key uncertainties were considered during plan formulation.

Existing Subsurface Condition of the Seawall: Design plans from the original construction of the seawall in the 1960s were provided by the NJDEP Bureau of Coastal Engineering and were reviewed by the PDT. Although these are not “as-built” plans, they were considered a close approximation of the interior and subsurface condition of the seawall. Historic photographs of the seawall from the 1980s and 1990s also show the condition of the seawall before the Federal beach project was constructed and were used by the PDT for design considerations. No additional subsurface borings have been performed by the USACE nor is there any knowledge of recent subsurface borings in the vicinity of the study area.

Plan Participation Rate: Participation in USACE nonstructural projects for property owners is dependent upon the type of nonstructural methodology. For feasibility study phase formulation purposes, it was assumed that all of the property owners in the vicinity of the project would participate in a nonstructural plan which involved elevation (which is voluntary) or acquisition (which is mandatory). This assumption was made because this participation rate best represents sufficient management of risk from coastal flooding. Based on coordination with non-Federal and local interests and the current trends in rebuilding, the PDT determined that this was an appropriate assumption.

4.6 Coastal Storm Risk Management Modeling

In order to demonstrate and quantify the economic benefits of alternative plans, coastal storm risk management modeling was performed. The effort was intended to generate a comprehensive simulation of the full range of coastal storm events which could impact Cape May. A storm database which was developed during the USACE NACCS Study was used to establish the duration and intensity of possible events and calculate the likelihood of the ocean overtopping the seawall at Beach and Wilmington Avenues (or elsewhere along the seawall during larger storms). The model was used to simulate water level (storm surge and tides) and wave conditions and calculate the cumulative volumes of ocean water which would overtop during each event. These volumes were then overlaid on the study area topography and used to estimate flood elevations for each storm.

Once overtopping simulations were completed for the existing conditions (without project), the model was used to test the effectiveness of different CSRM measures. The model was adjusted to simulate the presence of a higher barrier (seawall or sheet pile), with various changes to the height. With each incremental increase in height, the model would provide the resulting changes in expected overtopping water volumes.

Certain simplifying assumptions were applied during the modeling to generate the water surface elevations and flood stage frequency curves for the study area. The main assumption was that flooding was solely the result of overtopping volumes which are conveyed to the lowest lying elevations of the study area, with no additional inflow (rainfall, back bay flooding, etc.) or outflow (drainage, pumping, etc.) during the storm. The PDT determined that pump failure during a large coastal storm was a reasonable and plausible scenario given the likelihood of power outages and the pumps being inaccessible for refueling.

The flood damage calculations were performed using the Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) software, version 1.4.2 and used to model Future Without Project and Future With Project Conditions.

Additional details on the coastal storm risk management modeling are provided in the Engineering Support Documents Appendix.

4.7 Management Measures

Measures were developed to address problems and to capitalize upon opportunities. They were derived from a variety of sources including the USACE North Atlantic Coast Comprehensive Study (NACCS) Report (2015), prior studies, and the PDT. Although the initial array used as a starting point by the PDT was quite extensive, a majority of the measures were quickly screened out given the specificity of the problem and the constraints of study area. Large, new structural measures (levee, revetment, etc.) were screened out since the seawall is already present. Nature based features (wetlands, reefs, living shorelines, etc.) were determined to be infeasible given the dynamic ocean environment and the land-based location of the problem. And efforts to modify the Federal beachfill project to address the problem have already been explored (Section 4.1).

Certain non-structural measures were also screened out since they would not meet the study goal of managing the risk of flood damages in Cape May. Flood warning and evacuation would be effective for avoiding certain flood inundation risks, such as loss of life or damages to motor vehicles, but would not address the primary problem of structural damage in the study area. Regulation of land use and zoning is typically the responsibility of state and local governments and is intended for undeveloped areas rather than heavily developed areas, such as Cape May. The comparison of the with and without project condition for this measure are essentially identical since it is unlikely that any regulation of future development would reduce the susceptibility of this area due to the current level of development.

As suggested in the USACE NACCS Report, acquisition and relocation of the structures in Cape May which are vulnerable to flooding due to overtopping of the seawall would be a significant approach to coastal storm risk management. This tactic would equate to permanent evacuation and retreat from a large section of the City and would require acquisition of lands and structures either by purchase or through the exercise of powers of eminent domain, if necessary. Following this action, all commercial and residential property in the acquired areas would either be demolished or relocated to another site. The NACCS report provides a parametric cost estimate of $70,000 for structure removal, which does not include the significant additional fair market value cost of the property purchase price. Given that there are 1,392 buildings in the study structure inventory, this measure would be cost prohibitive. Typically, building acquisition or relocation is 300% more expensive than building elevation or retrofit while providing only similar benefits. The concept of permanent retreat is also not acceptable to state and local municipalities.

Following the initial round of screening, the following measures were considered:

Structural

- Steel sheet-pile
- Demolish and rebuild wall
- Cast-in place concrete cap

Non-structural

- Elevation/floodproofing of structures

5.0 Alternative Plans

5.1 Alternative Plan Formulation Strategy

The general plan formulation strategy was to maximize NED benefits while considering technical feasibility, environmental impacts, economic implications, and social consequences.

Technical Feasibility: Consideration was given to all feasible nonstructural and structural measures. Sound engineering judgment was utilized in selecting the structural components for each alternative.

Environmental Impacts: Impacts to the environment were evaluated for each alternative. Field data and literature were used to assess existing conditions and potential impacts.

Economic Implications: Construction costs were estimated for each alternative. These costs were developed for screening purposes only and did not reflect detailed designs which would be necessary for a selected plan. Economic benefits were developed for the with- and without-project conditions. This information was used to compare alternatives.

Social Consequences: The public may experience negative impacts of environmental impacts, visual aesthetics, and inconvenience due to construction, but the management of flooding or flood damage will greatly improve the quality of life.

5.2 Considerations for Formulation Strategy

The coastal storm damage modeling examined the ocean and wave conditions over a suite of storms to determine which scenarios would result in the overtopping of the seawall at the corner of Beach and Wilmington Avenues. The modeling also considered the conditions during Hurricane Sandy, which was the most recent event with significant overtopping. Based on the elevation of the existing seawall and adjacent topography, it was determined that the addition of a higher barrier along the alignment of the seawall would manage overtopping to varying degrees based on the height of the barrier. The length required for the additional barrier was determined to be approximately 350 linear feet (LF), with 90-foot tapers on either end to tie into equivalent high ground. Figure 22 shows the extent of the approximate 350 LF proposed barrier.

The length of the higher barrier seawall as well as seawall elevation tapers were determined based upon the alongshore limits of overtopping that have been experienced historically, including during the Halloween Storm of 1991 and Hurricane Sandy in 2012. The determination of the length of the higher barrier seawall is also supported by the overtopping modeling which indicates that significant inundation is focused within this limited area of narrow beach width fronting the seawall. This determination is based upon overtopping analysis which did account for overtopping of the adjacent shoreline and the associated residual flooding risks. While residual flooding risks remain for overtopping of the adjacent shoreline during low frequency events, the overtopping would not result in failure of the proposed project.

For the initial screening of structural alternatives, the conceptual barriers were all designed to an elevation of +13 feet (NAVD88) for comparison purposes. This height was selected based on the ocean water surface elevation that occurred during Hurricane Sandy and resulted in overtopping. A conceptual barrier with an elevation of +13 feet (NAVD88) would have likely prevented any significant overtopping during Sandy.

A decommissioned concrete storm water outfall pipe is present in the vicinity of the seawall at the corner of Beach and Wilmington Avenues. The pipe originally carried storm water from the Beach Avenue drainage system to the ocean. Due to frequent clogging of the pipe with sand and the associated maintenance required to keep it functioning, the City rerouted the storm water flow to the outfall at Brooklyn Avenue and decommissioned the Wilmington Avenue pipe in-place. The seawall was formulated with the understanding that the decommissioned pipe had the potential to increase flooding risk landward of the seawall. However, the existence of the pipe was not a factor in the evaluation and ultimate selection of the Recommended Plan, as all alternatives managed the risk associated with flooding concerns due to the existence of the pipe.

Figure 22: Extent of the 350-foot section where an elevated barrier is proposed.

The formulation of alternative plans including screening and plan selection was based upon the full assessment of all three USACE RSLC curves including the USACE Low, Intermediate and High RSLC curves.

5.3 Array of Alternative Plans

The initial array of alternative plans include the following:

- No Action Alternative
- Three Structural Alternatives
- Nonstructural Alternative

<u>Alternative 1 - No Action Alternative</u>

If USACE takes no action, the City of Cape May would continue to experience flooding during coastal storms when the ocean overtops the seawall at Beach and Wilmington Avenues. This plan includes additional Federal actions taken to provide for coastal storm risk management, such as grants from FEMA to support disaster recovery for homeowners and businesses. This plan fails to meet the USACE study objectives or needs for the majority of the study area. It will, however, provide the baseline against which project benefits are measured. The period of analysis is 2020 to 2070.

Alternative 2 – Demolish and Rebuild Seawall

Alternative 2 would remove the existing seawall and rebuild it to a higher elevation around the corner of Beach and Wilmington Avenues. The existing seawall would be demolished and material which could be reused would be staged on site. New capstone required for elevating the wall would be trucked to the site from a local quarry. Voids in the capstone would be grouted in a manner similar to the existing seawall.

Alternative 3 – Steel Sheet Pile

Alternative 3 would install steel sheet pile between the existing seawall and Beach and Wilmington Avenues. The area between the sheet pile and the seawall would be backfilled with stone to an elevation consistent with the top of the seawall. The decommissioned storm water pipe on Beach Avenue would be demolished and excavated so the sheet pile could be installed.

Alternative 4 – Concrete Cap

Alternative 4 would place a concrete cap on top of the existing seawall at elevation +17 feet (NAVD88). The cap would be 8 feet wide and cast in place with framing. The existing voids between the stones on top of the seawall would be cleared of grout so that new concrete poured for the cap would be anchored into the existing structure. This alternative would not require modification of the decommissioned storm water pipe.

Alternative 5 - Nonstructural Structure Elevation/Floodproofing

The non-structural alternatives were developed identifying vulnerable structures that may be eligible for structure elevation or floodproofing. Vulnerable structures were identified according to their First Floor Elevation (FFE) in comparison with the expected stage level at that comparable event frequency. FFE is a combination of Foundation Height and Ground Elevation. Foundation Height was identified by the PDT using a virtual inspection of each structure and Ground Elevation was estimated using LiDAR-derived Digital Elevation Models.

Elevating or floodproofing the structures within the 1% AEP flood event floodplain (398 structures) was approximately $89,550,000 in initial construction. Reducing the scope of the nonstructural floodplain to the 2.875% AEP event floodplain (82 structures) was approximately $18,450,000 in initial construction. Reducing the scope even further dramatically elevated the residual damages compared to the structural alternatives.

As the nonstructural alternatives were either more expensive and/or less effective than comparable structural alternatives, they were screened from further consideration.

5.4 Screening of Array of Alternative Plans

An estimate of average annual benefits was considered against the average annual costs for the No Action Plan and three structural alternatives including 1) Demolish and rebuild seawall; 2) Steel sheet pile and; 3) Concrete cap. The alternative that maximized average annual net benefits (concrete cap) was then optimized by modeling measure performance at various heights across all three USACE SLC scenarios. This initial screening and optimization used the then-current October 2017 (FY2018) Price Level and 2.75% Federal Discount Rate. Final economic results were updated to the October 2021 (FY2022) Price Level and 2.25% Federal Discount Rate.

The screening of the initial array of alternatives considered three different structural construction methods for elevations of +13 feet (NAVD88). In Table 4 below, Alternative #1 is a complete demolish and rebuild of the seawall, Alternative #2 is a steel sheet pile installation with stone backfill, and Alternative #3 is a concrete cap.

Table 4: Alternative cost summary for original study alternatives.

Alternatives	Description	Estimated Amount	Escalation 3.9%	Contingency 20%	PE&D 15%	S&A 6.8%	Total Cost $M
Alternative #1	Replace Existing Seawall with Corestone and Capstone @ El. +13	$6,600,912	$257,436	$1,371,670	$1,234,503	$643,587	$10,108,107
Alternatvie #2	Install Sheet Piling and Stone Backfill @ El. +13	$1,962,354	$76,532	$407,777	$366,999	$191,329	$3,004,991
Alternative #3	Adding 5ft Wide Concrete Cap @ El. +13	$1,287,989	$50,232	$267,644	$240,880	$125,579	$1,972,323
Alternative #3A	Adding 10ft Wide Concrete Cap @ El. +13	$1,826,380	$71,229	$379,522	$341,570	$178,072	$2,796,772
Alternative #4	Adding 10ft Wide Concrete Cap @ El. +14	$1,853,611	$72,291	$385,180	$346,662	$180,727	$2,838,471
Alternative #5	Adding 10ft Wide Concrete Cap @ El. +15	$1,887,118	$73,598	$392,143	$352,929	$183,994	$2,889,781
Alternative #6	Adding 10ft Wide Concrete Cap @ El. +16	$1,921,708	$74,947	$399,331	$359,398	$187,366	$2,942,749
Alternative #7	Install Sheet Piling and Stone Backfill @ El. +16	$2,399,752	$93,590	$498,668	$448,802	$233,975	$3,674,788
Alternative #8	Adding 10ft Wide Concrete Cap @ El. +17	$1,957,853	$76,356	$406,842	$366,158	$190,890	$2,998,099
Alternative #9	Adding 10ft Wide Concrete Cap @ El. +18	$1,981,189	$77,266	$411,691	$370,522	$193,165	$3,033,834

The rebuilding of the seawall (Alternative #1) and the sheet pile (Alternative #2) had higher initial construction costs than did the concrete cap (Alternative #3) without increases in performance or reliability. All three construction methods were considered equally effective over the 50-year period of analysis. The construction cost of the concrete cap at an elevation of +13 feet (NAVD88) (5-foot wide concrete cap) was $1,972,000, while the initial construction costs of the rebuilding the seawall (+13-foot elevation) and the steel sheet pile (+13-foot elevation) were $10,108,000 and $3,005,000, respectively. This cost differential was a determining factor in the selection of the concrete cap as a preferred alternative.

An additional deterrent of the steel sheet pile was the difficulty of driving the steel sheet pile into the subsurface as it could hit obstructions including a decommissioned sewer line. This would likely require near complete dismantling of existing seawall. Further, placement of a sheet pile landward of the existing seawall would be complicated due the limited space. In addition, a sheet pile would likely have less aesthetic values from a cultural/historic standpoint.

Alternative #3A to Alternative #9 were developed to facilitate optimization of the concrete cap measure. The concrete cap was widened from 5 feet to 10 feet during redesigns.

Plan formulation and NED optimization of study alternatives relied on all three USACE RSLC curves (Low (Historic), Intermediate and High). This RSLC analysis provides insight on project performance and economic justifiability among varying future sea level change scenarios. Additional information is provided in the Economics Appendix. The concrete cap seawall measure, the most cost-efficient construction method, was optimized under all three SLC curves in accordance with ER 1100-2-8162 *Incorporating Sea Level Change in Civil Works Programs*. Seawall heights (using the concrete cap construction method) from +13 feet (NAVD88) to +18 feet (NAVD88) were modeled in 1-foot increments to identify the net NED maximizing height. While HEC-FDA has limitations in modeling a dynamic inventory and “likely” future stakeholder actions during the Intermediate and High SLC scenarios, the results summarized in Table 14 of the Economics Appendix show that the economic viability and relative performance of each measure is not sensitive to SLC change.

As shown in Table 5 and Figure 23, the Low (Historic) and Intermediate RSLC curves for this study area are fairly linear across the 50-year period of analysis. These RSLC curves are developed from the USACE Sea-Level Change Curve Calculator (version 2021.12) in accordance with EC 1165-2-212 *Sea-Level Change Considerations for Civil Works Programs* and ER 1100-2-8162 *Incorporating Sea Level Change in Civil Works Programs*. Sea level height increases at a roughly uniform annual rate. In total, from Project Year 0 (2023) until Project Year 50 (2023), sea level increases of 0.53 feet in the Low RSLC scenario were identified.

Table 5: Relative Sea Level Change Scenarios(ft)

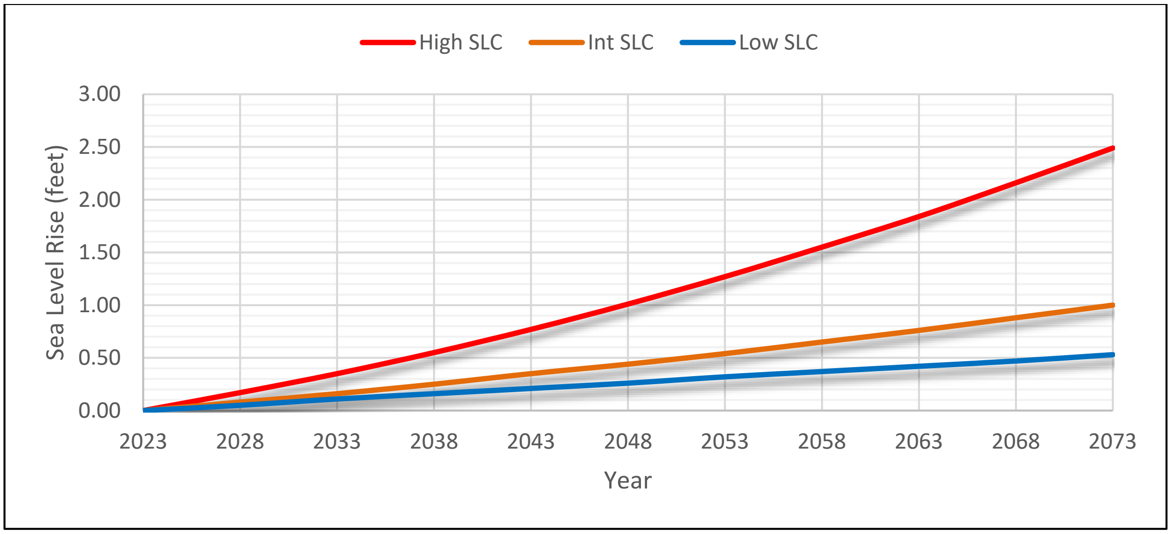
Year	PROJECT YEAR (PY)	LOW	INT	HIGH
2023	**PY00**	0	0	0
2028	**PY05**	0.05	0.08	0.17
2033	**PY10**	0.11	0.16	0.35
2038	**PY15**	0.16	0.25	0.55
2043	**PY20**	0.21	0.35	0.77
2048	**PY25**	0.26	0.44	1.01
2053	**PY30**	0.32	0.54	1.27
2058	**PY35**	0.37	0.65	1.55
2063	**PY40**	0.42	0.76	1.84
2068	**PY45**	0.47	0.88	2.16
2073	**PY50**	0.53	1	2.49

The High RSLC scenario for this study creates issues with two key project assumptions for the Future Without-Project Condition (FWOP) baseline. The FWOP scenario typically assumes the most-likely future condition will include a static inventory (maintains current volume, value, and characteristics) and no new coastal measures constructed by the Federal government, State government, Municipal government, or other entity. These assumptions are reasonable when considering the Low and Intermediate RSLC scenarios as future sea level conditions are not dramatically different than current sea level conditions. These assumptions, however, are not reasonable when considering High RSLC scenario.

Under the High RSLC curve, 10% annual chance exceedance (ACE) events (10-year flood response) and 2% ACE events (50-year flood response) in the Year 2020 would be equivalent to 50% ACE events (2-year flood response) and 20% ACE events (5-year flood response) in the Year 2070, respectively. This means that flood events expected to occur, on average, every 50 years would instead be expected to occur, on average, every 5 years. It is reasonable to assume that the future most-likely condition in this aggressive scenario would involve significant changes to the inventory in the form of building elevations / acquisitions and also in the form of modifications to the existing seawall to provide greater coastal storm risk management.

Predicting the exact nature and quantity of changes in the inventory for the High RSLC scenario is beyond the scope of this study and does not impact the selected alternative. Realistically, under the High RSLC scenario, the selected alternative would still be economically justified, but would need to be combined with additional actions to prevent ocean water from cresting the other parts of the seawall and measures to limit inundation from back bay flooding in order to provide realistic CSRM benefits.

Figure 1: Relative Sea Level Change Scenarios(ft)



Note: Clarification should be made that the original base year was 2020 but was updated to 2023 during the course of the study. This update did not include updated H&H analyses and resultant HEC-FDA inputs (beyond Price Level and Federal Discount Rate), so the period of analysis remains 2020-2070. This decision was made based on the fact that updating the period of analysis from 2020-2070 to 2023-2073 would require a significant Federal investment owing to substantial efforts to recalculate all H&H inputs and then perform additional HEC-FDA modeling runs, and modifying the period of analysis would unlikely change plan evaluation, comparison, or selection. Specifically, the net difference in projected SLC heights, even under the High SLC curve, between a 2020 base year and a 2023 base year is minimal. However, Table 4 and Figure 23 have been updated to reflect a period of analysis of 2023-2073.

The RSLC sensitivity results presented in Table 6 are meant to show the economic viability of the selected plan in comparison to other modeled alternatives and the project performance of the selected plan in terms of residual damages.

Table 6: Relative Sea Level Change Sensitivity Results

LOW RSLC	Beach Ave	Frog Hollow	Wash. Ave	Remaining AAD	Reduced AAD	Residual AAD	Total AAC	Total AANB
No Act.	$162,000	$460,000	$32,000	$654,000	$0	100.0%	$0	$0
13ft	$115,000	$340,000	$21,000	$476,000	$178,000	72.8%	$112,000	$66,000
14ft	$95,000	$333,000	$21,000	$448,000	$205,000	68.6%	$114,000	$91,000
15ft	$87,000	$328,000	$21,000	$435,000	$219,000	66.6%	$117,000	$102,000
16ft	$82,000	$323,000	$20,000	$426,000	$227,000	65.2%	$120,000	$108,000
17ft	$82,000	$319,000	$20,000	$421,000	$232,000	64.5%	$123,000	$109,000
18ft	$82,000	$319,000	$20,000	$421,000	$232,000	64.5%	$126,000	$106,000

INT RSLC	Beach Ave	Frog Hollow	Wash. Ave	Remaining AAD	Reduced AAD	Residual AAD	Total AAC	Total AANB
No Act.	$203,000	$658,000	$47,000	$908,000	$0	100.0%	$0	$0
13ft	$147,000	$467,000	$29,000	$643,000	$265,000	70.8%	$112,000	$153,000
14ft	$131,000	$454,000	$28,000	$614,000	$294,000	67.6%	$114,000	$180,000
15ft	$115,000	$444,000	$28,000	$588,000	$320,000	64.7%	$117,000	$203,000
16ft	$112,000	$435,000	$28,000	$575,000	$333,000	63.4%	$120,000	$213,000
17ft	$112,000	$433,000	$28,000	$573,000	$335,000	63.1%	$123,000	$212,000
18ft	$112,000	$433,000	$28,000	$573,000	$335,000	63.1%	$126,000	$209,000

HIGH RSLC	Beach Ave	Frog Hollow	Wash. Ave	Remaining AAD	Reduced AAD	Residual AAD	Total AAC	Total AANB
No Act.	$727,000	$3,094,000	$217,000	$4,038,000	$0	100.0%	$0	$0
13ft	$702,000	$2,683,000	$165,000	$3,550,000	$488,000	87.9%	$112,000	$376,000
14ft	$680,000	$2,492,000	$161,000	$3,333,000	$705,000	82.5%	$114,000	$591,000
15ft	$490,000	$2,339,000	$161,000	$2,991,000	$1,047,000	74.1%	$117,000	$931,000
16ft	$480,000	$2,284,000	$157,000	$2,921,000	$1,117,000	72.3%	$120,000	$997,000
17ft	$480,000	$2,283,000	$157,000	$2,920,000	$1,118,000	72.3%	$123,000	$995,000
18ft	$480,000	$2,283,000	$157,000	$2,920,000	$1,118,000	72.3%	$126,000	$991,000

Optimization results above are shown in the then-current October 2017 (FY2018) Price Level and 2.75% Federal Discount Rate. As discussed in more detail in the Economics Appendix, the NED optimizing alternative in the Low (Historic) RSLC scenario is the +17 feet (NAVD88) seawall with the +16 feet (NAVD88) seawall alternative only 1.4% lower in terms in average annual net benefits.

For the Intermediate RSLC, estimated FWOP damages increase 38.9% to $908,000 Total average annual damages. With this RSLC curve, inundation from elsewhere on the seawall and from back bay flooding occurs slightly more frequently, dropping the NED optimizing alternative to +16 feet (NAVD88) though the +17 feet (NAVD88) alternative is functionally identical with only 0.5% fewer average annual net benefits.

The High RSLC scenario also supports the construction of either the +16 feet (NAVD88) or +17 feet (NAVD88) alternative, but previously discussed limitations on this scenario prevent any reliable insights or inferences from the data results.

While HEC-FDA has limitations in modeling a dynamic inventory and “likely” future stakeholder actions during the Intermediate and High SLC curve scenarios, the results show that the economic viability and relative performance of each measure is not sensitive to SLC change. Under each SLC scenario, the maximizing alternative is always either the +16 feet (NAVD88) wall or the +17 feet (NAVD88) wall with only minimal differences in terms of average annual damages reduced and average annual net benefits.

The cost difference between the +16 feet (NAVD88) alternative and the +17 feet (NAVD88) alternative is minimal while the + 17 feet (NAVD88) provides slightly more average annual net benefits. As the +17 feet (NAVD88) alternative maximizes net NED benefits with minimal increases in costs, this alternative is identified as the NED Plan. As the average annual net benefits for the +16 feet (NAVD88) alternative and +17 feet (NAVD88) alternative are similar, it could theoretically be possible that the lower cost alternative is the NED Plan due to mitigated cost inefficiency risks. However, the costs for the two alternatives are nearly identical. Therefore, the reasonably maximizing NED alternative is the alternative that actually maximizes NED benefits; the +17 feet (NAVD88) alternative.

Further, it is reasonable to assume that a +17 feet (NAVD88) seawall will provide more NED and Regional Economic Development (RED) benefits over the 50-year period of analysis regardless of the experienced SLC rate. For the RED planning account, the taller seawall will more effectively limit business disruptions and job losses from storm event impacts compared to a smaller seawall. For the two remaining planning accounts, Other Social Effects (OSE) and Environmental Quality (EQ), there is no difference between the two leading alternatives.

In summary, the +17 feet (NAVD88) alternative is still the reasonably NED maximizing alternative when considering all three RSLC curve scenarios as this alterative maintains similar average annual net benefits and average annual costs in comparison to the +16ft (NAVD88) alternative with slightly reduced residual damages. By maximizing NED benefits and minimizing residual damages with insignificant cost increases, the +17 feet (NAVD88) alternative is the NED Plan in accordance with ER 1105-2-100 *Planning Guidance Notebook*.

In accordance with ER 1100-2-1, SLC resiliency and adaptability was considered when formulating, comparing, and selecting a recommended alternative. The +17 feet (NAVD88) is the most resilient alternative modeled and employs a conservative precautionary (anticipatory) approach to SLC adaptation. As the cost difference between different seawall heights is minimal, an adaptive approach is not cost efficient as it may require a second construction phase if SLC rates are higher than expected. By constructing the seawall to the maximum effective height without any sizeable increases in cost, the project remains resilient for the longest period of time regardless of SLC rate.

Additionally, from an impact perspective, there is no difference in environmental impacts between the two seawall heights since adding a vertical cap onto the existing seawall does not change the footprint of the seawall. There is also no difference in the visual impacts between the two elevations because the ocean view will be blocked at any elevation. There is no ocean view at this location currently due to the height of the sand

dunes above the seawall. Plantings and a more natural looking concrete treatment are also planned for the cap to minimize the visual impacts, regardless of cap elevation.
The NED Plan has been determined using technical expertise, professional judgment, and rigorous certified modeling to reasonably maximize net benefits in the reduction of coastal storm damage. With reduced damages from coastal high-frequency storm events, the NED Plan using to an October 2017 (FY2018) Price Level and 2.75% Federal Discount Rate has $109,000 in average annual net benefits with a BCR of 1.9. These economic analyses support an elevation +17-foot (NAVD88) seawall as the Recommended Plan.

Updating the NED Plan to an October 2021 (FY2022) Price Level and 2.25% Federal Discount Rate results in a final $154,000 in average annual net benefits with a BCR of 2.0.

Further formulation was conducted for this study in that all alternatives were evaluated for the four P&G criteria. A discussion is provided below detailing the application of these individual planning criteria to the alternatives.

The 1983 Principles and Guidelines (P&G) require that plans are formulated in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability. The plan must be complete in that it provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. Plans must be effective so as to alleviate the specified problems and achieve the desired goals. Efficiency demonstrates the plan’s cost effectiveness of alleviating the specified problems and realizing the specified opportunities. Plans must also be acceptable in that they are compatible with existing laws, regulations, and public policies.

<u>Completeness</u>
As discussed in (ER 1105-2-100), completeness is a determination of whether or not an alternative includes all elements necessary to achieve the objectives of the plan. It is an indication of the degree that the outputs of the plan are dependent upon the actions of others. Further, completeness is the extent to which an alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of planned effects. Alternatives with lower residual risk were considered more complete.

All of the with-project alternatives formulated for this study are considered complete, as the objectives of the plan- managing the risk of coastal storm flooding from inundation to residents, infrastructure, and property are achieved. However, the structure elevation alternative is subject to higher residual flooding risk than the other alternatives. Further, each of these alternatives except for the structure elevation alternative is a stand-alone plan and can be implemented independent of any other plan.

<u>Effectiveness</u>

Effectiveness is the extent to which an alternative plan alleviates the specified problems, achieves the desired goals, and makes significant contributions to all planning objectives. This criterion is the extent to which the action-oriented plans contribute to achieving the planning objectives.

All of the with-project alternatives would manage the risk of coastal storm flooding specifically from ocean wave overtopping and associated damages. However, the steel sheet pile bulkhead may not meet the secondary objective of the study offering resilient and sustainable risk management solutions for Cape May through 2070. The bulkhead may be less resilient to relative sea level change projections and associated increasing coastal flooding risk than the other alternatives.

From an overtopping analysis perspective, an evaluation of the overtopping at the 50-year future condition for all three RSLC curves (low, medium, and high) found that for high frequency events (2-yr) the degree of overtopping and the resulting economic damages, were not significant in driving the optimization of alternatives even for the high RSLC curve.

Efficiency

Efficiency is defined as the extent to which an alternative plan is the most cost-effective means of achieving the planning objectives. Generally, alternatives with higher BCRs were considered more efficient because each dollar spent resulted in more benefits accrued. Of the four alternatives, both the concrete cap and the steel sheet pile bulkhead alternatives were cost effective and had BCR ratios greater than 1.

Acceptability

Acceptability is the extent to which the alternative plans are acceptable in terms of applicable Federal, state and local laws, regulations and public policies. Plans that passed the Environmental Quality (EQ) screening were generally considered acceptable at this stage in the planning process. Other applicable laws, regulations and public policies that were considered included land use policies and real estate constraints in addition to environmental policies.

All of the with-project alternatives formulated for this study except for structure elevation are considered acceptable in terms of applicable Federal, state and local laws, regulations and public policies. The nonstructural elevation of structures alternative is considered unacceptable as preservation of historical attributes of the Cape May Historical District may be jeopardized.

A summary of the above discussion with respect to the four P&G criteria is presented in Table 7. Only the alternative adding a concrete cap to the existing seawall meet all four planning criteria.

Table 7: Evaluation of Plans Using the Four Planning Criteria

	Completeness	Effectiveness	Efficiency	Acceptability
No Federal Action	No Federal investments or actions	Does not manage the risk of coastal flooding and therefore does not achieve study goals and meet study objectives	Requires ongoing emergency risk management costs without sustainable risk management of the damage to infrastructure	Not acceptable to Federal, state and local agencies (maintains status quo of threatened infrastructure)
Demolish and Rebuild Seawall	Accounts for all necessary investment and actions	Manages the risk of coastal flooding, acheives goals and meets study objectives	High cost ($10.1M) and low BCR (0.47)	Acceptable to Federal, state and local agencies
Steel Sheet Pile Bulkhead	Accounts for all necessary investment and actions	Manages the risk of coastal flooding, acheives goals and meets study objectives	Low cost ($3.0M) and high BCR (1.6)	Acceptable to Federal agencies, but not acceptable to state and local agencies due to aesthetic qualities and inability to mimic natural conditions. Also, there is difficulty in development of a potential walkway.
Concrete Cap (8ft wide) (Elev: +17ft NAVD88	Accounts for all necessary investment and actions	Manages the risk of coastal flooding, acheives goals and meets study objectives	Low cost ($2.9M) and high BCR (1.6)	Acceptable to Federal, state and local agencies
Structure Elevations	Accounts for all necessary investment and actions, although may be subject to high residual flooding risk	Manages the risk of coastal flooding, acheives goals and meets study objectives	High cost ($60.7M) and low BCR (0.16)	Does not account for preservation of historical significance of the Cape May Historic District ; Also, implementation of a nonstructural plan may not be acceptable to Federal, State and local agencies

*Gray shading indicates that the measure did not meet the criteria. Costs for the Efficiency criteria for action alternatives are presented as high, medium, or low and are relative to the cost of the other alternatives.

In terms of Effectiveness, the +17-foot (NAVD88) seawall provides the greatest level of coastal storm risk mitigation in the economic analysis with the lowest amount of residual damages remaining in the future with-project condition.

In terms of Completeness, there are sources of uncertainty over the 50-year period of analysis, including future sea level change rates and actions from Federal and non-Federal entities to address this potential increase in coastal storm risk. The +17-foot (NAVD88) seawall, as part of a holistic system to mitigate coastal storm risk for the City of Cape May, is the most likely alternative to maintain project performance as other pieces of the system are retrofitted and strengthened in the future. Constructing a lower seawall height only reduces the time in which this project could reliably contribute to a robust CSRM system.

In terms of Efficiency, the +16 feet (NAVD88) seawall is slightly more cost effective, though both alternatives have the same 2.0 BCR (October 2021 (FY2022) Price Level). Constructing a lower seawall height would reduce approximately $3,000 in average annual cost with only a $1,000 corresponding reduction in average annual net benefits.

In terms of Acceptability, all the proposed alternatives, to date, are identical in terms of not violating any applicable laws, regulation, or public policies.

In total, the +17-foot (NAVD88) seawall maximizes net NED benefits, provides the greatest level of storm risk mitigation (Effectiveness), provides the greatest opportunity to contribute to a future holistic shore protection system (Completeness), and is only marginally less cost-effective than a +16 feet (NAVD88) floodwall (Efficiency). As such, the +17-foot (NAVD88) alternative is identified as the NED Plan.

<u>Regional Economic Development and Other Social Effects</u>

In accordance with ER 1105-2-100 *Planning Guidance Notebook*, Regional Economic Development (RED) impacts and Other Social Effects (OSE) are planning accounts that may be used to facilitate the evaluation and display of the effects of alternative plans. Unlike National Economic Development (NED) impacts, RED and OSE analysis is discretionary. If RED and OSE planning accounts do not help to distinguish between alternatives nor help to identify the Recommended Plan during the risk-informed decision-making process, then they are not required as part of the planning process.

RED displays the changes in the distribution of regional economic activity (e.g., income and employment) over the future without- and with-project conditions.

OSE displays the plan effects on social aspects such as community impacts, health and safety, displacement, and energy conservation.

For this analysis, considering the similarity in potential NED-maximizing alternatives, differences in RED and OSE impacts between competing alternatives are not likely to assist in identifying the Recommended Plan as part of the risk-informed decision-making process. However, understanding the RED and OSE impacts in the future without- and with-project conditions can be useful in displaying a complete depiction of the study area over the 50-year period of analysis. A qualitative assessment of RED and OSE impacts is presented to show the damages in the future without-project condition and the potential benefits in the future with-project condition.

Primary RED metrics, as detailed in the IWR 2011-RPT-01 *Regional Economic Development (RED) Procedures Handbook*, include employment, labor income generated, direct business taxes, indirect business taxes, "value added," population distribution, and total sales by sector. For these metrics, additional coastal flooding in the future without-project condition would have significant negative impacts on direct business taxes, indirect business taxes, total sales by sector, and potentially on population distribution if frequently flooded areas become uninhabitable. For the future-with project condition, all of the proposed seawall construction alternatives provide benefits to employment, "value added," and labor income generated. In simple terms, the more expensive seawall alternative would provide slightly more income-based benefits though all the alternatives are nearly identical in terms of RED benefits.

Relevant OSE factors, as detailed in IWR 2013-R-03 *Applying Other Social Effects in Alternatives Analysis*, include Health and Safety, Economic Vitality, Social Connectedness, Identity, Social Vulnerability and Resiliency, Participation, and Leisure and Recreation. Given the frequency of inundation in the future without-project condition, all of the social factors outlined above would be negatively impacted with a particular emphasis on Health and Safety and Social Vulnerability and Resiliency. Repeated coastal storm inundation presents hazards for vulnerable populations and a higher frequency of damaging events limits the resiliency of the community and ability to recover to pre-storm condition. In the future with-project condition, as the Recommended Plan minimizes coastal storm risk among the proposed alternatives, that plan would also minimize negative OSE impacts. However, all of the proposed alternatives are similar in the magnitude and manner in which they mitigate negative social effects.

Environmental Quality

Alternatives that met the NED screening criteria were carried forward to be screened against the EQ criteria. The potential environmental impacts of the various alternatives were assessed qualitatively using the best professional judgment of the PDT and through coordination with state and Federal resource agencies. Potential impacts of the implementation of alternatives to water quality, estuary circulation, sedimentation and scour, air quality, endangered species, fisheries, aquatic life, wetland habitat, aquatic habitat, and upland terrestrial habitat were considered and scored using a ranked ordinal scale to describe the magnitude of the impacts and risk related to their implementation.

The PDT analyzed the potential environmental impacts of the alternatives. Alternatives that had environmental impacts with a high certainty of hindering implementation failed the EQ criteria and were removed for further consideration. Findings associated with this analysis indicated that all of the four alternatives met the EQ criteria.

6.0 Recommended Plan

6.1 Plan Components

The Recommended Plan is Alternative 4 which consists of raising the elevation of the existing stone seawall along its current alignment by placing a reinforced concrete cap on top of the existing stone seawall to elevation +17 feet (NAVD88) for 350 feet. At this elevation, the existing stone seawall would be raised approximately 7.5 feet from its existing elevation. The extent of where the existing seawall will be raised is shown in Figure 24.

Prior to placing the concrete cap, any existing sand on top of the seawall would need to be removed and stockpiled in a nearby location to be reused later. In order to prevent any movement of the reinforced concrete cap, at this height, the cap will need to be 8 feet wide and cast in place with framing. The existing concrete grout between the existing stones on top of the seawall would need to be cleared of existing grout to a depth of one layer of capstone, approximately three feet, in order to anchor the new concrete into the existing stone structure. An existing steel bulkhead is located within the first layer of capstone and would also need to be cleared of existing grout.

The location of the existing bulkhead is approximated based on 1963 Cape May City Construction Plans. Expansion and contraction joints will be required at an even interval along the top of the concrete cap. At each end of the project limit, a taper will be required in order to transition from the top of the new concrete cap down to the elevation of the top of the existing stone seawall. The taper will be placed at a 12H:1V slope and span a distance of approximately 90 feet on each end of the concrete cap to best grade to the existing seawall elevation, bringing the total length of concrete cap to 530 feet. The landward face of the concrete cap would be textured to create a sand-looking facade so that it looks more like a natural feature and blends into the current environment. On the seaward side of the concrete cap, the stockpiled sand will be placed back up against the concrete cap to form a dune-like feature in front of the vertical face of the concrete cap. In order to reinforce the placed sand, plantings will be provided. An 8-foot wide reinforced concrete cap on top of the seawall was designed to best adjoin and tie-in with the existing seawall cap width which will most effectively facilitate potential adaptation for sea level rise as well as for public access considerations and possible walkway development. The placement of sand fill at a 5:1 slope on the seaward side of the seawall was designed to consider wave forcing and erosion as well as tie into existing dune conditions. Handrails for public safety will be designed during the Design and Implementation Phase and will not be sand-tight i.e. sand will be allowed to pass through. For a typical section of concrete cap, see Figure 24.

Figure 24: Site Plan

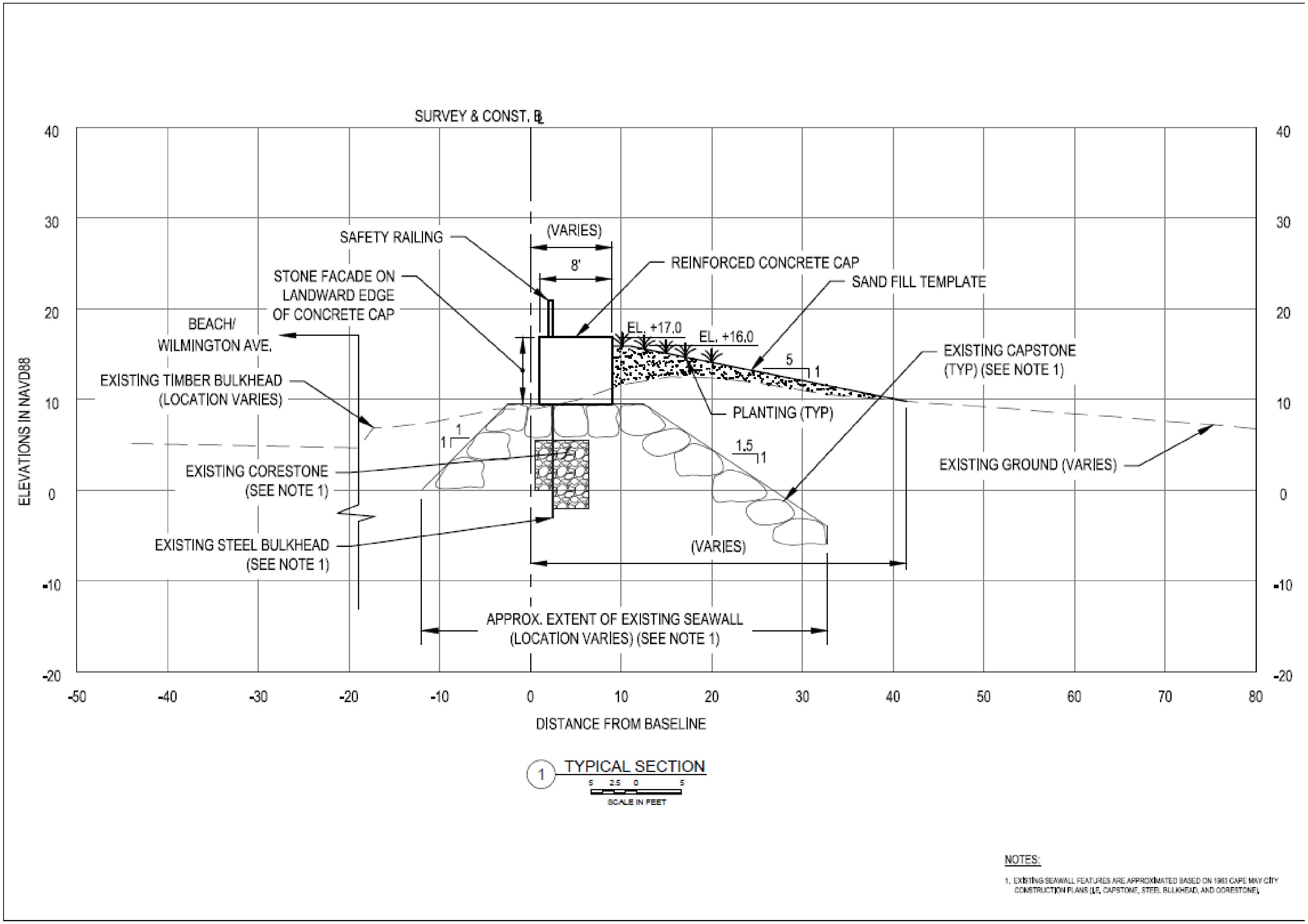


Figure 25: Typical Section

Staging areas and contractor access points needed for project construction are indicated on Figure 24. Due to the work being on top of the existing stone seawall, this alternative would not require modification of the decommissioned storm water pipe.

Visual renderings of the constructed seawall associated with this project are demonstrated in Figures 26 and 27.

Figure 26: Visual rendering from the Land

Figure 27: Visual rendering from the Ocean

6.2 Benefits of the Plan

The total average annual net NED benefits for the +17-foot (NAVD88) elevation alternative NED Plan, in October 2021 (FY2022) Price Levels with a 2.25% Federal Discount Rate, are $144,000 with a 2.0 BCR. The NED Plan produces $283,000 in average annual benefits with 64% residual damages under the USACE Low Sea Level Change curve.

The +17-foot (NAVD88) alternative is also the reasonably NED maximizing alternative when considering all three RSLC curve scenarios as this alternative maintains similar average annual net benefits and average annual cost in comparison to the +16-foot (NAVD88) alternative with slightly reduced residual damages.

The RED and OSE impacts of the NED Plan are expected to be minimal and have no impact on plan viability nor plan selection.

Additional economics information on the NED Plan can be found in the Economics Appendix.

6.3 Cost Estimates

The fully funded Total Project Cost for design and construction is $3.379 million in October 2021 (FY2022) Price Levels escalated to FY2023. The cost share for construction is split 65% Federal 35% non-Federal. The construction baseline is June 2023. The total construction costs include $700 thousand for design analysis, $2.571

million for construction including construction management, and $1 thousand for lands, easements, right of way, relocations and disposal [LERRD]. The Total First Cost is $3.085 million. Additional features added for aesthetic purposes such as plantings are considered project 'betterments' and the construction cost share may be adjusted accordingly during subsequent project phases.

The total cost estimate includes "contingencies" which is an allowance against some adverse or unanticipated condition not susceptible to exact evaluation. The contingency allowances used in the development of the cost estimate for this project were estimated as an appropriate percentage using the abbreviated method for preparing risk analysis. A contingency factor of 37% was included in the Breakwaters and Seawalls costs. A provided contingency factor of 30% was included in the Lands and Damages costs. Additional cost information can be found in Cost Engineering Section of the Engineering Appendix.

6.4 Operation, Maintenance, Repair, Replacement & Rehabilitation

The purpose of Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) is a broad category meant to capture the ongoing costs to the non-Federal sponsor after initial construction of the project is completed. OMRR&R is estimated based on the type of measure proposed and the initial construction cost of that measure, in this case the seawall. OMRR&R for seawalls typically include semi-annual inspections, regrouting/cementing of seawall components including the walkway, monitoring and maintenance to undercutting and scouring of the sand dune on the oceanfront side of the seawall, and monitoring and maintenance of the roadway and drainage on the landward side of the seawall. Average annual OMRR&R costs are estimated to be $34,000 (October 2021 (FY2022) Price Level) which is 1% of the construction cost for this project.

6.5 Risk and Uncertainty Analysis

Alternative 4, which includes placing a concrete cap on top of the existing seawall, was identified as the Recommended Plan during this feasibility study. Consequently, a study cost and schedule risk analysis was performed by the PDT to identify all possible project risks. The qualitative information derived from the risk meeting with the PDT provided the framework for the risk analysis. The risk assessment conducted for this alternative yielded a contingency factor of 37 percent.

Risks identified for this project include:

- Earthwork estimates and site grading.
- Existing seawall stability - The existing seawall stone size was not evaluated for design stability in the present study. However, due to the nature of a stone wall, it is likely able to support the weight of a concrete cap. The existing seawall has a demonstrated history of stability both prior to construction of the beach

nourishment project in 1991, when waves directly impacted the full structure; and after the beach project was constructed, when extreme storm runup and overtopping were focused on the cap of the structure. Risk of seawall instability due to wave impact is low due to presence of the shallow sloping profile fronting the structure which precludes large deeper water waves from directly breaking on the structure. Structure stability will be assessed further during the Design and Implementation Phase of the project as part of detailed design.

- Further engineering of design of the concrete cap, of grouting of existing seawall structure, and façade and planter aesthetic improvements requiring changes in quantities and cost.
- Unidentified, abandoned or improperly located utilities.
- Public Acceptability – Preservation of historical properties as the proposed project is located within the Cape May Historic District
- Potential alternative plans were formulated with less level of detail leading to uncertainty in economics, design and costs.
- Incomplete accounting of existing infrastructure, pipelines, utilities which resulted in increased uncertainty for the baseline potential damage and cost estimates.
- Residual risk of coastal flooding and overtopping as well as high frequency flooding events for the Recommended Plan as well as all alternatives.
- Relative Sea Level Change (RSLC) - Given the potential impacts of global climate change and associated RSLC, a rise in water surface elevation through RSLC may exacerbate erosion rates and storm-related flood damages over the 50-year period of analysis.
- Climate change impacts consider that the timing of benefits and impacts are not overly sensitive to the rate of sea level rise. As a result, identification of the accurate impact will be in the timing of future adaptive responses and the costs.

6.6 Life Safety Risk Assessment

In compliance with ER 1105-2-100 *Planning Guidance Notebook* and ER 1105-2-101 *Risk Assessment For Flood Risk Management Studies (2017)*, a comprehensive life safety risk assessment of the Recommended Plan is scheduled to occur during the Design and Implementation Phase of the study. The assessment will run concurrently with enhancements to the level of design as well as improvements to the level of certainty in construction cost estimates. The scope and detail of data collection and model assessment (analytical rigor) in the study are scalable, including assessments of the potential for life loss. The level of detail will depend on the decision being made, what is necessary to address uncertainty in the results, complexity of the problem, and cost of addressing the risks.

An abbreviated qualitative life safety risk assessment of the Recommended Plan is detailed in this section. This risk assessment includes a description of the various types of safety risks, a qualitative assessment of key life safety metrics, and an outline of the Tolerable Risk Guidelines (TRGs) as recommended by USACE Planning Bulletin (PB)

2019-04 *Incorporating Life Safety into Flood and Coastal Storm Risk Management Studies*.

Life safety risk assessments are a systematic approach for describing the nature of coastal storm risk, including the likelihood and severity of occurrence while explicitly acknowledging the uncertainty in the analysis. Life loss consequences are the determination of the population at risk and the estimated statistical life loss in a given area. An assessment of the various types of risk, including residual risk, transferred risk, transformed risk, and incremental risk, can help inform whether the Recommended Plan provides a tolerable level of safety for the study area in the future with-project condition.

Residual risk is the coastal storm risk that remains in the floodplain even after a proposed coastal storm risk management project is constructed and implemented. Physical damages, as well as potential life loss consequences, can remain even after the project is implemented due to a variety of causes. The Recommended Plan has 64.5% residual physical damages in the future with-project condition. Some of these residual damages are the result of coastal storm waters overtopping the proposed measure (incremental risk), but the majority of residual damages to the study area are due to flood waters reaching vulnerable structures from other sources. The southeast corner of the City of Cape May, the location for the Recommended Plan, was identified as the “weakest link” in the coastal storm risk management system. When modeling storm events of increasing magnitude, the southeast corner of the study area was the first to allow overtopping and inundation of the study area. Reducing inundation from just this one source of flooding reduces total coastal storm risk by 35.5%.

However, it is not the only source of flooding for the study area. As storm events increase in magnitude, inundation occurs from overtopping the dune and berm system on the southern end of the city, from flanking on the western end of the city, and from back bay flooding on the northern end of the city. These alternate sources of flooding are not mitigated by the Recommended Plan and contribute to the 64.5% residual physical damages figure. Qualitatively, residual life safety risk occurs due to the same processes. For large storm events, the population at risk would still need to evacuate to mitigate the potential for life loss.

Population at Risk (PAR) provides a brief overview of the vulnerable population within the study area. For this study, PAR is displayed for both the entire study area and for the population situated directly behind the proposed floodwall (Table 8). This area of highest vulnerability would be most adversely affected by a breach or failure. As the City of Cape May has a fluctuating population due to seasonal tourism, PAR is separated between off-season and peak-season. Demographics information, including the assumed number of occupants per structures (2.25 persons), the rate of occupation in the off-season (77.6%), and the percentage of population older than 65 years (27.3%) is derived from the U.S. Census Bureau (Population Estimates Program, 2019).

Table 8: Population at Risk (PAR)

	Highest Vulnerable Area		Total Study Area	
	Off-Season	Peak-Season	Off-Season	Peak-Season
Inhabitable structures	385	385	1,392	1,392
Occupied Rate	77.6%	100%	77.6%	100%
Population at Risk	672	866	2,430	3,132
Population at Risk (65+)	183	236	663	855

Transferred and transformed risks are also components of a future with-project life safety risk assessment. Transferred risk is the result of an action taken in one region shifting the risk burden to another region in the system. For the Recommended Plan, transferred risk is not a significant concern. An effective coastal floodwall will keep flood waters out of the vulnerable area without increasing the risk for any neighboring area.

Transformed risk is a new risk of flooding that emerges or increases as a result of mitigating another risk. The magnitude and nature of the risk of flooding is different with a seawall compared with conditions without a seawall. A seawall may transform the flood risk from one that may be gradual and observable before emergency action would be necessary for the originally protected properties to flood risk that may be sudden and catastrophic. If a seawall breaches or malfunctions, then the sudden increase in flood waters in vulnerable areas can increase the potential for life loss.

For the Recommended Plan, transformed risk is a significant concern and the comprehensive life safety risk assessment will need to investigate the impact of transformed risk on estimated statistical life loss. Transformed risks can be mitigated with drafting emergency action plans (EAPs) for vulnerable areas being protected by the coastal floodwalls. An EAP, as part of a larger floodplain management plan, will cover warning times, warning effectiveness, flood arrival time, and fatality rate thresholds.

The comprehensive life safety risk assessment will also fully cover the four TRGs detailed in USACE PB 2019-04 *Incorporating Life Safety into Flood and Coastal Storm Risk Management Studies*. Like all planning objectives, the extent to which the TRGs objectives can be met will vary based on the conditions in the study area and the efficiency and effectiveness of measures that contribute towards meeting the objectives.

6.7 Optimization of the Recommended Plan and Post-Feasibility Study Efforts

Additional detailed analyses and investigations will be undertaken by the Philadelphia District of the USACE during the Design and Implementation Phase. This will include a thorough investigation of the existing seawall condition and stability to ensure the cap and seawall function as intended during wave attack, as the reduction in storm damages can only be fully realized if the existing seawall beneath the cap is stable enough to withstand the design storm event. Additional Design and Implementation Phase analyses will consider including a recurved face on the oceanside face of the seawall to direct spray away from the street, including a splash pad on the landward side of the seawall to prevent scouring as well, identification of a structural feature to replace the existing timber bulkhead to keep sand out of the adjacent parking spaces and street, and consideration of walkways and handrails for safety.

Specific construction considerations addressed in the Design and Implementation Phase include the identification of specific locations of the contractor staging areas, removal and replacement of the existing timber bulkhead landward of the existing seawall, and the inspection and stability analysis of the existing seawall which will help to identify potential repairs of the existing seawall prior to placement of the concrete cap. A sliding stability analysis would also likely need to be performed during this phase owing to the addition of the additional weight of the concrete cap. The construction of concrete or MSE planters with shrubbery to aesthetically enhance the landward seawall façade will also be addressed during this phase.

7.0 Environmental Effects

In addition to the Recommended Plan and the no action plan, two other alternatives were evaluated in depth. These alternatives were 1) demolish and rebuild the existing seawall at a higher elevation, and 2) install a steel sheet pile bulkhead adjacent to the existing seawall. A qualitative analysis of the environmental impacts associated with these alternatives was conducted. Overall, the impacts associated with these two alternatives would be similar to those discussed below for the Recommended Plan. Demolishing the existing seawall and rebuilding it would have all of the impacts discussed below but on a larger scale. Construction of this alternative would take longer and has a greater likelihood of impacting beach nesting birds since construction would most likely extend over more than one nesting season. In addition, more excavation of the existing beach and dune habitat would be required in order to access the toe of the existing seawall. The additional time and equipment needed for this alternative may also result in increased emissions which could negatively affect air quality. There would be no impacts to any water resources with this alternative.

Similarly, the steel sheet pile alternative would have all of the impacts discussed below on a larger scale. Construction of this alternative would also take longer than the selected plan due to the need to excavate a larger quantity of sand from around the existing structure and the need to install bulkhead supports below the surface. This alternative would most likely have greater visual impacts since it reduces the available area to plant a vegetative buffer and would be harder to make look like a "natural" feature in the landscape.

As discussed previously, the Recommended Plan consists of the placement of a reinforced concrete cap on top of the existing seawall to reduce the risk of flooding in the project area. The existing seawall is bordered by Beach Avenue and Wilmington Avenue on the landward side and the Cape May City beach on the seaward side. This risk reduction measure would consist of the temporary removal and stockpiling of approximately 211 cy of sand from on top of and in front of the existing seawall. A reinforced concrete cap approximately 7.5 feet high will then be placed on top of the existing seawall for a length of approximately 350 feet. At each end of the 7.5-foot cap, a taper will be required in order to transition from the top of the new concrete cap down to the elevation of the top of the existing stone seawall. The taper will be placed at a 12H:1V slope and span a distance of approximately 90 feet on each end of the concrete cap, bringing the total length of concrete cap to 530 feet. The landward face of the concrete cap would be textured to create a sand-looking façade so that it looks more like a natural feature and blends into the current environment. On the seaward side of the concrete cap, the stockpiled sand will be placed back up against the concrete cap to form a dune-like feature in front of the vertical face of the concrete cap. In order to reinforce the placed sand, the area will be planted with dune grass following construction. The expected environmental impacts associated with this plan are presented below. This plan is the alternative with the least environmental impacts.

7.1 Air Quality

Raising the elevation of this portion of the seawall would cause temporary reduction of local ambient air quality due to fugitive dust and emissions generated by construction equipment. These temporary reductions in air quality would not have a significant impact on the long-term air quality of the surrounding area.

In 1993, the EPA promulgated the General Conformity Regulations, which ensure that Federal Actions comply with the National Ambient Air Quality Standards (NAAQS) and conform to a nonattainment area's State Implementation Plan (SIP). In the case of the Cape May Seawall project, the Federal Action is to manage coastal storm risk to the project area. The USACE Philadelphia District will be responsible for construction. Cape May, New Jersey, where the Federal Action will take place, is classified as nonattainment for ozone (oxides of nitrogen [NOx] and volatile organic compounds [VOCs]). The Cape May Seawall project site is within the Philadelphia-Wilmington-Atlantic City Nonattainment Area (PA-NJ-MD-DE). The PA-NJ-MD-DE nonattainment area is also currently in Marginal Nonattainment for the 2015 8-hour Ozone Standard.

There are two types of Federal Conformity: Transportation Conformity and General Conformity (GC). Transportation Conformity does not apply to this project because the project is not funded by the Federal Highway Administration and it does not impact the on-road transportation system. However, GC is applicable to this project. Therefore, the total direct and indirect emissions associated with the Cape May Seawall project construction must be compared to the GC trigger levels presented below.

Pollutant	**General Conformity Trigger Levels (tons per year)**
NOx	100
VOCs	50

To conduct a general conformity review and emission inventory for the Cape May Seawall project, the equipment necessary for construction including the number of engines, engine size (horsepower, or hp), work crew travel trips to the work site and back during the construction period, and duration of operation was identified (Refer to the Engineering Appendix for additional information). Once the hp-hrs are generated, load factor (LF) is assigned to the equipment, which provides an average of the degree of how hard the equipment is operating (e.g. full power or half power). Once the hp-hrs are adjusted based on load factor, they are multiplied by the emissions factor, which is an estimate of the amount of emissions produced per hp-hr (an example would be grams of NOx per hp-hr). The value is then converted into tons of the constituent emitted.

The direct and indirect emissions associated with the project were evaluated according to the requirements of 40 CFR Part 93, Subpart B. A conformity determination is not required for this project/action because:

1. An emissions estimate was completed to determine the Nitrogen Oxides (NOx) and Volatile Organic Carbon (VOC) emissions (precursors to ozone formation) associated with raising the elevation of a portion of the Cape May Seawall. Total direct and indirect emission from this project/action were calculated to generate a

total of 1.38 tons of NOx and 0.29 tons of VOCs that would be split over two calendar years.

2. The project is located in Cape May County, New Jersey, which has the following nonattainment-related designations with respect to the National Ambient Air Quality Standards (40CFR§81.133): Marginal Nonattainment 2015 8-hour Ozone Standard (primary and secondary).

3. The total direct and indirect emissions from this project are less than the 100 tons trigger level for NO_x for each project year and significantly below the 50 tons trigger level for VOC (40CFR§93.153(b)(1) & (2)), as VOCs, are typically a fraction of total NOx emissions.

4. The project conforms with the General Conformity requirements (40CFR§93.153(c)(1)) and is exempted from the requirements of 40 CFR §93 Subpart B. The project/action is not considered regionally significant under 40 CFR 93.153(c(2)).

A Record of Non-applicability (RONA) is provided in the Environmental/Cultural Support Documents Appendix of this EA.

The project would also cause short-term temporary increase in greenhouse gas emissions during construction activities. These emissions would most likely be in the form of carbon dioxide due to the burning of fossil fuels in construction equipment. Due to the small size of the project and short duration of construction activities, greenhouse gas emissions related to this project are expected to be minimal and have no significant effect on climate change. The project is designed to help the project area better withstand climate changes and sea level rise through the elevation of the existing seawall.

7.2 Terrestrial

As mentioned previously, native vegetation is practically non-existent in most of Cape May due to extensive development in the area, but some vegetation does exist within the construction footprint. It is anticipated that approximately 211 cy of sand will be removed from on top of and in front of the existing seawall in order to install the concrete cap. This quantity is based on current site conditions and may change based on conditions at the time of construction. The sand will be stockpiled on the beach near the seawall until construction is complete and will then be placed against the seaward face of the seawall and planted with dune grass or other similar vegetation. The stockpiled area will also be restored following construction and any vegetation impacted will be restored. Overall, it is expected that less than 13,000 square feet of beachfront sand will be temporarily impacted during construction activities and any vegetation that is disturbed or removed will be restored to pre-construction conditions.

7.3 Aquatic

Due to the fact that all construction and associated work will take place approximately 145 feet from the water's edge and will be confined to upland areas, the aquatic environment will not be affected.

7.3.1 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), requires all Federal agencies to consult with the National Marine Fisheries Service on all actions and proposed actions permitted, funded, or undertaken by the agency that may adversely affect Essential Fish Habitat (EFH). Since the proposed action will not take place in the water, no Federally managed species or their life stages will be affected by the project.

7.4 Wildlife

No long-term effects to the wildlife resources in the project area are anticipated as a result of this project. There will be some noise and general disturbances along the seawall and upper beach as a result of construction activities, but these will be minor and temporary in nature and it is anticipated that wildlife species in the area will move away from the active construction zone.

7.4.1 Birds

As previously discussed, many species of birds from various habitats are found in and around the project area. Typically, these species would be transient in nature within the actual area of construction. Beach species like sanderlings, sandpipers, and gulls which are consistently found in the beach environment generally feed near the water's edge or rest along the beach. The area of active construction will only extend along approximately 530 feet of the existing seawall. There will be some noise and general disturbances along the seawall and upper beach as a result of construction activities, but these will be minor and temporary in nature and it is anticipated that any bird species in the area will move away from the active construction zone and utilize other portions of the beach.

7.4.2 Mammals, Reptiles and Amphibians

As previously discussed, many species of mammals, reptiles and amphibians from various habitats are found in and around the project area. Typically, these species would be transient in nature within the actual area of construction. The area of active construction will only extend along approximately 530 feet of the existing seawall. There will be some noise and general disturbances along the seawall and upper beach as a result of construction activities, but these will be minor and temporary in nature and it is anticipated that any animal species in the area will move away from the active construction zone and utilize other portions of the beach and surrounding habitat.

7.4.3 Threatened and Endangered Species

As mentioned in a previous section, beach birds such as the piping plover and red knot, (Federally-listed as threatened and State-listed as endangered), seabeach amaranth (Federally-listed as threatened), and the least tern and black skimmer (State-listed as endangered) may be present on the Cape May beaches. To address the potential impacts to these species, the Philadelphia District developed a programmatic Biological Assessment (BA) for the piping plover and seabeach amaranth as part of formal consultation requirements with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act (ESA). The USFWS reviewed the BA and subsequently issued a Biological Opinion in December 2005. The requirements outlined in the Biological Opinion have been adopted in order to comply with the ESA. The Terms and Conditions outlined in the BO include actions such as monitoring during construction, imposing timing restrictions if nests are found, installation of temporary protective fencing, and avoidance during construction. While the BO generally deals with impacts related to beach nourishment activities, some of the protection measures outlined in the document would be applicable to this project as well. The project area, specifically the foredune area in the construction footprint, would be periodically monitored for the seabeach amaranth. Contingency plans for the presence of seabeach amaranth at the time of construction may involve avoidance of the area (if possible), collection of seeds to be planted in non-impacted areas, and timing restrictions.

While no significant direct impacts would be expected with regard to the above-named species, the project does have the potential for minor indirect impacts. The construction activities such as equipment on the beach and noise have the potential to impact the nesting behavior of piping plovers, as well as the presence of wintering red knots in the project area. Piping plovers have historically nested within the project area, but the last nest in Cape May City was in 2013. Piping plovers did nest at the Coast Guard Training Center (TRACEN) property in 2020. Overall, the NJDEP Division of Fish and Wildlife, has reported a concerning drop in plover nesting in all of Cape May County over the last few years. If piping plovers become established within the project area during construction activities, the implementation of protection measures, such as establishment of a buffer zone around the nest and limiting construction to be conducted outside of the nesting period (15 March – 30 August), will be required. No seabeach amaranth plants have been found in the project areas since 2004 when six plants were found at the Coast Guard Station. Amaranth surveys will be conducted prior to construction to confirm the presence or absence of the species within the project footprint. The proposed action may affect, but is not likely to adversely affect piping plovers or seabeach amaranth.

The red knot may be present at the site during the spring and fall migration, with some birds still being present in the early winter-time period. Previous surveys indicate minimal use of the project area by red knots. Due to the expected timing of the construction, it is not anticipated that any birds will be present during construction activities. If any birds are present, they will easily be able to move away from the construction activities to another portion of the beach where they will not be disturbed. The proposed action may affect, but is not likely to adversely affect the red knot. Informal consultation with regard to the red knot has been conducted and the USFWS has concurred with the not likely to adversely affect (NLAA) determination for the red knot..

This project is expected to have minimal effect on any threatened or endangered species due to the location and duration of the project. Piping plovers and seabeach amaranth and several state-listed bird species have the potential to be present in the project area. Piping plovers have historically nested in Cape May, including, most recently at the Coast Guard TRACEN center beach located immediately north of the project area. The USFWS has determined that the project is not likely to jeopardize the continued existence of the piping plover or seabeach amaranth per their June 8, 2021 letter.

Since all construction activities will occur on the upper beach and existing seawall, there will be no impact to the marine environment. As a result, the District has made a "No Effect" determination for threatened and endangered marine species such as sea turtles, whales and Atlantic sturgeon.

7.5 Cultural Resources

The Recommended Plan is within the boundaries of the Cape May Historic District, which is listed on the National Register of Historic Places (NRHP), the New Jersey Register of Historic Places and is designated by the National Park Service (NPS) as a National Historic Landmark. There are two individually eligible or listed contributing structures in the vicinity of the Recommended Plan construction location whose view of the beach may be impacted by the seawall. They are the John Forsythe House at 1601 Beach Avenue and another structure at 1613 Beach Avenue.

The USACE determined that the Recommended Plan will have no physical impact to any individually eligible or contributing historic property within the Undertaking's construction footprint. The USACE has determined that the proposed Undertaking will have a minimal visual impact to the Cape May Historic District, however it would not alter any of the characteristics that qualify the Cape May Historic District's inclusion in the NRHP.

Therefore, the USACE has determined that the proposed Undertaking will have *No Adverse Effect* to the Cape May Historic District and National Historic Landmark. This determination was sent to the NJSHPO on June 3, 2020.

In a letter dated June 30, 2020, the NJSHPO provided several comments on the Recommended Plan, including a request for a list of Consulting Parties, a definitive visual APE, and detailed plans and specifications. The USACE has identified the following as potential Consulting Parties:

- Greater Cape May Historical Society
- Cape May Historic Preservation Commission
- Cape May Museum
- National Park Service Landmarks Division
- The City of Cape May
- Property owner of 1601 Beach Avenue
- Property owner of 1613 Beach Avenue
- Delaware Nation
- Delaware Tribe of Indians
- Eastern Shawnee Tribe of Oklahoma
- Oneida Indian Nation
- St. Regis Mohawk Tribe
- Seneca Nation of Indians
- Stockbridge-Munsee Community of Wisconsin

In September 2020 the USACE hosted a virtual meeting with the NJSHPO to discuss a path forward for consultation. The NJSHPO requested project plans and specifications, and a verbal description and location of the visual APE. The USACE explained that, at the Feasibility Study level, project plans were very general. In lieu of detailed plans and specifications, the USACE suggested the creation of several renderings depicting the possible visual impact from the perspective of the contributing structures, with several aesthetic masonry treatments to provide a realistic perspective of the Recommended Plan. The NJSHPO were amenable to the creation of visual renderings, with a request for one with a more natural aesthetic.

In a letter dated February 8, 2021, the USACE addressed the NJSHPO comments, provided visual renderings of the seawall with several masonry treatments, a figure depicting the visual APE, and again made a *No Adverse Effect* determination regarding the Recommended Plan and its effects on the Cape May Historic District and National Historic Landmark. The NJSHPO did not concur with the determination and requested a formal Visual Impact Assessment be conducted by a historic architecture professional who meets the Secretary of Interiors Standards. In order to continue consultation and to conduct this cultural resource investigation, the USACE recommended the negotiation of a Programmatic Agreement. The NJSHPO agreed.

On May 26, 2021 the USACE conducted a Consulting Parties meeting to discuss the Recommended Plan and its potential to impact the historic viewshed to the Cape May Historic District and presented several renderings with aesthetic treatments. Representatives of the City of Cape May, the Cape May Historic Preservation Commission, the Greater Cape May Historical Society, the National Park Service (NPS), the Delaware Nation, and the Delaware Tribe were in attendance. Several Consulting Parties were in favor of the more natural sand-type treatment for the seawall. The USACE presented the Programmatic Agreement which was reviewed by the Consulting Parties; however, none requested to be a signatory on the document.

The final draft of the Programmatic Agreement was sent to the Advisory Council on Historic Preservation via the e106 submission protocol on July 20, 2021, and they declined to participate. The Programmatic Agreement was executed on August 19, 2021.

7.6 Coastal Barrier Resources Act

As discussed previously, a review of the Coastal Barrier Resources System (CBRS) Map did not identify any CBRS units or "Otherwise Protected Areas" within the Cape May City Seawall project area. As a result, there will be no impact to CBRS areas as a result of this project.

7.7 Recreation

As previously discussed, the coastal communities of New Jersey provide a wide variety of recreational activities that play a vital role in the State's economy. Beach access in the area immediately adjacent to this portion of the seawall will be restricted during the approximately six months of construction. Beach use in front of the seawall will still be available, so overall impacts to beachgoers will be minimal. No other recreational opportunities will be significantly impacted by the proposed project.

7.8 Noise

Temporary effects due to increased construction noise may be experienced by nearby homeowners during the project construction. Construction activities will require the use of heavy construction equipment. An increase in road traffic and possibly traffic interruption can also be anticipated. Construction activities are temporary in nature and would last for approximately six months. Under normal circumstances, noise will only be generated Monday through Friday during normal working hours. There will be no long-term adverse noise impacts associated with the proposed completed project.

7.9 Hazardous, Toxic and Radioactive Waste (HTRW)

As discussed in Chapter 3 - Existing Environment and Table 3, there are no SHWS sites at the Cape May Seawall construction area. In addition, there will be only minimal excavation of material in front of and above the base of the existing seawall to remove and replace existing grout at the Cape May Seawall site during the construction process, and thus there would be minimal if any adverse impacts to the existing subsurface, and subsequently SHWS sites.

7.10 Socio-economics

Seawall construction activities will be focused on the seaward side where a contractor staging area is situated. Contractor access will be to the northeast of the project area near the Bartram Tract. These construction activities as well as overall socio-economic effects of the constructed project associated with the seawall concrete cap will not affect the socio-economic activity in the local area. Further, the possible construction of a walkway atop the seawall will in fact add to the ability of senior members of the community to exercise and enjoy the oceanfront environment. Environmental Justice (EJ) communities and minorities will not be affected adversely as the location of the seawall is not in an identified environmental justice (EJ) community.

7.11 Visual and Aesthetic Values

Seawall construction activities will cover the existing seawall with a concrete cap so that the existing seawall will not be exposed. Since the concrete cap associated with this project will increase the overall seawall height which may result in a visual impact, the landward face of the concrete cap would be textured to create a sand-looking façade so that it looks more like a natural feature and blends into the current environment. In addition, vegetation will be planted on the landward side of the seawall to help the cap blend into the surrounding environment. On the seaward side of the concrete cap, the stockpiled sand originally removed during the construction process will be placed back up against the concrete cap to form a dune-like feature in front of the vertical face of the concrete cap. In order to reinforce the placed sand, plantings will be provided.

8.0 Environmental Justice

In accordance with Executive Order 12989 (Environmental Justice in Minority Populations), a review was conducted of the populations within the affected area. The U.S. Environmental Protection Agency definition for Environmental Justice is: “the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.” Based on a review of recent census data of the affected area, no impacts are expected to occur to any minority or low-income communities in the area (Cape May County New Jersey QuickFacts from the US Census Bureau).

9.0 Executive Order 11988

Executive Order 11988 requires federal agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with construction activities (occupancy) within flood plains. Where practicable alternatives exist, federal agencies must avoid direct and indirect support of floodplain development. The Recommended Plan involves temporary impacts to the floodplain. Flood flows will not be permanently impeded, retarded, or changed as a result of the Project. The eight-step decision support evaluation process found in ER 1165-2-26 is listed below as applicable to the proposed project:

1. Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year).
The entire proposed project area lies within the 100-year floodplain.

2. Conduct early public review, including public notice.
A public notice for the project was issued in February 2021 detailing the tentatively selected plan and the availability of the draft Feasibility report and EA. The City of Cape May has presented the proposed project at City meetings. Additional public involvement will take place during the next phase of the project.

3. Identify and evaluate practicable alternatives to locating in the base floodplain, including alternative sites outside the floodplain.
Since the Recommended Plan is a concrete cap on top of the existing seawall, relocation of the project was neither possible nor practicable. Alternatives outside of the floodplain would not support the project goals of protecting the project area from coastal storm damages.

4. Identify impacts of the proposed action.
Temporary impacts during construction will be limited to the removal and stockpiling of sand seaward of the seawall and the temporary presence of construction equipment.
There will be no permanent negative impacts to the floodplain. The installation of the concrete cap will serve to protect the project area from future storm damages and flooding.

5. If impacts cannot be avoided, develop measures to minimize the impacts and restore and preserve the floodplain, as appropriate.
The proposed concrete cap will be placed on top of the existing seawall so there will be no change in the footprint of the existing seawall. As a result, no impact to the

100-year floodplain will occur.

6. Reevaluate alternatives.
As discussed above, placement of a concrete cap on top of the existing seawall results in the least possible impact to the surrounding resources and floodplain since there will be no change in the footprint in the floodplain.

7. Present findings and a public explanation.
The public have been afforded an opportunity to comment on the proposed project as described previously.

8. Implement Action
The placement of the 530-foot long concrete cap on the existing seawall will be completed Section 103 of the Continuing Authorities Program Section.

10.0 Compliance with Environmental Statutes

Compliance with applicable Federal Statutes, Executive Orders, and Executive Memoranda is presented in Table 9. This is a complete listing of compliance status relative to environmental quality protection statutes and other environmental review requirements.

The proposed elevation of a portion of the Cape May Seawall at Beach and Wilmington Avenues complies with and will be conducted in a manner consistent with New Jersey's Coastal Zone Management Act requirements. A Federal Zone Consistency Determination was received from the State of New Jersey in a letter dated April 26, 2021 and is included in Appendix A.

The seawall modification described in this document is not expected to have significant air quality impacts. A Clean Air Act Record of Non-Applicability (RONA) that demonstrates a typical emissions output projected over two calendar years is presented in the Environmental/Cultural Support Documents Appendix, and demonstrates compliance with Section 176(c)(1) of the Clean Air Act amendments of 1990.

Table 9: Compliance with Environmental Quality Protection Statutes and Other Environmental Review Requirements.

FEDERAL STATUTES	COMPLIANCE W/PROPOSED PLAN
Archeological - Resources Protection Act of 1979, as amended	Full**
Bald and Golden Eagle Protection Act	Full
Clean Air Act, as amended	Full

Clean Water Act of 1977	N/A
Coastal Barrier Resources Act	N/A
Coastal Zone Management Act of 1972, as amended	Full
Endangered Species Act of 1973, as amended	Full
Estuary Protection Act	N/A
Federal Water Project Recreation Act, as amended	N/A
Fish and Wildlife Coordination Act	Full
Land and Water Conservation Fund Act, as amended	N/A
Marine Protection, Research and Sanctuaries Act	N/A
Magnuson-Stevens Fishery Conservation and Management Act	N/A
Migratory Bird Treaty Act	Full
National Historic Preservation Act of 1966, as amended	Partial
National Environmental Policy Act, as amended	Full
Rivers and Harbors Act	N/A
Watershed Protection and Flood Prevention Act	N/A
Wild and Scenic River Act	N/A
Executive Orders, Memorandums, etc.	
EO 11988, Floodplain Management	Full
EO 11990, Protection of Wetlands	Full
EO 12114, Environmental Effects of Major Federal Actions	Full
EO 12989, Environmental Justice in Minority Populations and Low-Income Populations	Full
EO 13045, Protection of Children from Environmental Health Risks and Safety Risks	Full
County Land Use Plan	Full

Full Compliance - Requirements of the statute, EO, or other environmental requirements are met for the current stage of review.
Partial Compliance - Some requirements and permits of the statute, E.O., or other policy and related regulations remain to be met.
Noncompliance - None of the requirements of the statute, E.O., or other policy and related regulations have been met.
N/A - Statute, E.O. or other policy and related regulations are not applicable.
** - A Programmatic Agreement has been executed to continue coordination with regard to potential visual impacts

11.0 Plan Implementation

The deliverable for this study will be a feasibility report with an integrated NEPA compliance documentation (Environmental Assessment). Upon the USACE North Atlantic Division approval of the final feasibility report, the project will proceed into the

Design and Implementation Phase pending execution of a Project Partnership Agreement (PPA) with the non-Federal sponsor.

11.1 Cost-Sharing and Non-Federal Sponsor Responsibilities

The initial project cost of the CAP Section 103 Cape May Seawall Project will be cost shared, with 65 percent of initial cost paid by the Federal Government and 35 percent paid by the non-federal sponsor. A Project Partnership Agreement (PPA) package will be coordinated and executed subsequent to the feasibility phase. The PPA reflects the recommendations of this Feasibility Report.

Cost Apportionment

The total project cost would be shared between the USACE and the City of Cape May, with 65 percent of the cost from Federal funds and 35 percent non-Federal. Section 103 projects have a federal expenditure limit of $10,000,000. Table 10 presents the fully funded cost estimate for the proposed project which includes the Federal and non-Federal cost shares. The fully funded cost estimate assumes a single construction season in fiscal year 2023. Feasibility costs include those costs spent to date on the study. It should be noted that the first $100,000 of the project study costs are 100 percent Federally funded and not included in the estimated Total Project Cost shown in Table 10 (Pricing is FY21 escalated to FY23).

Table 10: Federal and non-Federal Cost Share Apportionment Table (Pricing is FY21 Escalated to FY23)

	Total Project Costs
Feasibility Study Costs	**$700,000**
FED Share	$400,000
Non-FED	$300,000
Design and Implementation Costs	**$3,298,000**
Design Analyses, Plans & Specs	$700,000
Construction (including Construction Management)	$2,571,000
Monitoring[1]	$26,000
LERRDs[3]	$1,000
FED Share	$2,144,000
Non-FED Share	$1,154,000
Non-FED Cash	$1,087,270
Non-FED LERRD credit	$1,000
TOTAL PROJECT COST[2]	**$3,998,000**
FED Share	$2,544,000

Non-FED	$1,454,000
Note: Costs are based on Total Project Cost Fully Funded Estimate from TPCS 1 Monitoring Costs are incurred after the project is constructed. 2 Total Project Costs do not include operations and maintenance costs. 3 LERRDs are a 100% non-Federal responsibility for which the sponsor gets cost sharing credit.	

As the non-Federal project partner, the City of Cape May must comply with all applicable Federal laws and policies and other requirements, including but not limited to:

1. Provide all lands, easements, rights-of-way and relocations (LERRD) necessary for the construction, operation and maintenance of the proposed project, and perform or ensure performance of any relocations determined by the Federal Government to be necessary for the initial construction, operation, and maintenance of this project.
2. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law (PL) 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the construction, operation, and maintenance of the Project. However, for lands that the Federal Government determines to be subject to the navigational servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal project partner with prior specific written direction, in which case the non-Federal project partner shall perform such investigations in accordance with such written direction.
3. Coordinate all necessary cleanup and response costs of any CERCLA-regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the Project.

11.2 Real Estate Requirements

The one landowner within the project footprint is the City of Cape May which owns approximately 0.898 acres and consists of five parcels and street rights-of-way. No Federal or State lands are within the footprint of the project. The Real Estate Project Map shown in Figure 28 delineating the areas required for this project, which are the only Land, Easements, Rights of Way and Relocation (LERRD) requirement for the Project. There are two Standard Estates, including a temporary work area easement over approximately 0.517 acres of land (Estate No.15) and a perpetual beach storm damage reduction easement for a permanent right-of-way over approximately 0.381 acres of land (Estate No. 9). There are no non-standard estates necessary for this project. Further information can be found in the Real Estate Plan Appendix.

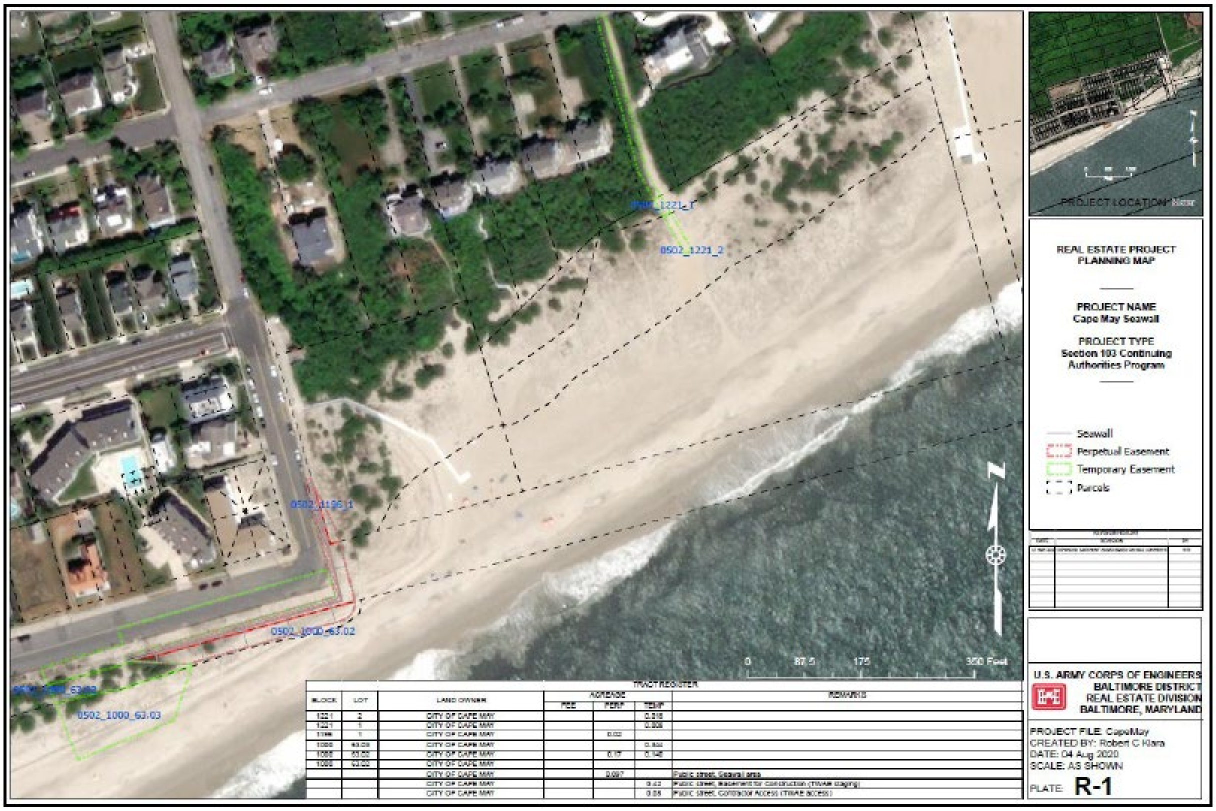


Figure 28: Real Estate Project Planning Map

The project's non-federal sponsor, the City of Cape May, will provide all land, easements and rights-of-way necessary for the construction, operation and maintenance of the project. The project boundary represented in the Real Estate Plan Appendix may be modified during the Design and Implementation Phase as construction engineering requirements and construction procedures are further refined. The lands, easements, rights-of-way, and disposal sites (LERRDS) required to support construction and subsequent operation and maintenance are presented in the Real Estate Plan Appendix.

11.3 Views of the Non-Federal Sponsor and Other Agencies

The City of Cape May, as the non-Federal sponsor, passed a resolution (Resolution 178-07-2018) which supports the Recommended Plan and expressed agreement in the forward path for the project. The Cape May City Historical Preservation Committee (CMHPC) commented that the aesthetic values of the constructed seawall could be improved by upgrading the original small curb wall to match the new wall to provide consistency of design for the streetscape. The Committee also commented that planters could be integrated in the immediate vicinity of the wall or on top of the wall (i.e. on the dune that will eventually drape over the wall) to break up the "flatness" of the seawall presentation. Further coordination is needed between the City of Cape May and the New Jersey Historic Sites Council under the New Jersey Register of Historic Places Act and will require written authorization from the Commissioner of the New Jersey Department of Environmental Protection. Specifically, further consultation and approval is needed between Cape May City and the New Jersey Historic Sites Council under State law. This coordination will address the impact to cultural and historical sites in the project area, and is not a USACE responsibility.

In a correspondence dated 22 March 2018, NJDEP commented on the Cape May Seawall Study NEPA Scoping Letter (dated 14 February 2018). Comments included the necessity to adhere to the Green Acres program.

Easements are required for the project over the following parcels which are unfunded Green Acres encumbered beach: Block 1000, Lots 63.02 and 63.03; Block 1196, Lots 1 and 1.01; and Block 1221, Lots 1, 2, and 2.01. The draft EA states that 0.517 acre will be needed for temporary use during construction and an additional 0.381 acre will be needed as a perpetual beach storm damage reduction easement for a permanent right-of-way.

Green Acres recommends that the City go through the Change in Use process in accordance with *N.J.A.C.* 7:36-25.6 for the permanent easement. All temporary construction areas must be returned to pre-existing or improved condition following construction of the project.

Additional comments were made concerning compliance with land use regulations, not reducing nesting habitat for birds, adherence to Section 106 of the National Historic Preservation Act of 1966, and further compliance with air quality, water allocations, discharge to surface water and storm water management regulations. Nesting bird habitat protection and noise concerns can be addressed by taking advantage of construction scheduling windows

The New Jersey State Historical Preservation Office (SHPO), in a letter dated 30 June 2020 expressed concerns about the impact this project could have on the Cape May Historic District and National Landmark and made preliminary comments regarding a list of Consulting Parties, a definitive visual APE analysis, and detailed plans and specifications. The USACE has developed a list of Consulting Parties and will further consult with the NJSHPO in the future. A Programmatic Agreement dated August 19, 2021 has been negotiated with the NJSHPO and the Consulting Parties that will define further analyses and investigations during the Design and Implementation Phase.

The Tribes were sent NEPA Scoping Letters (dated 14 February 2018). USACE received no responses. A copy of the Environmental Assessment has been provided to the tribes for their review.

12.0 Coordination, Public Views, and Comments

This Final Integrated Feasibility Report and Environmental Assessment will be distributed for review by the public, stakeholders, the City of Cape May, and Federal and State resource agencies.

13.0 Recommendations

As a result of this Final Feasibility Study and Environmental Assessment Report, USACE recommends that the least cost alternative with the highest average annual net benefits proceed to a final design in the Design and Implementation Phase of the project. Further, this Final Report consists of all planning and design activities that demonstrate that Federal participation is warranted at this time. During the Design and Implementation Phase, other actions such as completing plans and specifications and obtaining necessary permits will be conducted leading to a construction contract award. Additional funding is required to scope the PMP and execute the Project Partnership Agreement (PPA) to construct the least cost alternative plan with the highest average annual benefits.

This Final Integrated Feasibility Report and Environmental Assessment has been prepared to evaluate coastal storm risk management alternatives for the restoration of the seawall along Beach Avenue and Wilmington Avenue in the borough of Cape May City, New Jersey in regard to their relative completeness, effectiveness, efficiency and acceptability and potential impact to existing ecological, cultural and socio-economic resources. Alternative 4 has the highest average annual net benefits and was the only alternative that met all planning criteria. This recommended alternative places a concrete cap on top of the existing seawall at elevation +17 feet (NAVD88). The cap would be 8 feet wide and cast in place with framing. The existing voids between the stones on top of the seawall would be cleared of grout so that new concrete poured for the cap would be anchored into the existing structure.

This Final Integrated Feasibility Report and Environmental Assessment has given consideration to aspects in the overall public interest, including environmental, social, and economic impacts; feasibility; and the ability and interests of the non-Federal sponsor. The sponsor, the City of Cape May, will enter a Project Partnership Agreement to perform the required items of cooperation, including provision of all needed real estate interests, provision of cash as needed beyond real estate values to constitute 35 percent of total costs, and post-construction operation and maintenance of the project.

I recommend that the proposed plan for coastal storm risk management be approved and implemented. This recommendation reflects the information available at this time and with respect to current departmental policies.

20 SEP 2022

Date Signed

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Ramon Brigantti
Lieutenant Colonel, U.S. Army
District Engineer

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