City of Milford Coastal Resilience Plan

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Under the direction of the City of Milford Hazard Mitigation Committee

CONNECTICUT Department of Housing

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City of Milford Coastal Resilience Plan
Executive Summary

The City of Milford has over 53,358 residents (as of 2014) living within 22.2 square miles of land. The city has over 17.5 miles of shoreline along Long Island Sound and the tidal Housatonic River estuary. Recent events such as Tropical Storm Irene and Hurricane Sandy[1] have underscored the risks associated with occupying coastal areas and highlighted the fact that property owners and municipalities bear a heavy financial burden to recover from these types of events.

This Coastal Resilience Plan has been developed as a toolbox to build coastal resilience in the coming years. The plan presents a menu of citywide and location-specific options that are available to adapt to changing conditions or, at the very least, prepare for the future events like Hurricane Sandy. As time passes and our collective understanding of sea level rise[2] is refined, Milford will have the option to update this plan to reflect the city's evolving approaches to building resilience.

Preparation of this Coastal Resilience Plan was funded through the United States Department of Housing and Urban Development's (HUD's) Community Development Block Grant Disaster Recovery Program (CDBG-DR). The money was allocated to HUD through the 2013 Disaster Relief Appropriations Act, which designated aid assistance for communities affected by Hurricane Sandy. The CDBG-DR program is intended to target underserved, low-to-moderate income (LMI) populations – and communities that house these populations – for additional building resilience while addressing unmet needs after disasters. In Milford, LMI neighborhoods are located at Wildemere Beach and Walnut Beach.

Many regulations, plans, projects, and programs are maintained by the City of Milford to advance the city's pursuit of becoming a resilient coastal community. This coastal resilience plan acknowledges the contribution these resources make to Milford's resilience capabilities, and is designed to work *with* these existing documents and actions. Examples include the Hazard Mitigation Plan, the Community Rating System (CRS) Maintenance and Improvement Plan, and the many CDBG-DR planning grants and project grants awarded to the city after Hurricane Sandy.

The planning process undertaken by the City of Milford was loosely based on the coastal resilience planning process established in 2011-2012 by The Nature Conservancy (TNC) to address the current and future social, economic, and ecological resilience of the shoreline to the impacts of sea level rise and anticipated increases in the frequency and severity of storm surge, coastal flooding, and erosion. The four steps of the coastal resilience process are:

1. Generate awareness of coastal risks.
2. Assess coastal vulnerabilities, risks, and opportunities.
3. Identify options or choices for addressing risks.
4. Develop and implement an action plan to pursue selected options.

[1] Often called "Superstorm Sandy," the official title of the event according to the U.S. Department of Housing and Urban Development is "Hurricane Sandy."

[2] The nearest operational long-term NOAA tide gauge to Milford is the gauge in Bridgeport. Based on tide gauge data collected at that station between 1964 and 2014, mean sea level has been increasing at a rate of 2.87 millimeters (0.11 inches) per year, which is equivalent to a rise of 0.94 feet over 100 years.

In reality, this four-step process in Milford commenced years ago when other planning efforts involved the public, such as the Hazard Mitigation Plan. The specific planning process for this coastal resilience plan commenced in September 2015 and was completed in March 2016. Public involvement included two informational meetings and an internet-based survey. Vulnerability and risk assessment was conducted from September 2015 through January 2016, and the adaptation/resilience options for Milford were reviewed and selected from January through March 2016.

In the context of hazards, **risk** is the product or the sum of **vulnerability** and **frequency**. In the context of coastal hazards, risk depends on the vulnerability of coastal communities and infrastructure and the frequency of flooding and storm events. Coastal storms may be increasing in frequency[3], and periodic high-tide flooding will increase in frequency as sea level continues to rise. Thus, even if coastal vulnerabilities remain static, risks will increase. If vulnerabilities increase as well, due to new development in hazard areas or failure to maintain existing protective structures, risks will increase dramatically. Alternatively, if vulnerabilities are reduced through adaptation, risk levels can be held steady into the future. If vulnerabilities can be reduced even further, then risks can be lowered in the face of rising sea level and increased coastal storms, leading to **increased resilience**.

Resilience is the ability to resist, absorb, recover from, and adapt to disasters. **Coastal Resilience**, referring specifically to coastal hazards such as sea level rise, increased flood inundation, and more frequent and intense storm surges, can be achieved by decreasing coastal vulnerabilities through increased adaptation and planning.

For the purposes of this plan, the coastal neighborhoods of Milford[4] are broken into the following:

- Milford Point / Cedar Beach – residential neighborhood on a sand spit southeast of the Charles E. Wheeler Wildlife Area ("Wheeler") and east of the mouth of the Housatonic River
- Laurel Beach – medium-density residential area fronted by 50- to 100-foot-wide nourished and groin-maintained beaches
- Wildemere Beach – medium-density residential area with homes fronted by private seawalls and narrow, rocky, significantly eroded beaches
- Walnut Beach – many condominium buildings set back from the shorelines, which is fronted by wide beaches; bordered to the northeast by Silver Sands State Park
- Silver Beach – narrow, low-elevation neighborhood of finger roads extending west off of East Broadway into tidal wetlands associated with Great Creek; neighborhood and Great Creek wetlands are located east of Silver Sands State Park
- Fort Trumbull – higher-elevation neighborhood protected from inundation, though not waves; riprap protects Trumbull Ave from erosion
- Downtown – the area between State Route 162 to the south and State Route 1 to the north along the Wepawaug River; coastal flood hazards are typically limited to the southern limit of this area,

[3] According to NOAA, NASA, The Intergovernmental Panel on Climate Change, and the Union for Concerned Scientists, climate change will likely lead to increased intensity of storms, including tropical cyclones (such as hurricanes). For example, see <http://www.gfdl.noaa.gov/global-warming-and-hurricanes>.

[4] This plan does not specifically address risks along the tidal Housatonic River estuary. Lands along the river tend to be higher in elevation, and critical facilities such as the Milford Water Pollution Control Facility (wastewater treatment plant) are not at risk from storm surges.

just south of Route 162 around the Milford Library and Wilcox Park; this is the only inland area addressed in this plan

- Gulf Beach and Welches Point – a low-density coastal neighborhood containing the important throughway of Gulf Street, protected by riprap; the only beach here is at the mouth of Milford Harbor, at the western end of the area; most of the area is at a fairly high elevation
- Bayview Beach/Field Court – high-density, low-elevation neighborhood that suffers from drainage issues under present-day conditions
- Calf Pen Meadow Creek – Melba Street at the mouth of the creek is vulnerable to flooding from both the creek and Long Island Sound; Beachland Avenue on the east side of the creek is regularly flooded.
- Pelham Beach – a fairly steep shoreline here has some sections protected by seawalls and riprap and others that are experiencing erosion. Structures are typically somewhat set back from the shore.
- Point Beach – high-density, low-elevation neighborhood that suffers from drainage issues under present-day conditions
- Morningside – medium-density, higher-elevation area with main road along shoreline, protected by riprap and a seawall
- Hillside – higher-density, higher-elevation area with homes fronted by private seawalls along the water; no beach present at this site
- Burwells Beach – small cove with a beach to the south and a wetland to the north of the main road (Merwin Avenue); somewhat vulnerable to flooding
- Woodmont – including Anchor Beach, Crescent Beach, and Woodmont's eastern shore. This Borough within Milford has rocky shorelines to the south with small pockets of beach and a wide nourished beach to the east.

Milford's neighborhoods already have experience dealing with coastal hazards. The neighborhoods of Milford Point (Cedar Beach) and Bayview Beach regularly experience flooding at especially high high-tide events, such as those associated with low-pressure systems or full- or new-moon conditions. Residents suffer from blocked access to homes and damage to property and vehicles on a regular basis in those locations. Wildemere Beach has seen its sandy shoreline eroded to gravel and cobbles and has often taken damage from storms. Trumbull Avenue and Gulf Beach Road have to be regularly maintained to prevent failure due to erosion by high waves. Aged tide-controlled drainage systems have led to problems at Bayview Beach and Point Beach. Rising waters and increasing storm severity and frequency will exacerbate these problems and give rise to as-yet-nonexistent problems in other parts of the city.

To illustrate just two types of risk[5], the following table summarizes projected inundation risks to homes and roads caused by daily high tides in the 2020s, 2050s, and 2080s:

[5] Extensive information about neighborhood vulnerabilities and risks is presented in Appendix B.

Inundation Risks by Neighborhood

	Daily High Tide					
Neighborhood	**Risk to Homes**			**Risk to Roads**		
DHT Decade →	***2020***	***2050***	***2080***	***2020***	***2050***	***2080***
Milford Point/Cedar Beach	Low	Low	Med	Med	Med	High
Laurel Beach	None	None	Low	Med	Med	Med
Wildemere Beach	None	None	Low	None	None	Low
Walnut Beach	None	None	None	None	None	None
Silver Beach	Med	High	High	Low	Med	High
Fort Trumbull	None	None	None	None	None	None
Downtown	None	None	None	None	None	None
Gulf Beach	None	None	None	None	Low	Med
Bayview	Med	Med	High	Med	Med	High
Calf Pen Meadow	Med	Med	Med	High	High	High
Point Beach	Med	Med	High	Med	Med	High
Morningside	None	None	None	None	None	None
Hillside	None	None	None	None	None	None
Burwells Beach	Low	Low	Med	Med	Med	Med
Woodmont	None	None	None	None	None	Low

Of course, inundation risks are not the only coastal risks in Milford. Destructive waves, eroding coastal banks, eroding beaches, and ineffective drainage systems pose other coastal risks. Combined with storm surges and sea level rise, these risks are compounded and becoming worse over time.

The Intergovernmental Panel on Climate Change (IPCC) published the landmark paper "Strategies for Adaptation to Sea Level Rise" in 1990. Three basic types of adaptation were presented in the report:

- Retreat involves no effort to protect the land from the sea. The coastal zone is abandoned.
- Accommodation means that people continue to use the land at risk but do not attempt to prevent the land from being flooded.
- Protection involves protecting the land from the sea so that existing land uses can continue.

In 2010, the National Oceanic and Atmospheric Administration's (NOAA's) Office of Ocean and Coastal Resource Management published the manual "Adapting to Climate Change: A Planning Guide for State Coastal Managers." According to the manual, NOAA's seven categories of "Climate Change Adaptation Measures" are:

- Impact Identification and Assessment
- Awareness and Assistance
- Growth and Development Management
- Loss Reduction
- Shoreline Management
- Coastal Ecosystem Management
- Water Resource Management and Protection

Elements of *protection, retreat*, and *accommodation* are found in several of these categories and subcategories of adaptation.

Coastal adaptation strategies include both planning (nonstructural) and structural-related modifications. Nonstructural measures include preparedness, emergency response, retreat, and regulatory and financial measures to reduce risk. Structural measures include dikes, seawalls, groins, jetties, temporary flood barriers, and the like. Ideally, the measures that are taken should be robust enough to provide adequate protection and flexible enough to allow them to be adapted to changing future conditions. Such robustness and flexibility typically require combinations of methods rather than one solution. Structural measures can be site-specific, "neighborhood-scale," or large-scale structures that protect multiple square miles of infrastructure. Site-specific measures pertain to floodproofing a specific structure on a case-by-case basis. Neighborhood-scale measures apply to a specific group of buildings that are adjacent to each other. Large-scale structures might include large dike and levee systems or tide gates that can prevent tidal surge from moving upstream.

Many of the city's municipal planning documents already recognize sea level rise and coastal storms as a key issue in need of strong action. The Hazard Mitigation Plan[6] identifies at-risk locations, tracks mitigation projects, and suggests additional possibilities for reducing damage from coastal events. The Plan of Conservation and Development encourages the protection of and acquisition of additional open space to protect development and assist in the continued existence of tidal marshland. The Harbor Management Plan addresses future sea level change and covers the topic of sediment flow and dynamics which is so important to Milford's beaches and residents. The Community Rating System (CRS) Maintenance and Improvement Plan links many resilience initiatives to the city's participation in the CRS program.

To develop a suite of viable options for the city's consideration, coastal resilience projects undertaken by other communities were reviewed, local physical and political factors were considered, and options were discussed with Milford municipal officials and residents. The suite of options most applicable to the City of Milford is summarized in the following table:

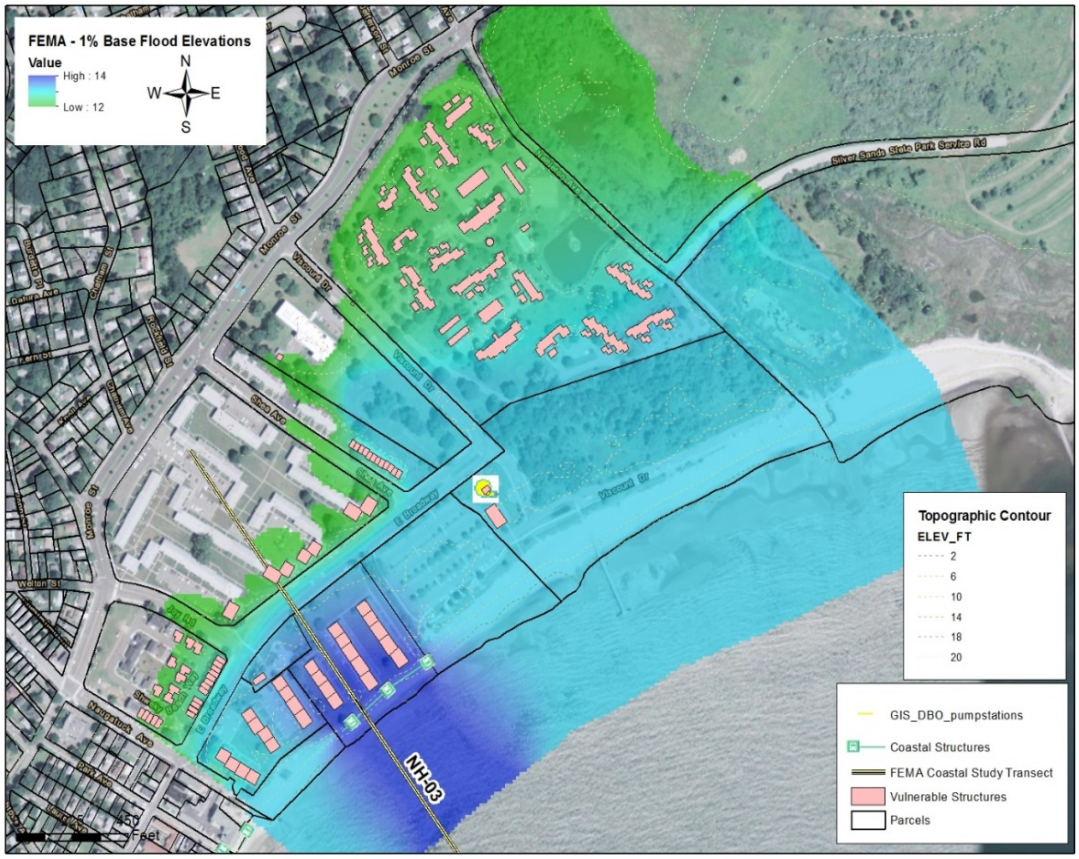
Categories of Options	Specific Options
Hard Shoreline Protection	Seawalls
	Bulkheads
	Revetments
	Dikes
	Groins
	Offshore breakwaters
Soft Shoreline Protection	Beach Restoration or Nourishment
	Dune Creation or Restoration
Hybrid Shoreline Protection	Bioengineered bank stabilization
	Artificial Reefs (reef balls)
Infrastructure Improvements, Retrofits, and Hardening	Storm Drain Maintenance and Improvement including pumping stations
	Road Elevation
	Wastewater Treatment Plant Floodproofing
	Sewer Pumping Station Elevation and Floodproofing
Home Protection	Elevation
Regulatory Tools	Flood Damage Prevention Modifications: • Freeboard • V zone standards in Coastal A zones

[6] Existing capabilities, plans, etc. are described in Appendix A.

Categories of Options	Specific Options
	Other Zoning Modifications: • Height Limit Flexibility • Reconstruction Flexibility
Coastal Realignment	Road Retirement (with or without alternate route development)
	Property Acquisitions

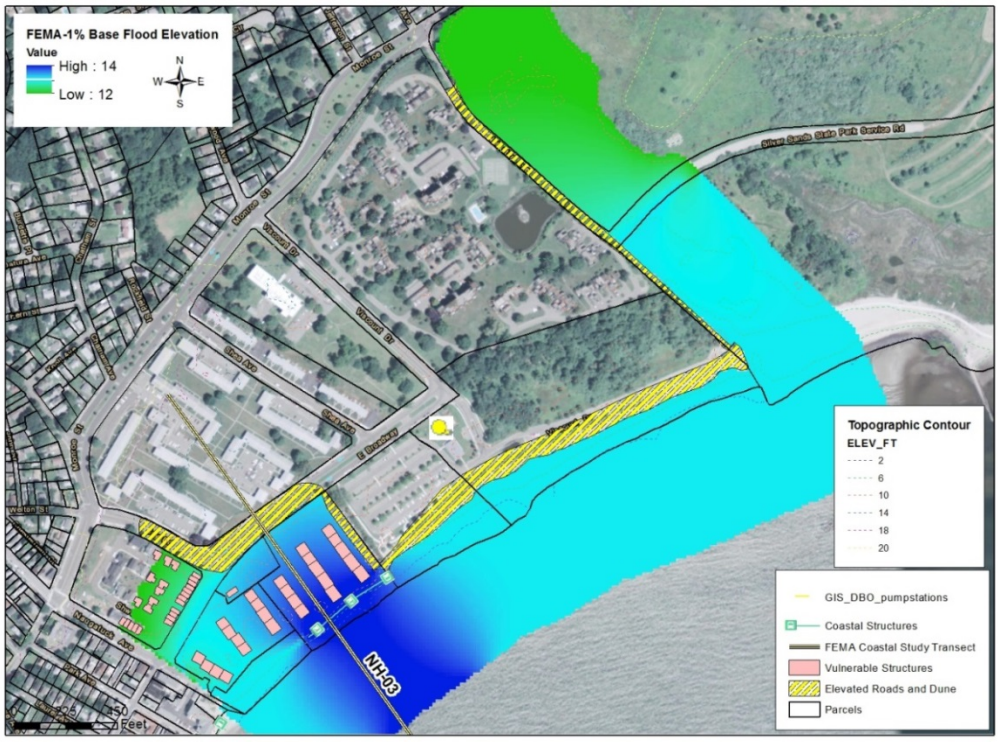
This document presents two examples for building resilience at the neighborhood scale. These are Walnut Beach and Point Beach.

Walnut Beach is at risk for inundation during storm surges as pictured below.



The Walnut Beach neighborhood plans depict choices for a system of elevated roads and dunes to provide flood protection from daily high tides and storm surges. The plans provide the city with an example of how a flood protection system (pictured below) can be designed with different components[7] for different outcomes.

[7] Refer to the appendix for plan views that show the different components of the flood protection system.

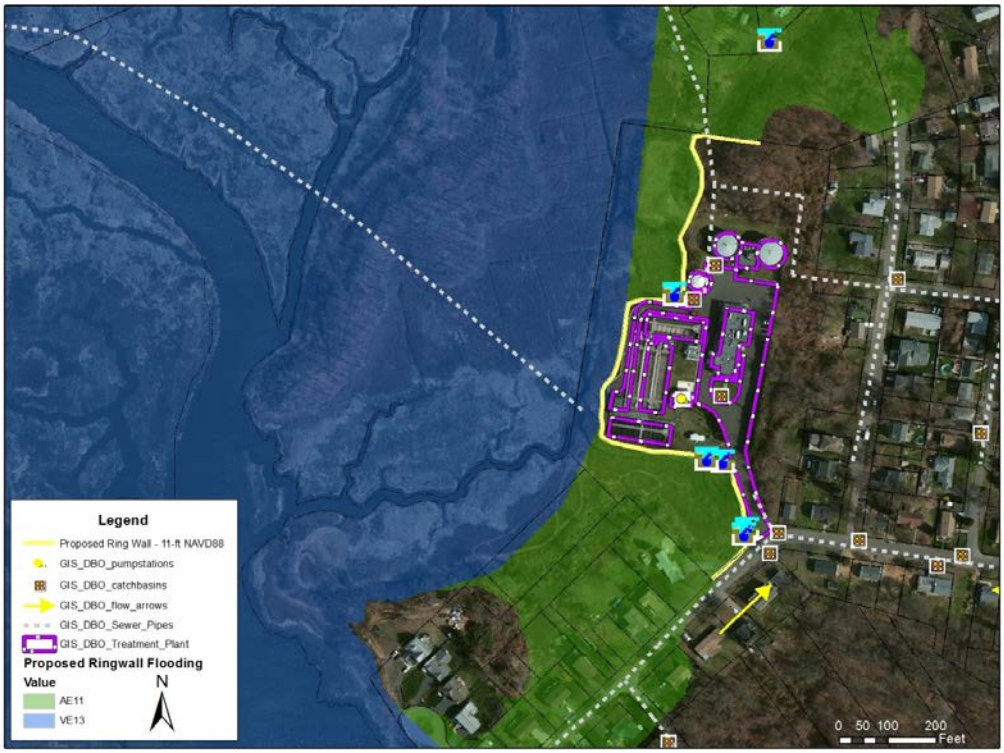


The Point Beach neighborhood plans depict three potential different outcomes for the neighborhood: a floodable neighborhood, protection from the daily high tide with a continuous floodwall of nominal height, and protection from storm surges with a levee or berm system (the latter two are pictured below). The Point Beach plans provide the city with an example of how a more densely developed neighborhood that lacks city-owned waterfront will face flood protection challenges that others (such as Walnut Beach) may not face, creating difficult choices in the future.

The Walnut Beach and Point Beach examples both show resilience methods that may not be desired or cost effective. The examples demonstrate that there may be tradeoffs and choices to make when reducing shared risks to build resilience, but taking a phased approach may help the city address the most urgent and well-understood vulnerabilities and risks in the short term while addressing remaining vulnerabilities and risks later.

Likewise, this plan presents two examples of choices for building resilience through infrastructure projects. The first is a potential beach nourishment project for Wildemere Beach. The image to the right shows current conditions at Wildemere Beach with the VE zone in blue and the AE zone in green. The graphic below shows potential future base flood conditions with a restored beach and created dune at Wildemere Beach.

The second example for building resilience through an infrastructure project is a flood protection system for the Beaverbrook Wastewater Treatment Plant (WWTP). The image below shows the location of the facility in the flood zone and the potential floodwall.



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The conceptual designs prepared for Wildemere Beach and the Beaverbrook Water Pollution Control Facility can be used to make additional planning decisions for these two areas/facilities, and may provide a basis for further design.

A number of steps must be taken to implement this Coastal Resilience Plan. First, the appropriate municipal agency must be identified or created to administer this plan. The Hazard Mitigation Committee is the appropriate entity for prioritizing and tracking the actions presented in this plan. This committee's involvement will ensure that objectives from the Hazard Mitigation Plan and the Coastal Resilience Plan are addressed in a coordinated manner. Specific actions in this coastal resilience plan are presently being implemented by specific agencies such as the Flood and Erosion Control Board and Planning and Zoning Commission and departments such as Public Works, Land Use, and Emergency Management.

A matrix of coastal resilience actions and implementation strategies is provided following this page.

Implementation Strategy
City of Milford Coastal Resilience Plan

	Action	Responsible Agency or Department	Timeframe	Funding Sources
Citywide Regulatory Changes				
CR1	Relax the 35-foot (ft) height restriction to facilitate elevation projects for 2- and 3-story homes	Planning and Zoning	2017-2018	• Not applicable
CR2	Eliminate restrictions that prevent people from reconstructing more resilient homes (for example, the width restriction that comes into play when people reconstruct nonconforming houses)	Planning and Zoning	2017-2018	• Not applicable
CR3	Adopt freeboard that exceeds the state-recommended 1 ft	Planning and Zoning	2017-2018	• Not applicable
CR4	Enforce V zone standards in coastal A zones (to the limit of moderate wave action)	Planning and Zoning	2017-2018	• Not applicable
Citywide Promotion of Property Protection				
PP1	Implement the CRS Maintenance Plan and the CRS "Program for Public Information" (PPI)	Flood and Erosion Control Board	Milestones throughout the year; some actions are annual	• Nominal costs associated with outreach should be covered through operating budgets
PP2	Partner with property owners to apply for FEMA mitigation grants to elevate homes	Economic and Community Development	Annual outreach in April of each year (HMA applications are due in June or July each year)	• FEMA Hazard Mitigation Assistance (HMA)
PP3	Promote Shore Up and similar home-elevation loan programs	Economic and Community Development	A one-time promotion should be scheduled for mid-2016 with at least one follow-up in late 2016	• Shore Up CT
Milford Point Projects				
MP-1	Execute CDBG-DR Project Grant to elevate section of Milford Point Road	Public Works	2016-2017	• CDBG-DR
Wildemere Beach and Walnut Beach Projects				
WW1	Execute dune restoration project at Walnut Beach	Park, Beach, and Recreation Commission	2016-2017	• CIRCA grant
WW2	Execute CDBG-DR Planning Grant for Wildemere and Walnut Beaches	Public Works	2016-2017	• CDBG-DR

	Action	Responsible Agency or Department	Timeframe	Funding Sources
WW3	Restore beach at Wildemere from Laurel Beach to Walnut Beach.	Public Works	2020-2021	• FEMA HMA • USACE • City bond program
WW4	Depending on outcome of CDBG-DR Planning Grant study, Install measures such as jetties and/or offshore breakwaters to retain sand at a restored beach at Wildemere.	Public Works	2020-2021	• FEMA HMA • USACE • City bond program
WW5	Pursue Wildemere Beach LOMR if the project results in reduced base flood elevations or reduced extent of the 1% annual chance flood	Public Works	2022-2023	• Costs associated with consultant services should be covered through operating budgets
WW6	Construct Walnut Beach flood protection system segment 1 – Dune system	Public Works	2020-2021	• FEMA HMA • USACE • City bond program
WW7	Construct Walnut Beach flood protection system segment 2 – Elevated section of Nettleton Road.	Public Works	2021-2022	• FEMA HMA • USACE • City bond program
WW8	Construct Walnut Beach flood protection system segment 3 – Westerly sections (Joy Road and East Broadway road surface elevations)	Public Works	2022-2023	• FEMA HMA • USACE • City bond program
WW9	Pursue Walnut Beach LOMR with reduced base flood elevations or reduced extent of the 1% annual chance flood	Public Works	2024-2025	• Costs associated with consultant services should be covered through operating budgets
Gulf Beach Projects				
GB-1	Execute CDBG-DR Project Grant for Gulf Beach breakwater reconstruction	Public Works	2016-2018	• CDBG-DR
GB-2	Execute CDBG-DR Planning Grant for Gulf Beach and Welch's Point	Public Works	2016-2017	• CDBG-DR
GB-3	Implement recommendations from CDBG-DR Planning Grant for Gulf Beach and Welch's Point	Public Works	2017-2020	• USACE • City bond program
Bayview Beach Projects				
BB1	Support Army Corps dredging of Milford Harbor and placement of sand offshore from Bayview Beach	Office of the Mayor	2016-2018	• USACE

	Action	Responsible Agency or Department	Timeframe	Funding Sources
BB2	Execute CDBG-DR Project Grant to implement Bayview drainage system design: Install new stormwater system components, green infrastructure (rain gardens, etc.), and effective backflow protection on drainage outfalls	Public Works	2017-2019	• CDBG-DR
BB3	Install stormwater pumping station	Public Works	2020-2023	• FEMA HMA • City bond program
BB4	Pursue flood protection system (wall system) that protects from the current and future daily high tide; this will require gaining access to private properties	Public Works	2025-2030	• FEMA HMA • USACE • City bond program
Melba Street and Calf Pen Meadow				
MC1	Stabilize bridge scour at Melba Street over Calf Pen Meadow Creek	Public Works	2018-2019	• Capital improvement
MC2	Execute Carmen Road drainage projects	Public Works	2018-2019	• City bond program
MC3	Execute CDBG-DR Project Grant to elevate section of Beachland Avenue	Public Works	2016-2017	• CDBG-DR (existing grant)
MC4	As a pilot program in the city, in the long term consider retiring a section of Beachland Avenue between Chester and Melba Street and switch access to the homes on the east side of Beachland Avenue to Buckingham Avenue	Public Works, Economic and Community Development	2027-2030	• FEMA HMA (if combined with MC5 below) • NRCS
MC5	Acquire marshside properties on the west side of Beachland Avenue between Chester and Melba Street and convert to tidal wetlands	Public Works, Economic and Community Development	2027-2030	• FEMA HMA • NRCS
MC6	Execute CDBG-DR Planning Grant for Pelham Street	Public Works	2016-2018	• CDBG-DR
MC7	Implement recommendations from CDBG-DR Planning Grant for Pelham Street	Public Works	2019-2021	• USACE • Capital improvement
Point Beach Projects				
PB1	Install effective backflow protection on stormwater drainage systems	Public Works	2017-2019	• FEMA HMA • City bond program
PB2	Install stormwater pumping station	Public Works	2020-2023	• FEMA HMA • City bond program
PB3	Pursue flood protection system (wall system) that protects from the current and future daily high tide; this will require gaining access to private properties	Public Works	2025-2030	• FEMA HMA • USACE • City bond program

	Action	Responsible Agency or Department	Timeframe	Funding Sources
PB4	As a pilot program in the city, promote home elevations to a future base flood elevation	Economic and Community Development	2020-2025	• FEMA HMA • CDBG or CDBG-DR
Morningside and Hillside				
MH1	Replace the failing revetment at the condos on Point Beach Road using a hybrid green/gray technology that will not increase wave energy at adjacent properties	Public Works, Economic and Community Development	2018-2020	• Future CDBG-DR grants • Combine with association funds
MH2	Execute CDBG-DR Project Grant for Morningside Revetment	Public Works	2016-2018	• CDBG-DR
MH3	Monitor condition of granite revetment along Hillside Avenue and repair as needed	Public Works	2018-2028	• Operating budgets
Burwells Cove and Woodmont				
BW1	Execute Rock Street drainage project	Public Works	2017-2018	• City bond program
BW2	Execute CDBG-DR Planning Grant for Crescent Beach	Public Works	2016-2018	• CDBG-DR (existing grant)
BW3	Implement recommendations from CDBG-DR Planning Grant for Crescent Beach	Public Works	2018-2019	• Capital improvement program
Sanitary Sewer Systems				
SS1	Pursue flood protection system for Beaverbrook WWTP	Public Works	2025-2028	• FEMA HMA • Capital improvement program
	Elevate or floodproof pumping stations:			
SS2	Kinlock Street	Public Works	2018-2028	• Capital improvement program
SS3	East Broadway	Public Works	2018-2028	• Capital improvement program
SS4	Rogers Ave	Public Works	2018-2028	• Capital improvement program
SS5	Oldfield Lane	Public Works	2018-2028	• Capital improvement program
SS6	Carmen Road	Public Works	2018-2028	• Capital improvement program
SS7	Anderson Ave	Public Works	2018-2028	• Capital improvement program

	Action	Responsible Agency or Department	Timeframe	Funding Sources
SS8	West Mayflower	Public Works	2018-2028	• Capital improvement program
Miscellaneous Property Acquisitions				
PA1	Acquire properties at the ends of dead-end roads that extend into tidal wetlands, thereby reducing the risks faced by emergency management personnel. Examples include the north ends of finger roads extending from East Broadway in Silver Beach.	Public Works, Economic and Community Development, and Emergency Management	2017-2030	• FEMA HMA • NRCS
PA2	Acquire individual properties citywide as owners approach the city for grant assistance and convert to open space.	Economic and Community Development	Annual outreach in April of each year (HMA applications are due in June or July each year)	• FEMA HMA

Implementation Strategy Table Legend:

CR – Citywide Regulatory
PP – City Promotion of Property Protection
MP – Milford Point
WW – Wildemere and Walnut Beaches
GB – Gulf Beach
BB – Bayview Beach
MC – Melba Street and Calf Pen Meadow
PB – Point Beach
MH – Morningside and Hillside
BW – Burwells and Woodmont
SS – Sanitary Sewer Pumping Stations and Wastewater Treatment Plants
PA – Miscellaneous Property Acquisitions

Based on a review of this plan involving the Milford Hazard Mitigation Committee and Flood and Erosion Control Board, the following areas are suggested for prioritized further study and improvement:

- ❑ Walnut Beach
- ❑ Wildemere Beach
- ❑ Milford Point Road
- ❑ Silver Beach
- ❑ Melba Street and Calf Pen Meadow Creek
- ❑ Point Beach
- ❑ The Beaverbrook Wastewater Treatment Plant

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Appendices

1 Introduction

Recent events such as Tropical Storm Irene and Hurricane Sandy have underscored the risks associated with occupying coastal areas and highlighted the fact that property owners and municipalities bear a heavy financial burden to recover from these types of events.

Resilience is the ability to resist, absorb, recover from, and adapt to disasters. **Coastal Resilience**, referring specifically to coastal hazards such as sea level rise, increased flooding, and more frequent and intense storm surges, can be achieved by decreasing coastal vulnerabilities through increased adaptation and planning. This Plan has been developed as a toolbox to build coastal resilience in the coming years. As time passes and our collective understanding of sea level rise is refined, Milford will have the option to update this plan to reflect the city's evolving approaches to building resilience.

1.1 Project Goal

The overall goal of the "coastal resilience program" undertaken by the City of Milford is to address the current and future social, economic, and ecological resilience of the city's shoreline to the impacts of sea level rise and anticipated increases in the frequency and severity of storm surge, coastal flooding, and erosion. The planning process undertaken by the City of Milford was loosely based on the coastal resilience planning process established in 2011-2012 by The Nature Conservancy (TNC). The four steps of the process are:

1. Generate awareness of coastal risks.
2. Assess coastal vulnerabilities, risks, and opportunities.
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4. Develop and implement an action plan to pursue selected options.

In reality, this four-step process in Milford commenced years ago when other planning efforts involved the public, such as the Hazard Mitigation Plan. The specific planning process for this coastal resilience plan commenced in September 2015 and was completed in March 2016. Public involvement included two informational meetings and an internet-based survey. Vulnerability and risk assessment was conducted from September 2015 through January 2016, and the adaptation/resilience options for Milford were reviewed and selected from January through March 2016.

This program is intended to highlight underserved low-to-moderate income (LMI) populations and communities for additional consideration. In Milford, LMI neighborhoods are located at Wildemere Beach and Walnut Beach.

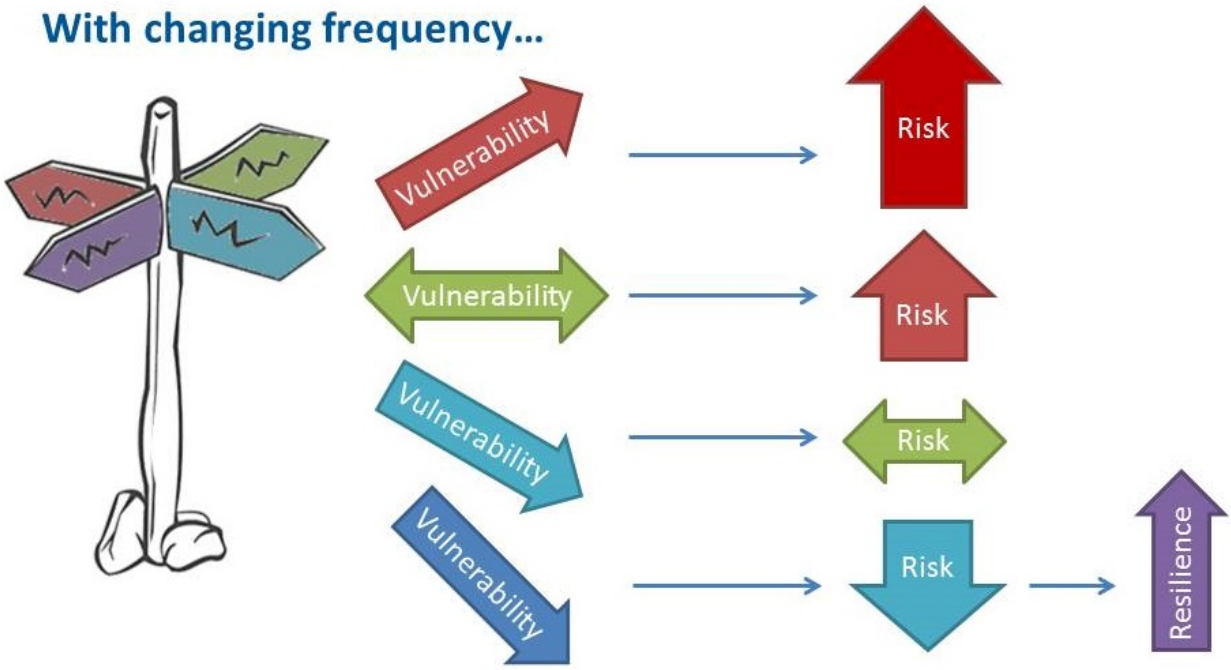
1.2 Project Funding

Preparation of this Community Coastal Resilience Plan was funded through the United States Department of Housing and Urban Development's (HUD) Community Development Block Grant Disaster Recovery Program (CDBG-DR). The money was allocated to HUD through the 2013 Disaster Relief Appropriations Act, which designated aid assistance for communities affected by Hurricane Sandy.

2 Vulnerability and Risk

2.1 Risk and Resilience Concepts

In the context of hazards, **risk** is the product or the sum of **vulnerability** and **frequency**. In the context of coastal hazards, risk depends on (1) the vulnerability of coastal communities and infrastructure, and (2) the frequency of flooding and storm events. Coastal storms are believed to be increasing in frequency, and flooding will increase in frequency as sea level continues to rise (refer to discussion below). Thus, even if coastal vulnerabilities remain static, risks will increase. If vulnerabilities increase as well, due to new development in hazard areas or failure to maintain existing protective structures, risks will increase more dramatically. Alternatively, if vulnerabilities are reduced through adaptation, risk levels can be held steady into the future. If vulnerabilities can be reduced even further, then risks can be lowered in the face of rising sea level and increased coastal storms, leading to **increased resilience**.



2.2 Existing Conditions

2.2.1 Setting

Milford has approximately 53,358 residents living within 22.2 square miles of land. The city has over 17.5 miles of coastline. Density varies throughout the city, but high density residential areas exist at the Wildemere Beach, Bayview Beach, Point Beach, and Woodmont neighborhoods along the coast. The undeveloped areas along the coast are the Charles E. Wheeler Wildlife Refuge at the southwestern

corner and Silver Sands State Park west of Milford Harbor. For the purposes of this report, the coastal neighborhoods of Milford are broken into the following:

- Milford Point / Cedar Beach – private residential neighborhood on a sand spit southeast of the Charles E. Wheeler Wildlife Area ("Wheeler") and east of the mouth of the Housatonic River
- Laurel Beach – medium-density residential area fronted by 50- to 100-foot-wide nourished and groin-maintained beaches
- Wildemere Beach – high-density residential area with homes fronted by private seawalls and narrow, rocky, significantly eroded beaches
- Walnut Beach – many condominium buildings set back from the shorelines, which is fronted by wide beaches; bordered to the northeast by Silver Sands State Park
- Silver Beach – narrow, low-elevation neighborhood of finger roads extending west off of East Broadway into tidal wetlands associated with Great Creek; neighborhood and Great Creek wetlands are located east of Silver Sands State Park
- Fort Trumbull – higher elevation neighborhood protected from inundation, though not waves; riprap protects Trumbull Ave from erosion; there is no beach at this site
- Downtown – the area between State Route 162 to the south and State Route 1 to the north along the Wepawaug River; coastal flood hazards are typically limited to the southern limit of this area, just south of Route 162 around the Milford Library and Wilcox Park; this is the only inland area addressed in this plan
- Gulf Beach and Welches Point – a low-density coastal neighborhood containing the important throughway of Gulf Street, protected by riprap; the only beach here is at the mouth of Milford Harbor, at the western end of the area; most of the area is at a fairly high elevation
- Bayview Beach/Field Court – high-density, low-elevation neighborhood that suffers from drainage issues under present-day conditions
- Calf Pen Meadow Creek – Melba Street at the mouth of the creek is vulnerable to flooding from both the creek and Long Island Sound; Beachland Avenue on the east side of the creek is regularly flooded
- Point Beach – higher density neighborhood that suffers from a failing drainage system
- Morningside – medium-density, higher elevation area with main road along shoreline, protected by riprap and a seawall
- Hillside – higher density, higher elevation area with homes fronted by private seawalls along the water; no beach present at this site
- Burwells Beach – small cove with a beach to the south and a wetland to the north of the main road (Merwin Avenue); somewhat vulnerable to flooding
- Woodmont – borough of Milford with rocky shorelines to the south and a wide nourished beach to the east

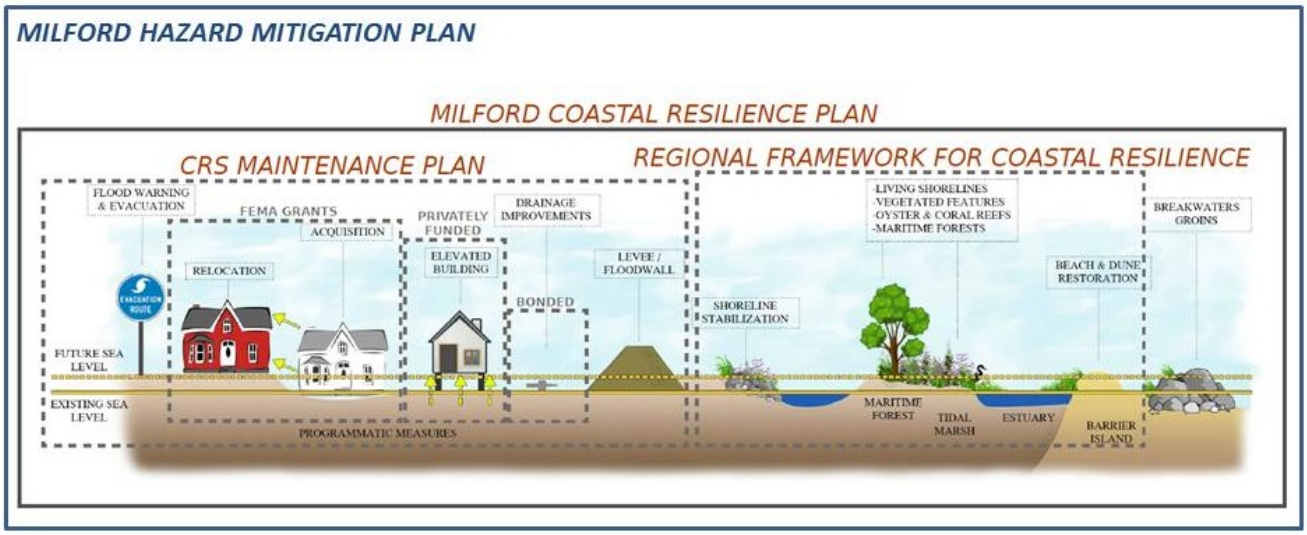
This plan does not specifically address risks along the tidal Housatonic River estuary. Lands along the river tend to be higher in elevation, and critical facilities such as the Housatonic Treatment Plant are not at risk from storm surges.

2.2.2 Existing Capabilities

There are a suite of existing regulations, plans, projects, and programs within the city of Milford that relate to, address, or are otherwise pertinent to the city's pursuit of becoming a more resilient coastal community. This plan acknowledges the contribution that these resources make to Milford's resilience capabilities, and was designed to work *with* these existing documents and actions. These resources (described in Appendix A) include the following:

- Milford Hazard Mitigation Plan
- Milford Plan of Conservation and Development
- Milford Zoning Regulations
- Milford Code of Ordinances
- Milford Harbor Management Plan
- TNC Salt Marsh Advancement Zone Assessments
- FEMA New Haven County Flood Insurance Study and FIRM Panels
- Milford CRS Maintenance and Improvement Plan
- Regional Framework for Coastal Resilience in Southern Connecticut
- Publications and Studies Addressing Regional Coastal Issues
- Individual Drainage, Flood Mitigation, and Roadway Resilience Projects
- Individual HMGP- and CDBG-DR-Funded Projects

The following graphic depicts the unique relationship between the Milford Hazard Mitigation Plan and this Coastal Resilience Plan (which covers a subset of all of the hazards in Milford). Meanwhile, the Milford Community Rating System (CRS) Maintenance and Improvement Plan and the 10-town Regional Framework for Coastal Resilience address landward and waterward resilience issues, respectively, which are subsets of this Coastal Resilience Plan.



Most of the relevent municipal planning documents recognize sea level rise and coastal storms as a key issue in need of consideration. The Hazard Mitigation Plan identifies at-risk locations, tracks mitigation projects, and suggests additional possibilities. The Plan of Conservation and Development encourages

the protection and acquisition of additional open space to protect development and assist in the continued existence of tidal marshland. The Milford Harbor Management Plan also addresses future sea level change and covers the topic of sediment flow and dynamics which is so important to Milford's beaches and residents.

Milford's Zoning Regulations include many requirements to protect property from flooding, but sea level rise and climate change are not explicitly included. Some flexibility is given to the city to implement stricter requirements within the Coastal Boundary.

Many local and regional research efforts can also be considered capabilities because they add the base of knowledge in Milford with regard to future conditions, vulnerabilities, and adaptation options. The TNC Salt Marsh Advancement Zone Assessment will help the city plan for long-term sustainability of this ecosystem. The CT DEEP Shoreline Change study points to specific erosion risk zones and can inform development of sediment management projects. The NACCS results provide suggestions with regards to prioritizing areas for protection and choosing applicable adaptation projects. Other studies, many still ongoing, cover a wide range of topics such as nonstructural adaptation approaches, maintaining healthy aquatic and shoreline habitats, the balance between flood and wind protection, developing high-resolution sea level rise projection, and the feasibility of a variety of specific local adaptation plans.

As part of building resilience, it is essential that the City of Milford implement and monitor the projects and plans listed in this memo, as well as others that are developed over time, and ensure collaboration and communication between these efforts.

2.2.3 Existing Challenges

Milford already has experience with coastal hazards. The neighborhoods of Milford Point/Cedar Beach, Point Beach, Bayview Beach, and Melba Street/Calf Pen Meadow regularly experience flooding at especially high high-tide events, such as those associated with low-pressure systems or full- or new-moon conditions. Residents suffer from blocked access to homes and damage to property and vehicles on a regular basis in those locations. Wildemere Beach has seen its sandy shoreline eroded to gravel and cobbles and has frequently taken damage from storms. Trumbull Avenue and Gulf Beach Road need to be regularly maintained to prevent failure due to erosion by high waves. Malfunctioning tide-controlled drainage systems have led to problems at Bayview Beach and Point Beach. Rising waters and increasing storm severity and frequency will exacerbate these problems and give rise to as yet nonexistent problems in other parts of the city.

2.3 Sea Level Rise

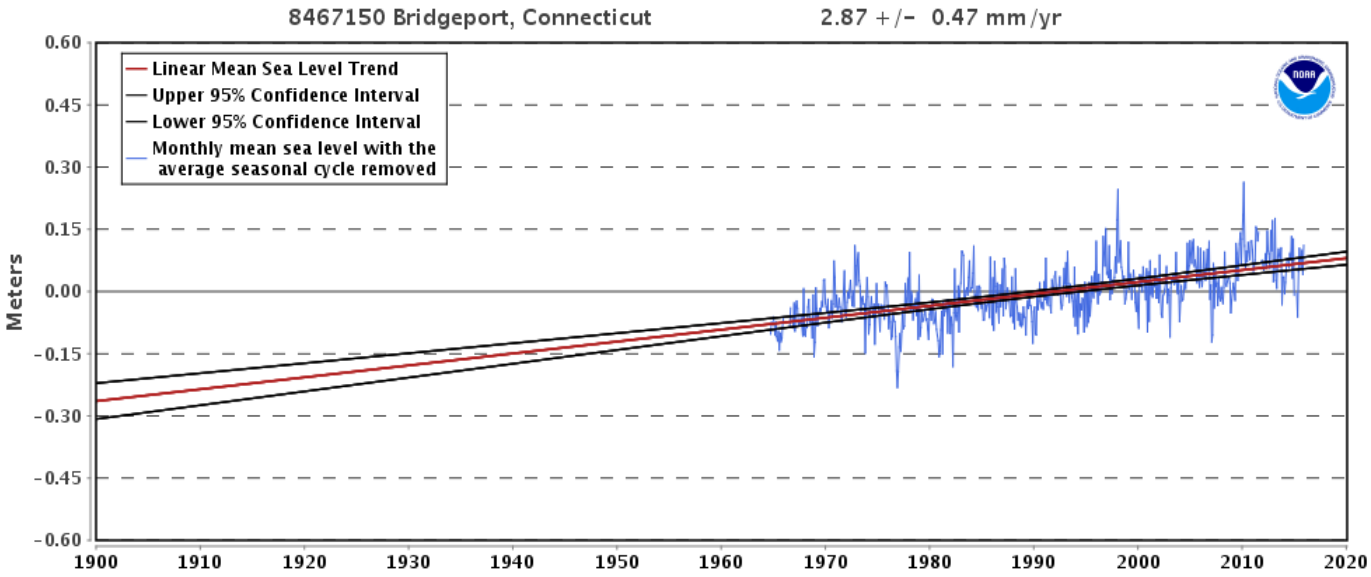
2.3.1 Existing Conditions and Historic Trends

A single tide gauge was operated by the National Oceanic and Atmospheric Administration (NOAA) within Milford from October 1987 to March 1988. The gauge was located at the mouth of the Wepawaug River in Milford Harbor south of High Street. According to data collected by this gauge (available online at tidesandcurrents.noaa.gov), the mean sea level (MSL) in Milford Harbor is negative (-) 0.23 feet, or 0.23 feet below the North American Vertical Datum of 1988 (NAVD88). The average maximum elevation of high tide ("mean higher-high water, or MHHW") is 3.48 feet above the MSL, or

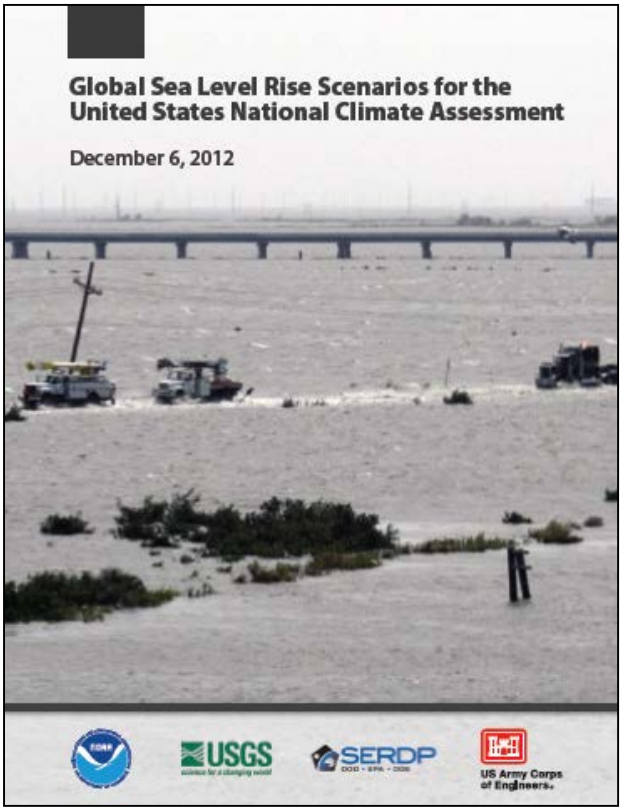
3.25 feet elevation (NAVD88). These figures will vary along Milford's coastline and have likely changed since 1988, as discussed below.

The nearest ***long-term*** operational gauge to Milford is the tide gauge in Bridgeport, CT. Based on tide gauge data collected at that station between 1964 and 2014, MSL has been increasing at a rate of 2.87 millimeters (0.11 inches) per year (mm/yr), which is equivalent to a rise of 0.94 feet over 100 years (see Figure 1 below). Another station in New London, CT, has measured an increase of 2.58 mm/yr, or 0.85 feet-per-100-years, based on measurements since 1938.

Figure 1



2.3.2 Sea Level Projections



Projections of the rate and extent of sea level rise in the future were used to determine Milford's vulnerabilities to future coastal conditions. Uncertainties exist with regard to multiple factors that contribute to sea level change, including the rate of change in the land surface elevation, the extent and rate of glacial melting, and changes in human development and greenhouse-gas emission patterns. For this reason, multiple projections are available. For planning purposes, it is advisable to use medium or high sea level rise projections such that a community will be better protected against worst-case scenarios.

The U.S. Army Corps of Engineers (USACE) hosts a sea level projection web tool ("Sea-Level Change Curve Calculator") at http://www.corpsclimate.us/ccaceslcurves.cfm. The calculator provides sea level rise projections using both U.S. Army Corps of Engineers and NOAA projections at existing tidal gauges. The nearest gauge to Milford is the tide gauge in Bridgeport. Calculated sea level rise for this gauge is depicted in the following table and graph. In each case, the base year is 1992. Rates are as follows:

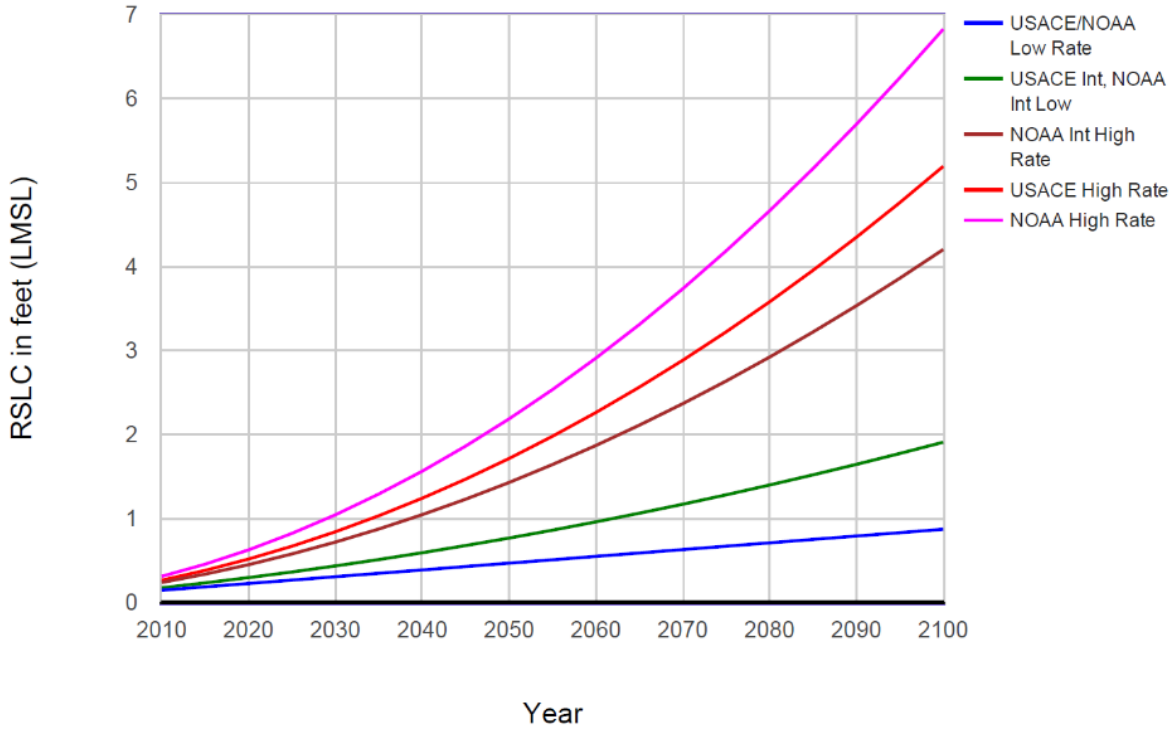
- NOAA Low and USACE Low: historic rate of sea level change is the rate of change moving forward.
- NOAA Intermediate Low and USACE Intermediate: ocean warming and the local rate of vertical land movement determine sea level change rate.
- NOAA Intermediate High: the projected rate assuming both ocean warming and a moderate rate of melting of the arctic ice sheets.
- USACE High: considers both the most recent Intergovernmental Panel On Climate Change (IPCC) projections and modified National Research Council projections with the local rate of vertical land movement added.
- NOAA High: rate based on heating of the oceans and a maximum loss of the ice caps.

Table 1

Gauge 8467150, Bridgeport, CT NOAA's Regional Rate: 0.00807 feet per year Values expressed in feet relative to the 1992 Local Mean Sea Level (LMSL)					
Year	USACE Low NOAA Low	USACE Int NOAA Int-Low	NOAA Int-High	USACE High	NOAA High
2010	0.14	0.17	0.24	0.27	0.31
2020	0.23	0.30	0.45	0.52	0.63
2030	0.31	0.44	0.72	0.84	1.04
2040	0.39	0.59	1.05	1.24	1.56
2050	0.47	0.77	1.43	1.72	2.19
2060	0.55	0.96	1.87	2.26	2.91
2070	0.63	1.17	2.37	2.89	3.74
2080	0.71	1.40	2.92	3.58	4.67
2090	0.79	1.65	3.54	4.35	5.70
2100	0.87	1.91	4.21	5.20	6.83

Figure 2

Relative Sea Level Change Projections
Gauge 8467150, Bridgeport, CT



The ranges calculated in Figure 1 and Table 1 are quite wide, but even the low projections show that sea level rise will continue throughout the current century. The United States Geological Survey (USGS) has demonstrated that sea levels along the mid-Atlantic and northeast coasts of the United States are already rising three to four times faster than the global average since 1990. This heightens the need for resilience planning in Milford. More information on sea level rise projections is presented in Appendix B.

2.4 Specific Vulnerabilities and Risks

2.4.1 Summary

Milford's coastal neighborhoods are diverse, and each will be faced with a combination of vulnerabilities with sea level rise and the increased incidence and severity of coastal storms. Generally, coastal **hazards** can include:

- Stillwater Inundation – flooding from high water without the effects of waves
- Wave Setup and Runup – wave action allows water to reach areas that would otherwise be protected
- Wave Action – can cause damage to buildings directly
- Erosion of coastal banks
- Erosion of beaches

- Drainage-related flooding (outlet submerged and/or insufficient capacity of systems)
- Wind – can cause direct damage by blowing debris into structures

Risks and vulnerabilities in the city of Milford were determined through review of city documents such as the Milford Hazard Mitigation Plan, discussion with city representatives, public meetings, an online survey, and utilization of The Nature Conservancy's Coastal Resilience Mapping Portal. Milford's shoreline specifically is most susceptible to erosion or drowning of beaches, inundation of low-lying areas with poor drainage systems, and flooding of properties surrounding tidal wetlands. These risks are anticipated to increase over time due to sea level rise and climate change, and may be compounded by continuing trends of increased development and population growth. High winds during storm events, which are also predicted to increase with climate change, may put further pressure on vulnerable coastal communities.

Coastal **vulnerabilities** can fall under a variety of categories, as follows:

- Social – Residents, business community, and visitors
- Economic – Residential Properties, commercial/industrial businesses, municipal resources, tourism, and future development
- Infrastructure – Roads, bridges, railroads, stormwater, seawalls, tide gates, the marina, and municipal facilities
- Utilities – Public and private water supplies, septic systems, telecommunications, and electricity
- Emergency Services – Fire, police, medical, sheltering, evacuation/egress
- Natural Systems – Tidal wetlands and other coastal landforms

Vulnerabilities can also be viewed in the context of primary and secondary impacts. Primary impacts describe direct damages to building and infrastructure, while secondary impacts include disruptions to commerce, isolation of areas from emergency services, and the like. The most vulnerable aspects of Milford's coastal area are its residential structures, its infrastructure and utilities, and its natural systems. Homes are vulnerable to inundation from Long Island Sound, erosion, failed drainage infrastructure, and damage from water and high winds. Many coastal roads are vulnerable to being submerged by rising waters or eroded by waves. Much of the city's water and wastewater utility infrastructure lies near the coastline, and will need to be protected from encroaching seawater. Finally, Milford's beaches and wetlands are vulnerable to rising waters and increasing storms. Much of Milford's commercial and industrial activity takes place farther inland and is not expected to be directly impacted by coastal hazards even though indirect, or secondary, impacts are possible. Milford's emergency services are also not directly vulnerable to coastal flooding or storms, and emergency access to most areas that are vulnerable should remain passable in most storm scenarios.

Significant roads at risk of flooding under future sea level rise (daily-high-tide flooding) and storm scenarios include:

- Route 162 / New Haven Avenue
- Route 736 / Buckingham Avenue, Edgefield Avenue, Merwin Avenue
- Naugatuck Avenue
- Milford Point Road
- Seaview Avenue
- Broadway Street

- East Broadway Street
- Viscount Drive
- Surf Avenue
- Rogers Avenue
- Gulf Street
- Old Field Lane
- Field Court
- Bayshore Drive
- Melba Street
- Point Beach Drive
- Beach Avenue
- Seabreeze Avenue
- Anderson Avenue

Vulnerabilities and risks within Milford are described in significant detail in Appendix B.

2.4.2 Vulnerable Neighborhoods

Different neighborhoods and areas of Milford face different hazards presented by current and future daily high tide and storm conditions. The expected extent of flooding from sea level rise and storm surge effects was determined using The Nature Conservancy's Coastal Resilience Mapping Portal, as described in Appendix B section 2.3.2. It is important to note that these projections are predictions of future conditions based on currently available data. The most immediate projections (those of conditions in the 2020s) have the highest level of confidence with uncertainty increasing further into the future.

Wave setup and runup can increase the height of floodwater above the "stillwater" elevation, and the extent of those effects are related to the topography of the coastline at a particular location. The TNC Coastal Resilience Mapping Portal is not able to capture these details, so further analysis was performed with wave modeling software used by the Federal Emergency Management Agency (FEMA) and USACE, as described in Appendix B section 2.3.3. These modeling tools determine the effects of waves through analysis of topographic transects. There are five FEMA transects along the Milford coastline that are at or near locations with significant concerns about coastal hazards. These are located at Wildemere Beach, Walnut Beach, Silver Beach, Melba Street, and just east of Point Beach. It is important to note that the conditions at a given transect may not reflect those at adjacent properties. Further analysis would be required to verify or correct the results for areas currently without transects.

Both The Nature Conservancy's sea level rise and storm surge mapping tool, and the wave setup and runup models from FEMA and USACE, were used to assess risk and vulnerability at different neighborhoods long the Milford coast. This analysis is presented in detail in Appendix B sections 4.2 and 4.3 and is summarized below.

Milford Point / Cedar Beach

This neighborhood is within a FEMA-designated coastal VE zone (velocity zone, or high-hazard zone). As such, all of the homes here are required to be elevated above base flood levels when substantial damage/substantial improvement thresholds are met. For this reason, many of the structures are relatively protected from coastal flood damage. The neighborhood's roads are expected to flood often

under future sea level rise scenarios, however, causing access issues. The structures may also be vulnerable to higher flood elevations with sea level rise.

Laurel Beach

The most vulnerable part of this neighborhood is Milford Point Road, which experiences high-tide flooding even under present day conditions. The homes and roads in the area between Seaview Avenue and Long Island Sound, from 3rd Avenue to 7th Avenue, are vulnerable to high sea level conditions expected in the 2080s. There is also a sewer pumping station off of 1st Avenue that could be at risk of flooding during daily high tide in the 2080s.

Wildemere Beach

Although daily-high-tide flooding is projected to affect a number of homes by the 2080s, this neighborhood's main risk is to surge and wave action impacting waterfront homes. The beach itself has also historically been subject to devastating erosion events and will continue to be vulnerable in the future.

Walnut Beach

A large condominium complex east of Viscount Drive is at risk of inundation from a tidal wetland in Silver Sands State Park, east of the closed Nettleton Road. A present-day Category 2 hurricane would flood much of the complex, with water flowing from the tidal wetland as well as directly from the Sound. The full extent of flooding is projected to worsen in future decades.

WHAT DO OTHER STUDIES SAY ABOUT MILFORD?

Analysis of Shoreline Change in Connecticut: 100 Years of Erosion and Accretion (July 2014)

A cooperative effort between the Connecticut Department of Energy and Environmental Protection, UConn CLEAR, and Connecticut Sea Grant

The analysis shows the following trends along the Milford shoreline:

Accretion

Milford Point, parts of Silver Sands State Park, Silver Beach, Fort Trumbull Beach, Burwells Beach, and Woodmont

Erosion

Wildemere Beach, Walnut Beach, Gulf Beach, Bayview Beach, Point Beach, Morningside, Anchor Beach

Silver Beach

Most of the properties in this neighborhood are repetitive loss properties (RLP). Homes are not consistently elevated, though many are. The neighborhood is served by public utilities. A sewer pumping station at the eastern edge of Silver Sands State Park will be vulnerable to high-tide flooding as soon as the 2020s. By that decade, this entire neighborhood is projected to experience daily flooding on the inland side of East Broadway. The tide gate under East Broadway controls drainage for the entire tidal wetland associated with Great Creek, located northeast of Silver Sands State Park. The entire peninsula will become inundated under present-day Category 2 storm conditions. The Milford Animal Control facility is also located at the eastern edge of Silver Sands State Park and is vulnerable to future high tides. This facility must be evacuated during some storm events.

Fort Trumbull

This neighborhood marks the western edge of Milford Harbor. It lies at a relatively high elevation and is not vulnerable to coastal inundation, even under 1% annual chance storm wave setup and runup

conditions. The neighborhood is fronted to the south by Trumbull Avenue which is currently protected by a riprap revetment but which is vulnerable to wave action and erosive forces.

Downtown

Some key sections of downtown Milford are located within the FEMA-designated of the Wepawaug River and are vulnerable to flooding from that source. However, the only area at risk of flooding from rising sea levels or storm surge is Wilcox Park, behind the city library.

Gulf Beach

The sandy beach to the east of the mouth of Milford Harbor will be inundated regularly under future high-tide scenarios, and may be at risk of erosion. A more detailed study of sediment dynamics would be required to define that risk. Gulf Street is a key throughway that fronts the Sound at this location and is therefore vulnerable to erosion. It is currently protected by riprap and seawalls.

WHAT DO OTHER STUDIES SAY ABOUT MILFORD?

Conceptual Regional Sediment Budget for USACE North Atlantic Division (March 2015)

A conceptual regional sediment budget (CRSB) was developed for the USACE North Atlantic Division as a component of the Comprehensive Hurricane Sandy study.

Net sediment transport in Long Island Sound was found to be toward the west with local reversals. The CRSB along the Milford shoreline was found to be "balanced." The CRSB for Long Island Sound was found to be accreting.

The report recommends "better characterization of regional sediment transport patterns for beaches along Long Island Sound. Although this area is less vulnerable to direct impact from hurricanes and northeasters, there are navigation channels and sediment management activities that could reduce future erosion of this area."

Bayview Beach

The Bayview Beach neighborhood, including Field Court and Bayshore Drive, is lower than the surrounding land and therefore is vulnerable to drainage system failures and surcharging conditions even under current high-tide conditions. As sea level rises, pumping water out of the neighborhood and preventing the backflow of water through stormwater outfall pipes will be even more important. The risk of water overtopping the higher-elevation land along the shore is not a major concern outside of Category 2 storm conditions.

Calf Pen Meadow

Like Silver Beach, the vulnerable homes in this neighborhood are those that border the tidal wetland. Inundation from the wetland is the main risk here. Beachland Avenue is flooded during many high tides along with the homes on the west side of the street.

Point Beach

This neighborhood is characterized by a fairly steep-sided "bowl" shape with the lowest-elevation land surface towards the center surrounded by higher-elevation areas. The effect this has is to confine flooding to an area that remains relatively constant even under increasing sea level scenarios and storm surge conditions. Similarly to Bayview Beach, the main current risks here come from inadequate or failing drainage infrastructure that often surcharges during high tides.

Morningside

Similar to Fort Trumbull, this neighborhood is higher in elevation and fronted by a road (Morningside Drive). The area is not at risk to flooding, but the wall- and riprap-protected road may be vulnerable to

erosion. The erosion of the coastal bank in front of the condominium complex at the end of Point Beach Drive is striking.

Hillside

The Hillside neighborhood is also higher in elevation and protected from flooding, but private residences front the Sound rather than a public road. These homes may be at risk to wave setup and runup as well as to erosion. Wave damage was prominent here during Hurricane Sandy despite the presence of the continuous granite block revetment.

Burwells Beach

This neighborhood is lower in elevation, fronted by a cove, and backed by a tidal wetland. Inundation from both pose a threat under future sea level rise conditions although vulnerabilities are low until the 2080s. The road (Merwin Avenue / State Route 736) may be more vulnerable to future flooding than the homes.

Woodmont

The southern edge of Woodmont consists of waterfront homes built on high bedrock outcrops, which are not vulnerable to inundation or erosion. The eastern edge has a wide beach and is also not projected to be vulnerable to inundation under future sea level rise scenarios.

Inundation Risks by Neighborhood

The following table summarizes the risks of different Milford neighborhoods to inundation over time:

	Daily High Tide					
Neighborhood	**Risk to Homes**			**Risk to Roads**		
DHT Decade→	2020s	2050s	2080s	2020s	2050s	2080s
Milford Point / Cedar Beach	Low	Low	Med	Low	Low	Med
Laurel Beach	None	None	Low	Med	Med	Med
Wildemere Beach	None	None	Low	None	None	Low
Walnut Beach	None	None	None	None	None	None
Silver Beach	Med	High	High	Low	Med	High
Fort Trumbull	None	None	None	None	None	None
Downtown	None	None	None	None	None	None
Gulf Beach	None	None	None	None	Low	Med
Bayview	Med	Med	High	Med	Med	High
Calf Pen Meadow	Med	Med	Med	High	High	High
Point Beach	Med	Med	High	Med	Med	High
Morningside	None	None	None	None	None	None
Hillside	None	None	None	None	None	None
Burwells Beach	Low	Low	Med	Med	Med	Med
Woodmont	None	None	None	None	None	Low

In this table, hazard levels are defined as follows:

- **None –** no coastal structures or roads are affected by flooding
- **Low –** fewer than approximately 25% of the roads or structures in the coastal area are affected by flooding

- **Med –** between approximately 25% and 50% of the roads or structures in the coastal area are affected by flooding
- **High –** between approximately 50% and 75% of the roads or structures in the coastal area are affected by flooding
- **Critical –** greater than approximately 75% of the roads or structures in the coastal area are affected by flooding

More information about neighborhood vulnerabilities, including wave runup modeling results, is discussed in Appendix B.

3 Coastal Adaptation Strategies

3.1 Approaches to Adaptation

The Intergovernmental Panel On Climate Change published the landmark paper "Strategies for Adaptation to Sea Level Rise" in 1990. Three basic types of adaptation were presented in the report:

- **Retreat** involves no effort to protect the land from the sea. The coastal zone is abandoned.
- **Accommodation** means that people continue to use the land at risk but do not attempt to prevent the land from being flooded.
- **Protection** involves protecting the land from the sea so that existing land uses can continue.

In 2010, NOAA's Office of Ocean and Coastal Resource Management published the manual "Adapting to Climate Change: A Planning Guide for State Coastal Managers." According to the manual, NOAA's seven categories of "Climate Change Adaptation Measures" are:

- Impact Identification and Assessment
- Awareness and Assistance
- Growth and Development Management
- Loss Reduction
- Shoreline Management
- Coastal Ecosystem Management
- Water Resource Management and Protection

Elements of *protection, retreat*, and *accommodation* are found in several of these categories and subcategories of adaptation. NOAA notes that these adaptation measures are organized into categories that describe their primary purpose but, in many cases, they serve multiple purposes and could fit into multiple categories.

A thorough evaluation of adaptation approaches and options is described in Appendix C. This chapter provides an overview.

WHAT IS A LIVING SHORELINE?

Many definitions of "living shoreline" are available in the literature. Restore America's Estuaries (2015) provides a broad definition that "living shoreline are any shoreline management systems that is designed to protect or restore natural shoreline ecosystems through the use of natural elements and, if appropriate, man-made elements. Any elements used must not interrupt the natural water/land continuum to the detriment of natural shoreline ecosystems."

SAGE (2015) notes that living shorelines achieve multiple goals such as:

- Stabilizing the shoreline and reducing current rates of shoreline erosion and storm damage
- Providing ecosystem services and increasing flood storage capacity
- Maintaining connections between land and water ecosystems to enhance resilience.

3.2 Adaptation Options

Coastal adaptation strategies include both planning (nonstructural) and structural-related modifications. Nonstructural measures include preparedness, emergency response, retreat, and regulatory and financial measures to reduce risk. Structural measures include dikes, seawalls, groins, jetties, temporary flood barriers, and the like. Ideally, the measures that are taken should be

robust enough to provide adequate protection and flexible enough to allow them to be adapted to changing future conditions. Such robustness and flexibility typically require combinations of methods rather than one solution.

Structural measures can be site-specific, "neighborhood-scale," or large-scale structures that protect multiple square miles of infrastructure. Site-specific measures pertain to floodproofing a specific structure on a case-by-case basis. Neighborhood-scale measures apply to a specific group of buildings that are adjacent to each other. Large-scale structures might include large dike and levee systems or tide gates that can prevent tidal surge from moving upstream.

Table 3 provides a summary of adaptation and resilience methods considered for Milford.

Measure	Summary	Benefits	Barriers to Implementation
Structural Measures			
Hard Shore-Protection	Structure parallel to shore (seawall, levee, bulkhead, revetment)	• Long lasting • Effective	• False sense of security • Expensive maintenance • Ecosystem damage
Sediment Management Structures	Structures reduce wave energy & manage sediment	• Long lasting • Support natural processes	• Does not address stillwater inundation • Secondary Impacts
Soft Shore-Protection	Replenish sediment and dunes	• Support natural processes • Support ecosystems • Aesthetic	• Regular maintenance • May not be long lasting
Green Infrastructure	Natural elements reduce wave energy and trap sediment	• Support natural processes • Support ecosystems • Aesthetic • May use structural support	• Limited areas of applicability
Living Shorelines	Creation/restoration of tidal marsh	• Reduce wave energy • Critical habitat	• Limited areas of applicability • Does not address stillwater inundation
Stormwater Management	Remove water from low areas while preventing backflow	• Support other protection methods	• May be expensive • Requires maintenance • Does not address direct hazards
Transportation Infrastructure	Elevate roads or create alternative egresses	• Protect emergency access and evacuation	• Elevation may increase hazards for neighboring properties
Elevation	Raise structure above flood level	• Reduce insurance premium • Open to residences • Permitted in V zones	• Harder to access • "Dead space" under structure • Difficult for some buildings
Wet Floodproofing	Abandon Lowest Floor, Remove all contents	• Relatively inexpensive	• Extensive post-flood cleanup
Dry Floodproofing	Waterproof structure, install barriers at openings	• Relatively inexpensive • Does not require additional land	• Manual barrier installation • Subject to storm predictions • Vulnerable to flow & waves
Floodwalls & Levees	Concrete or earthen barriers protection	• Prevent water contact • Avoid structural retrofits	• May require large area • Obstructs views
Temporary Flood Barriers	Plastic or metal barrier	• Prevent water contact • Relatively inexpensive	• Manual installation • Subject to storm predictions • Short term only

Measure	Summary	Benefits	Barriers to Implementation
Relocation	Move structure to safer location	• All vulnerability removed • Open to residences	• Decreased value of new site • Loss of neighborhood cohesion • Expensive
Regulatory Tools			
Building Code	Increase standards for structures	• Protect new & improved construction	• Older structures often exempt
Zoning Regulations	Prevent hazardous development patterns	• Control degree of risk in hazardous areas	• Balance with economic pressures
Easements	Control activities on private land	• Work with landowners for mutual benefit	• Private landowner may not be willing partners

3.3 Options Relevant to Milford

The comprehensive list of options presented above and evaluated in Appendix C includes adaptation measures that may be:

- ❑ Technically, financially, or otherwise not feasible for Milford to implement
- ❑ Not relevant to Milford's particular geography, geology, and hazard profile
- ❑ Socially unacceptable to Milford's citizens

To develop a suite of viable options for the city's consideration, coastal resilience projects undertaken by other communities were reviewed, local physical and political factors were considered, and options were discussed with Milford's municipal officials and residents. Details of this process are discussed in Appendices C and G. The suite of options most applicable to the City of Milford is summarized in the following table:

Categories of Options	Specific Options
Hard Shoreline Protection	Seawalls
	Bulkheads
	Revetments
	Dikes
	Groins
	Offshore breakwaters
Soft Shoreline Protection	Beach Restoration or Nourishment
	Dune Creation or Restoration
Hybrid Shoreline Protection	Bioengineered bank stabilization
	Artificial Reefs (reef balls)
Infrastructure Improvements, Retrofits, and Hardening	Storm Drain Maintenance and Improvement including pumping stations
	Road Elevation
	Wastewater Treatment Plant Floodproofing
	Sewer Pumping Station Elevation and Floodproofing
Home Protection	Elevation
Regulatory Tools	Flood Damage Prevention Modifications: • Freeboard • V zone standards in Coastal A zones

Categories of Options	Specific Options
	Other Zoning Modifications: • Height Limit Flexibility • Reconstruction Flexibility
Coastal Realignment/Retreat	Road Retirement (with or without alternate route development)
	Property Acquisitions

Beach replenishment and nourishment through sediment placement and control efforts will be a large part of Milford's resilience efforts. Similarly, dune restoration and creation on beaches that are currently, or will in the future be, appropriate for such projects will also be a part of Milford's resilience efforts. Although tidal marsh living shorelines are not appropriate for most of the Milford coast, the city is encouraged to explore the use of soft, hybrid, and green/gray alternatives to hard shoreline protection where space is limited. Such techniques include bioengineered banks.

Assisting homeowners to elevate their residences, or purchasing properties from those who no longer wish to invest in protecting their residences, should also be a continuing focus of the city. Milford should enact regulatory changes to support resiliency efforts, including making height restrictions flexible to facilitate rather than impede home elevations and altering zoning regulations to encourage development away from hazard areas.

3.3.1 Application of Adaptation Options in Milford

The following section summarizes some of the specific challenges in Milford where different adaptation options may be relevant. Many of the sites are listed under multiple options, indicating that there are multiple approaches to resiliency at that location, or that the best option would be to implement multiple adaptation measures in unison.

Hard Shoreline Protection

Milford's shoreline is densely developed, and options in many areas will be limited to ensure basic protection of important areas. Some of this protection may be accomplished through shoreline

WHAT DO OTHER STUDIES SAY ABOUT MILFORD?

North Atlantic Coast Comprehensive Study (January 2015)

The North Atlantic Coast Comprehensive Study (NACCS) was authorized by the Disaster Relief Act of 2013 on January 29, 2013. The study area included the Atlantic Ocean coastline, back-bay shorelines, and estuaries within portions of the USACE North Atlantic Division.

As part of the NACCS analysis for the State of Connecticut, the Fairfield–Milford area was selected as an example to further evaluate flood risk as part of the comprehensive coastal storm risk management framework. Defined as "Area CT1_L," the area includes the shoreline of Fairfield, Bridgeport, Stratford, and Milford. The example area represents an area within the State of Connecticut at risk to coastal flooding. In Milford, no structural risk reduction options are suggested for the area of the Wheeler Wildlife Area, including Milford Point Road, although floodproofing existing structures and acquisition and relocation are suggested. Beach and dune nourishment, floodproofing, and acquisition and relocation are all applicable to the Laurel, Wildemere, and Walnut Beach areas, as well as to the Silver Beach neighborhood. Floodproofing and acquisition, but no coastal protection projects, are suggested for the neighborhoods of Bayview Beach and surrounding areas. Beach nourishment, dune nourishment, floodproofing, and acquisition are all determined to apply to the area of Point Beach.

management and protective structures.

Sections of the city with assets such as structures, roads, and other infrastructure located very close to the water may require hard shoreline protection. Such areas may include those that are not geographically conducive to softer shoreline protection, those without the space to implement other protection methods, those with high banks susceptible to erosion, or those with naturally hard or rocky shorelines where structures may be vulnerable to wave action.

These areas may include Trumbull Avenue, the Point Beach neighborhood, Morningside Drive, Hillside Avenue, and some of the southern shore of Woodmont.

- Seawalls
- Bulkheads
- Revetments
- Dikes

Additional hard protections that are not necessarily parallel to the shoreline or that are parallel but offshore include the following:

- Jetties
- Breakwaters
- Groins

These reduce the energy of waves and currents, often for the purpose of managing sediment. Potential suitable sites for these types of shoreline protection include Wildemere Beach, Silver Beach, Bayview Beach, and Burwells Beach.

One specific possibility is the installation of groins or other sediment management structures at Wildemere Beach in order to restore a sandy beach in that area. A more extensive beach would mitigate wave action, potentially removing the FEMA "velocity zone" designation for some areas and lowering base flood elevations. This may qualify Wildemere Beach for a Flood Insurance Rate Map Letter of Map Revision (LOMR).

WHAT DO OTHER STUDIES SAY ABOUT MILFORD?

Connecticut Coastal Design Project (2014-2015)

The Connecticut Coastal Design Project was an effort coordinated by The Nature Conservancy's Coastal Resilience Program to create a dialogue between coastal engineers, regulatory agents, coastal geomorphologists, landscape design professionals, and natural resource managers around the implementation of environment and ecosystem supportive shoreline protection projects.

The western part of Milford falls within the "Shoreline District B." This zone was identified as having the second-highest potential in Connecticut for installation of natural infrastructure projects. Milford Harbor eastward is within "Shoreline District C," noted as having low suitability for natural infrastructure projects.

Milford was mentioned specifically only a handful of times. The dune at Walnut Beach in Milford was identified as a feature that had historically been successful at mitigating coastal hazards, and which was a strong candidate for restoration after it was damaged by Hurricane Sandy. A salt marsh area at the Milford Head of Harbor, behind the Coast Guard auxiliary building, was noted as a good example of a natural shoreline. Finally, the report noted that there is some history of soft or hybrid structures that have been successful in Connecticut including in Woodmont (a blue mussel project).

Soft Shoreline Protection

Some sections of Milford are able to be served using soft shoreline protection, which is often more aesthetically acceptable and more supportive of natural systems and processes. Areas where soft protection measures can be implemented include Laurel, Wildemere, and Walnut Beaches, Bayview Beach, the northern section of Point Beach, and Burwells Beach. Options for these areas include:

- Beach Nourishment
- Dune Creation or Restoration
- Sediment Management

WHAT IS A LIVING SHORELINE?

A definition of "living shoreline" was provided on page 15. In general, the living shorelines of interest to communities in Connecticut include tidal marsh restoration or protection projects, bioengineered bank protection, beach nourishment, and vegetated dune restoration or creation. The latter three are believed appropriate as risk reduction methods in Milford.

Walnut Beach is a good candidate for a soft shoreline protection project. Specifically, a dune could be installed landward or waterward of the public parking area to act as a natural flood barrier. Such a project would need to be connected to an elevated Nettleton Road to the east in order to be effective for flood protection.

Beach nourishment could potentially be performed at Bayview Beach with sand to be dredged from Milford Harbor by the Army Corps of Engineers. This could be performed in concert with installation of flood protection structures and improvement of storm drainage systems to provide comprehensive protection to the Bayview Beach neighborhood.

Possibilities for both of these areas are discussed in more detail in section 4.

Due to the character of Milford's shoreline – developed and fronted by beaches and hard structures – there are not many areas that would support tidal wetland living shorelines, so they will likely not be a significant part of the city's resilience planning.

Bioengineered Banks

Living shorelines such as bioengineered banks protect from erosion while enhancing habitat and water quality and preserving the natural processes and connections between riparian, intertidal, and subaqueous areas. Many of the areas listed as potential sites for hard and soft shoreline protection measures could also be suitable for these Green Infrastructure methods

One specific project suggestion is replacement of the failing revetment at the condos on Point Beach Drive. Using a hybrid green/gray technology here could protect this site without increasing wave energy at adjacent properties, thereby avoiding an increase in their level of risk. Utilizing green infrastructure would also support local ecosystems and improve the aesthetic and recreational value of this beach.

Infrastructure Retrofits and Upgrades

- **Drainage**

Some areas of Milford have adequate protection from inundation and wave action, but still experience damage due to failing, inadequate, malfunctioning, or surcharging drainage infrastructure. Areas that

would benefit from upgrades to these systems include the Bayview Beach / Field Court neighborhood, Calf Pen Meadow, and the Point Beach neighborhood.

Bayview Beach (Field Court, Bayshore Drive) specifically has an urgent need for upgrades to its drainage system. Installation of effective backflow protections on its stormwater drainage pipes are necessary, and installation of a stormwater pumping station should be considered. Such efforts might be completed in concert with a more extensive flood protection system.

- **Roadways and Transportation**

The layout of Milford is such that even if some major roads are impassable, other routes should remain open for most residents. Nevertheless, there are some neighborhoods that might be isolated under high sea level conditions. Alternate routes will need to be identified for those that are accessible but have had major throughways cut off, and under current conditions there are already roads that experience chronic flooding.

Some of the most significant roads at risk in Milford are listed in section 2.4.1.

Areas of the city vulnerable to isolation include Milford Point, Silver Beach, Knobb Hill, and the Morningside neighborhood. Transportation adaptation options for these neighborhoods may include:

- Roadway elevation
- Roadway strengthening and reinforcement
- Roadway abandonment
- Mapping of alternative routes
- Construction of alternative routes

Elevations of Milford Point Road (serving the neighborhood of Cedar Beach) and Beachland Avenue is currently underway. This is an effective adaptation method for the short term. In the long term, retirement of Beachland Avenue (north of Melba Street on the east side of Calf Pen Meadow Creek) may be a reasonable solution to chronic flooding of a relatively low-use street. Converting the road to tidal wetland may also act to diminish hazards related to this creek elsewhere while providing important habitat. Retiring this road would also require acquisition of properties.

- **Wastewater**

The wastewater treatment plant at Beaverbrook is within a mapped floodplain and will be affected by sea level rise and coastal storms. Continued maintenance and improvement of any existing flood mitigation methods will be necessary moving into the future. Options for strengthening the plant against future conditions are discussed in section 4.

Many of Milford's sewer pumping stations lie within hazard zones and may be vulnerable to sea level rise. One example is the pumping station at Sailor Lane, which is not housed in a pump house. There are six stations located in areas expected to be inundated on a daily basis by the 2080s. These are on the following roads:

- Kinlock Street
- East Broadway
- Rogers Ave

- Oldfield Lane
- Carmen Road
- Anderson Ave

Private Property Protection

All properties within flood zones are required to implemented flood protection measures when substantial damage/substantial improvement thresholds are triggered, but additional actions should be taken to prepare for rising seas. Furthermore, there are some areas of Milford where neighborhood-scale protective measures, such as construction of floodwalls or nourishment of beaches, are not feasible or would not provide adequate protection to individual structures. In such areas, individual property owners should implement additional flood protection measures. These areas include elongated sections of Cedar Beach, Silver Beach, and Melba Street.

There are some areas of Milford where, due to chronic and increasing flood inundation combined with access challenges, acquisition of properties from willing landowners should be pursued. These areas include the northern ends of the finger roads at Silver Beach which could be converted to tidal wetlands and incorporated into the Great Creek wetland system. Properties on Beachland Avenue, off of Melba Street, should also be considered for acquisition. Acquiring and removing those properties would allow for the retirement of Beachland Avenue, and conversion of residential lands back to tidal wetlands.

Natural Resource Protection

Areas that can be targeted for protective measures include the neighborhoods around the Charles E. Wheeler Wildlife Management Area, Silver Beach, Wilcox Park, and Calf Pen Meadow Creek (especially Beachland Avenue).

Other Options

Other adaptation options – such as regulatory tools and incentives – apply throughout Milford. Relevant regulatory tools will vary based on the needs of specific locations. Some examples of specific planning, zoning, and regulatory options include:

- Adoption of freeboard requirements that exceed the state-required 1 foot
- Enforcement of V-zone requirements in coastal A-zones (up to the limit of moderate wave action)
- Relaxation of the 35-foot height restriction to facilitate elevation projects for 2- and 3-story homes
- Elimination of restrictions that prevent people from reconstructing more resilient homes (for example, the width restriction that comes into play when people tear down and reconstruct nonconforming houses)
- Implementation of the Community Rating System Maintenance Plan and the Program for Public Information
- Partnering with property owners to apply for FEMA mitigation grants
- Promotion of Shore Up and similar loan programs to assist homeowners with property protection

3.3.2 Milford Options Summary

The following table summarizes where different adaptation options are most applicable throughout the Milford shoreline.

	Possible Options →	Shoreline Protection					Structures & Infrastructure			"Realignment"		
		Hard Protection	Beach Nourishment	Dune Creation/Restoration	Hybrid Protection	Bioengineered Banks	Drainage Improvement	Road Elevation	Structure Elevation	Road Retirement	Alternate Route Development	Property Acquisition
Appropriate Neighborhoods	Milford Point / Cedar Beach		X	X				X	X			X
	Laurel Beach		X						X			
	Wildemere Beach	X	X	X	X	X			X			
	Walnut Beach		X	X				X			X	
	Silver Beach		X	X	X			X	X	X		X
	Fort Trumbull	X			X	X						
	Gulf Beach	X	X	X	X	X		X				
	Bayview Beach	X	X	X	X		X	X	X			
	Calf Pen Meadow		X				X	X	X	X		X
	Point Beach	X				X	X		X			X
	Morningside	X				X						
	Hillside Avenue	X					X	X	X			
	Burwells Beach		X					X	X			
	Woodmont	X	X		X	X			X			

4 Conceptual Plans

In addition to an assessment of current and future hazard and risk conditions, and development of a general list of adaptation approaches and options, part of the scope of this planning project was to develop a set of more specific concept designs for protection of two neighborhoods and two infrastructure assets in Milford.

The two specific neighborhoods and two specific infrastructure assets targeted for more focused planning efforts were chosen based on the participation of members of the public, impacts from Hurricane Sandy, the location of LMI populations, locations of critical community facilities, and the results of the vulnerability and risk assessment. This decision process is described in Appendix D. The following table cross-references the issues of interest listed in the paragraph above:

Neighborhood	RL Properties	LMI Census Tract	Irene & Sandy Damage	DHT Risk 2020s-2050s	Critical Facilities	At-Risk Roads	Public Input	
Milford Point	Yes		Yes	Yes	*	Yes		
Laurel Beach	Yes	**			*	Yes		
Wildemere Beach	Yes	Yes	Yes		*	Yes	Yes	
Walnut Beach		Yes	Yes			Yes	Yes	
Silver Beach	Yes		Yes	Yes		Yes		
Gulf Beach						Yes		
Bayview Beach	Yes			Yes		Yes	Yes	
Melba Street	Yes		Yes	Yes		Yes		
Point Beach	Yes	**	Yes	Yes		Yes	Yes	
Morningside								
Hillside	Yes		Yes					
Burwells Beach	Yes					Yes		
Woodmont						Yes	Yes	

**Served by Beaverbrook WWTP*

[1]*** These areas are not Low or Moderate Income, but do fall within tracts that have lower median income levels than much of the rest of Milford.*

Point Beach and Wildemere Beach are the neighborhoods that meet the most applicable criteria (five). The neighborhoods with the second-highest number of criteria checked are Milford Point, Walnut Beach, Silver Beach, Bayview Beach, and Melba Street (all at four columns).

Wildemere Beach and Point Beach have the most applicable criteria and are either technically LMI neighborhoods (Wildemere Beach) or characterized by relatively low income levels (Point Beach). They were both selected for more focused planning efforts. The layout of Wildemere Beach and the nature of

[1] At the time of the CDBG-DR grant application in 2014, the Low and Moderate Income (LMI) Census block groups were mapped based on estimates from the 2007-2011 American Community Survey (ACS) where the median income was 80% or lower of the Area Median Income (AMI). ACS estimates are based on a 5-year rolling average of a small sample size. LMI limits are revised annually. The starred neighborhoods fall into the "LMI" Census blocks as calculated in 2014 using the ACS method.

the problem (limited beach at high tide, contributing to elevated base flood elevations) are such that it was determined that an infrastructure design would be more appropriate than a neighborhood-scale approach. Additionally, because the Beaverbrook Wastewater Treatment Plant (WWTP) is at risk and serves LMI areas, it was selected as an infrastructure design.

Bayview Beach was briefly considered as an additional neighborhood for focused planning, but the consultant assigned to the Bayview Beach CDBG-DR grant had already prepared preliminary plans for drainage improvements and green infrastructure as of February 2016. For that reason, it was deemed redundant.

A primary area of interest previously advanced to the 10-town "*Regional Framework for Coastal Resilience*" is the Walnut Beach area. Several different kinds of projects can be completed there, including a new dune for flood protection, green infrastructure drainage systems such as rain gardens and swales, and elevating a section of Nettleton Avenue to provide flood protection and improved egress from East Broadway's dead end. Because Milford's coastal resilience plan should dovetail with the *Regional Framework,* and because Walnut Beach is an LMI neighborhood with a high number of applicable criteria met (as seen in the table above), Walnut Beach was selected as the second neighborhood for focused planning.

In summary, the four selections for focused planning were:

<u>Neighborhoods</u>
- ❑ Point Beach
- ❑ Walnut Beach

<u>Infrastructure</u>
- ❑ Beaverbrook WWTP
- ❑ Wildemere Beach (with a restored/created beach and dune as the "infrastructure")

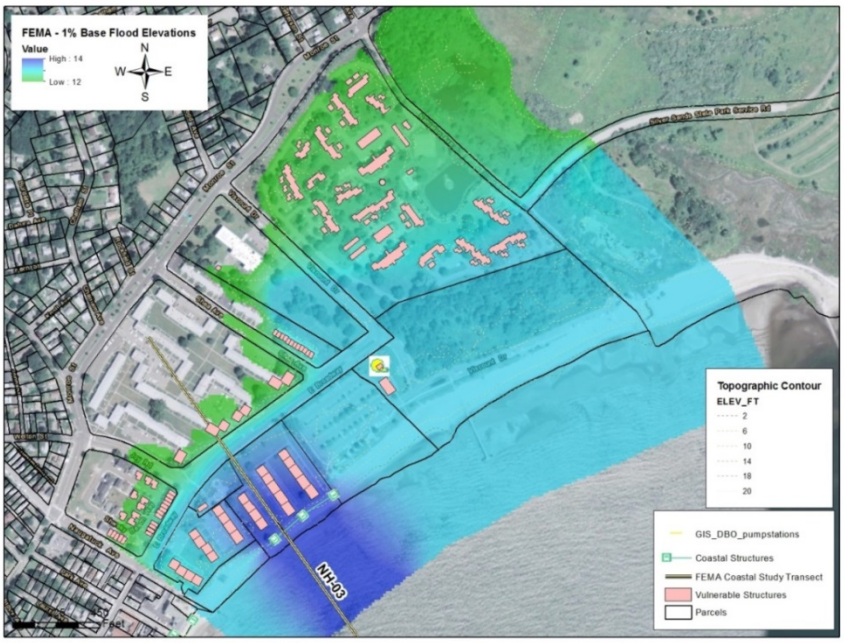
The results of these plans are summarized below. More detailed plans, including estimates of project costs and benefits, are included in Appendices E-1, E-2, F-1, and F-2.

4.1 Neighborhood Conceptual Plans

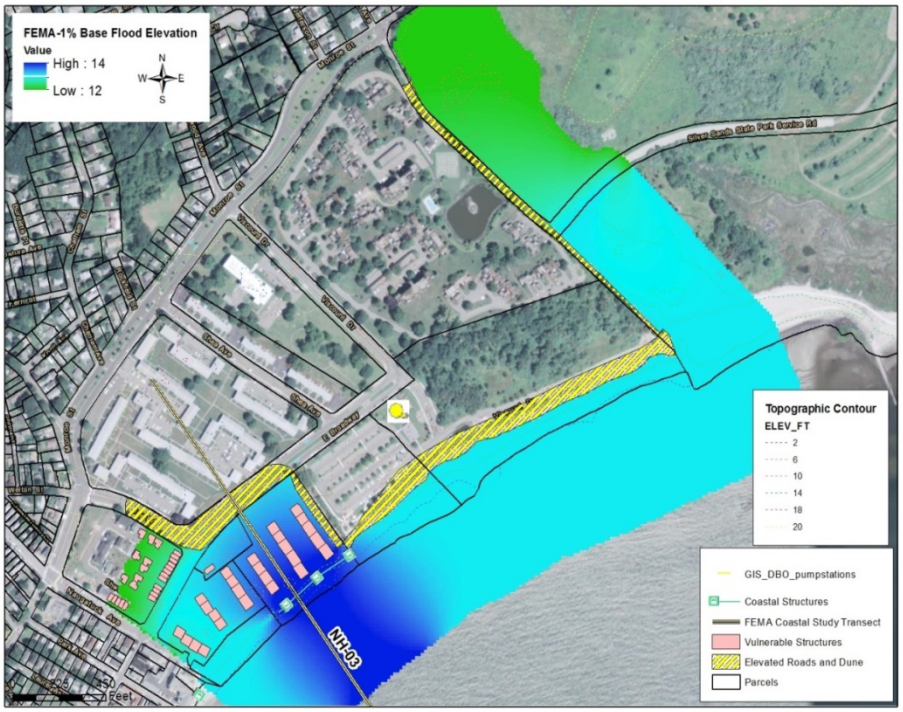
This plan presents **two examples** for resilience at the neighborhood scale: Point Beach and Walnut Beach. Both examples demonstrate that there may be tradeoffs and choices to make when reducing shared risks to build resilience, but taking a phased approach may help the city address the most urgent and well-understood vulnerabilities and risks in the short term while addressing remaining vulnerabilities and risks later.

Walnut Beach

Based on the most recent FEMA Flood Insurance Study, the area of Walnut Beach is vulnerable to inundation by a 1% chance storm event under present-day conditions, with Base Flood Elevations ranging from 13 ft to 12 ft NAVD88. This event would cause approximately 127 homes/structures to be impacted by flooding as depicted in the blue and green areas to the right.



The neighborhood plans prepared for Walnut Beach depict three choices for a system of elevated roads and dunes to provide protection from a base-flood scale event (1% annual chance storm). The plans provide the city with a complete example of how a flood protection system (pictured below) can be designed with different components for different outcomes.



The three coastal protection alternatives, as well as a "floodable neighborhood" option, are summarized below:

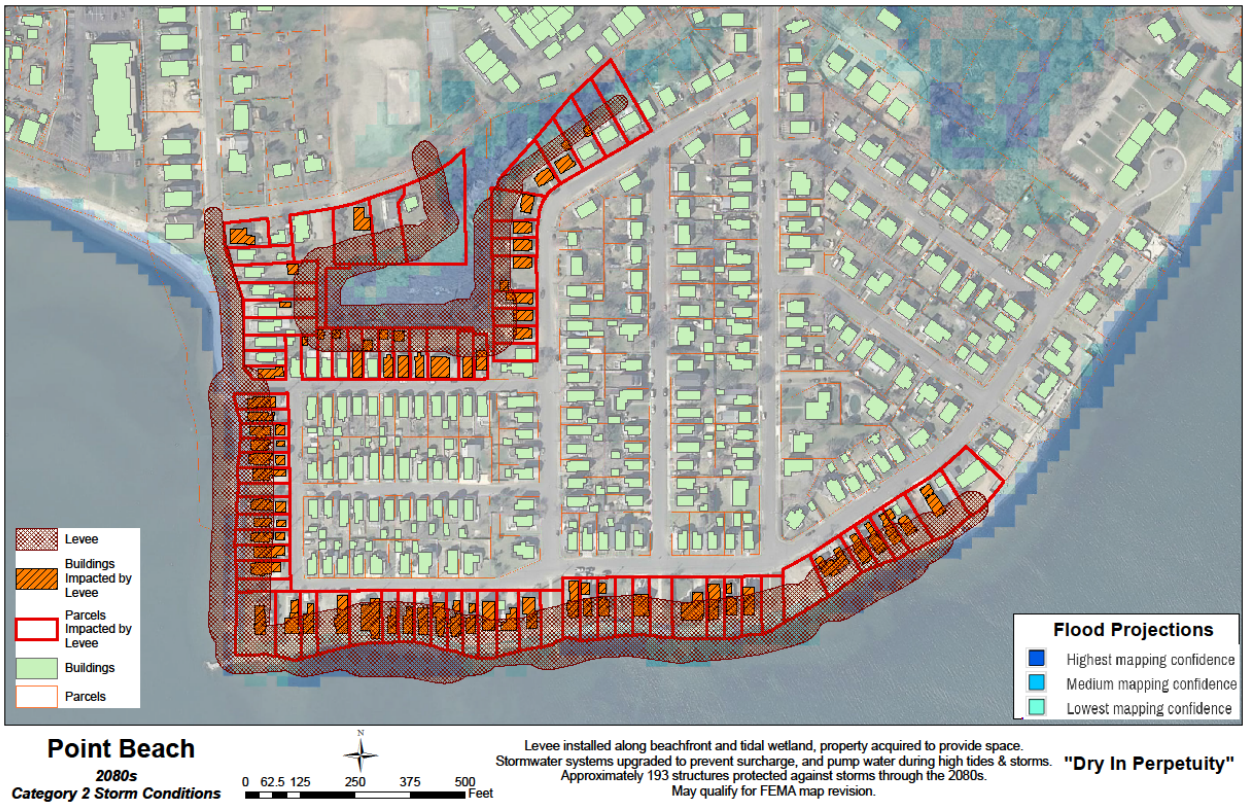
Alternative Description	Modeled Outcome
Elevate & floodproof structures to create a "floodable neighborhood"	Structure types and quantities make neighborhood-scale implementation either not technically feasible, or **cost prohibitive**.
Elevate Nettleton Avenue to 13.5 feet NAVD88	Flooding reduced immediately to west/southwest of Nettleton. **Limited impact** on number of buildings affected by flooding
Elevate Nettleton & Construct/**Nourish Dune**	**Dramatic decrease** in inundation area. About 69 structures in study area would still be impacted by flooding.
Elevate Roads (Nettleton, Joy Road, E. Broadway) & Construct/**Nourish Dune**	**Greatest reduction** in flooding impacts. About 53 structures would still be impacted by flooding.

Details on the designs, costs, and effectiveness of these alternatives are provided in Appendix E.

Point Beach

The Point Beach neighborhood currently experiences nuisance flooding from "surcharging" storm drainage systems during high tides. High-tide flooding through malfunctioning infrastructure will be an increasing risk with rising sea levels. By the 2080s, high-tide waters are projected to overtop the neighborhood's higher-elevation waterfront land, threatening the neighborhood with flooding even with working drainage systems. The neighborhood is almost entirely within a FEMA 1% annual chance floodplain.

Plans depict three potential different outcomes for the neighborhood: a floodable neighborhood, protection from the daily high tide with a continuous flood wall of nominal height, and protection from storm surges with a levee or berm system (pictured below). The Point Beach plans provide the city with an example of how a more densely developed neighborhood that lacks city-owned waterfront will face flood protection challenges that others (such as Walnut Beach) may not face, creating difficult choices in the future.



The three coastal protection alternatives, as well as a "floodable neighborhood" option, are summarized below.

Alternative Description	Modeled Outcome
Elevate homes & minimally improve drainage infrastructure to create "floodable neighborhood"	Many structures already elevated, but additional elevations would likely be necessary. Daily flooding would become a nuisance and access during and after storm events would be impaired.
Construct a **floodwall** system to protect against high tide through 2080s sea level rise conditions.	With improved drainage infrastructure, will protect neighborhood from high tides. Wall will not provide protection from storm surges.
Construct a **dike or levee** system to protect against base flood elevations (1% annual chance, or Category 2, storm) through 2080s sea level rise conditions.	With improved drainage, will protect neighborhood from all but the most extreme flood events. Requires acquisition and displacement of many properties and structures.

Point Beach differs from Walnut Beach in the way in which floodwaters access the area. At Walnut Beach, it will be possible to protect some areas from a 1% annual chance flood event while not protecting others or perhaps to expand the area of protection over time. In Point Beach, building only part of a surge-protection berm or levee, for example, will have no positive impact.

On the other hand, risks at Point Beach will most likely progress over time in a manner that could be tolerated, which could be reflected in prioritized order of operation for adaptation options. Milford could begin by immediately improving drainage infrastructure, which is already envisioned as of the date of this plan. The city could then improve daily-high-tide protection by constructing a wall by the 2050s or 2080s. Over those decades, the city could also work to acquire the property necessary to build a berm or dike system and protect the neighborhood against future high waters and storm surges.

4.2 Infrastructure Conceptual Plans

This plan also presents two examples of choices for building resilience through infrastructure projects. The conceptual designs prepared for Wildemere Beach and the Beaverbrook Wastewater Treatment Plant can be used to make additional planning decisions for these two areas/facilities, and may provide a basis for further design.

Wildemere Beach

The infrastructure project proposed at Wildemere Beach is a potential beach nourishment effort. Current conditions at Wildemere Beach include a FEMA VE Zone (coastal high hazard) extending inland to Broadway in one area, as well as high Base Flood Elevation (12 to 14 feet NAVD88) AE Zones covering a significant area. These are depicted to the right with blue and green, respectively.

A substantial amount of infrastructure (for example, roadways, water, sewer, and gas) is also vulnerable along this section of Milford shoreline.

The proposed alternative for this area is the construction of a beach and bermed dune for limited flood protection. In order to construct a dune/berm sufficient to protect against a 1% annual chance storm event, it is suggested that the beach be built to a width of more than 70 feet beyond the current extent, due to the narrowness of the existing beach. A narrower beach or lower dune/ berm could be designed to decrease wave heights, and so would still have a positive impact on the area's resiliency despite not protecting from larger storm events. Offshore wave attenuation structures would likely be necessary to defend against beach erosion.

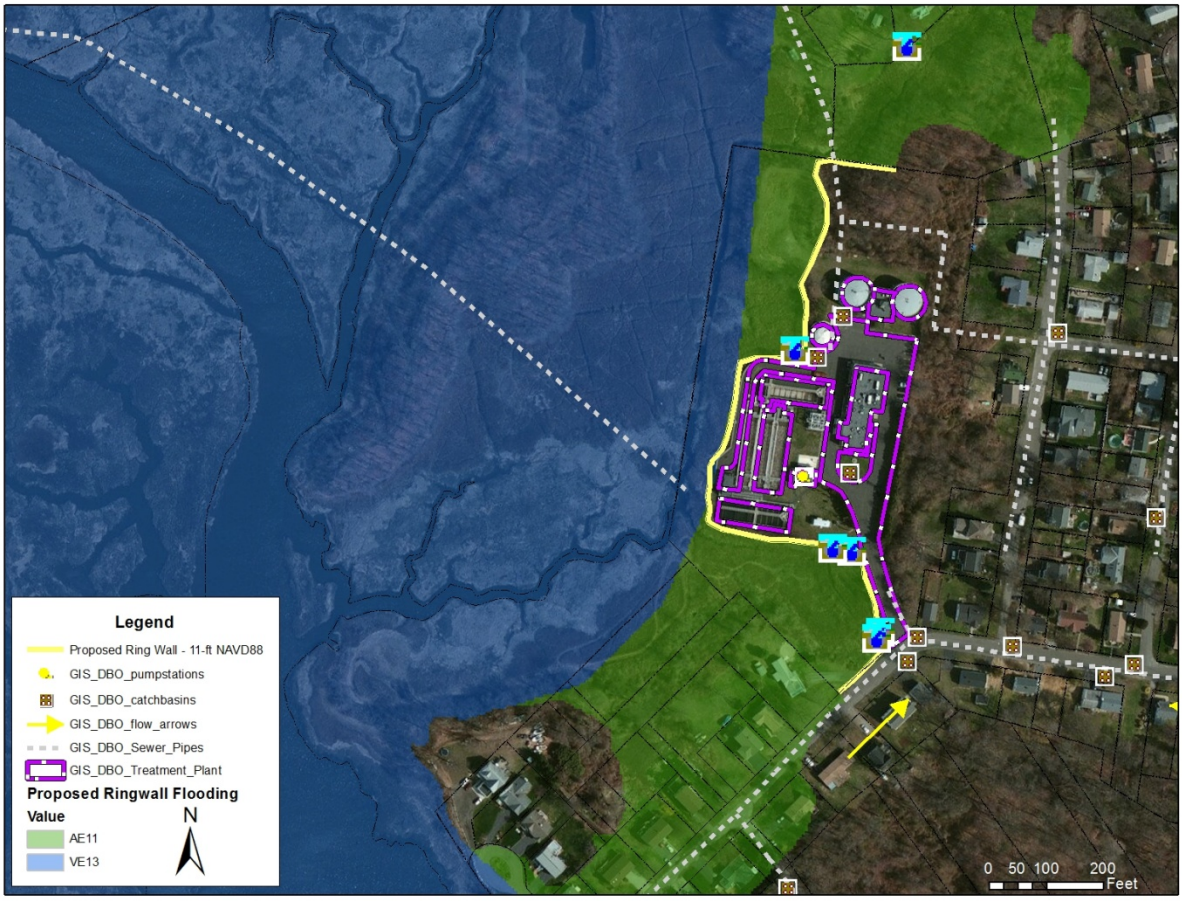
The graphic below shows potential future base flood conditions with a restored beach and created dune or berm at Wildemere Beach.

Beaverbrook Wastewater Treatment Plant

The second example of a choice for building resilience through an infrastructure project is a flood protection system for the Beaverbrook Wastewater Treatment Plant. This facility is located at the edge of the FEMA VE zone, adjacent to the Charles E. Wheeler Wildlife Area at the mouth of the Housatonic River. The facility is critical to the wastewater infrastructure for much of Milford, including LMI areas.

Adaptation options are limited to floodproofing or elevating individual features of the plant, constructing a floodwall around the entire facility, and upgrading the outflow components to prevent infiltration of floodwaters.

The graphic below shows the Beaverbrook WWTP with FEMA flood zones, the proposed floodwall location, and key outflow components.



4.3 Conceptual Plans Summary

These designs are intended to illustrate the costs, benefits, and tradeoffs presented by different adaptation options as well as how the unique characteristics of vulnerable areas will impact which types of adaptation methods are appropriate. They may also be used as a starting point for development of more in-depth designs, or even as visual aids for discussions about the avoidance of high-cost, low-benefit alternatives. Implementation of any of these projects will require further analysis to be performed. More detailed discussion of these plans can be found in Appendices E and F.

5 Implementation

A number of steps must be taken to implement this Coastal Resilience Plan. First, the appropriate municipal agency must be identified or created to administer this plan. The Hazard Mitigation committee is the appropriate entity for prioritizing and tracking the actions presented in this plan. This committee's involvement will ensure that objectives from the Hazard Mitigation Plan and the Coastal Resilience Plan are addressed in a coordinated manner. Specific actions in this coastal resilience plan should be implemented by specific agencies such as the Flood and Erosion Control Board and Planning and Zoning Commission, and departments such as Public Works, Land Use, and Emergency Management.

5.1 Implementation Matrix

A matrix of coastal resilience actions and implementation strategies is provided below.

Implementation Strategy
City of Milford Coastal Resilience Plan

	Action	Responsible Agency or Department	Timeframe	Funding Sources
Citywide Regulatory Changes				
CR1	Relax the 35-ft height restriction to facilitate elevation projects for 2- and 3-story homes	Planning and Zoning	2017-2018	• Not applicable
CR2	Eliminate restrictions that prevent people from reconstructing more resilient homes (for example, the width restriction that comes into play when people reconstruct nonconforming houses)	Planning and Zoning	2017-2018	• Not applicable
CR3	Adopt freeboard that exceeds the state-recommended 1 ft	Planning and Zoning	2017-2018	• Not applicable
CR4	Enforce V zone standards in coastal A zones (to the limit of moderate wave action)	Planning and Zoning	2017-2018	• Not applicable
Citywide Promotion of Property Protection				
PP1	Implement the CRS Maintenance Plan and the CRS "Program for Public Information" (PPI)	Flood and Erosion Control Board	Milestones throughout the year; some actions are annual	• Nominal costs associated with outreach should be covered through operating budgets

	Action	Responsible Agency or Department	Timeframe	Funding Sources
PP2	Partner with property owners to apply for FEMA mitigation grants to elevate homes	Economic and Community Development	Annual outreach in April of each year (HMA applications are due in June or July each year)	• FEMA Hazard Mitigation Assistance (HMA)
PP3	Promote Shore Up and similar home-elevation loan programs	Economic and Community Development	A one-time promotion should be scheduled for mid-2016 with at least one follow-up in late 2016	• Shore Up CT
Milford Point Projects				
MP-1	Execute CDBG-DR Project Grant to elevate section of Milford Point Road	Public Works	2016-2017	• CDBG-DR
Wildemere Beach and Walnut Beach Projects				
WW1	Execute dune restoration project at Walnut Beach	Park, Beach, and Recreation Commission	2016-2017	• CIRCA grant
WW2	Execute CDBG-DR Planning Grant for Wildemere and Walnut Beaches	Public Works	2016-2017	• CDBG-DR
WW3	Restore beach at Wildemere from Laurel Beach to Walnut Beach.	Public Works	2020-2021	• FEMA HMA • USACE • City bond program
WW4	Depending on outcome of CDBG-DR Planning Grant study, Install measures such as jetties and/or offshore breakwaters to retain sand at a restored beach at Wildemere.	Public Works	2020-2021	• FEMA HMA • USACE • City bond program
WW5	Pursue Wildemere Beach LOMR if the project results in reduced base flood elevations or reduced extent of the 1% annual chance flood	Public Works	2022-2023	• Costs associated with consultant services should be covered through operating budgets
WW6	Construct Walnut Beach flood protection system segment 1 – Dune system	Public Works	2020-2021	• FEMA HMA • USACE • City bond program
WW7	Construct Walnut Beach flood protection system segment 2 – Elevated section of Nettleton Road.	Public Works	2021-2022	• FEMA HMA • USACE • City bond program

	Action	Responsible Agency or Department	Timeframe	Funding Sources
WW8	Construct Walnut Beach flood protection system segment 3 – Westerly sections (Joy Road and East Broadway road surface elevations)	Public Works	2022-2023	• FEMA HMA • USACE • City bond program
WW9	Pursue Walnut Beach LOMR with reduced base flood elevations or reduced extent of the 1% annual chance flood	Public Works	2024-2025	• Costs associated with consultant services should be covered through operating budgets
Gulf Beach Projects				
GB-1	Execute CDBG-DR Project Grant for Gulf Beach breakwater reconstruction	Public Works	2016-2018	• CDBG-DR
GB-2	Execute CDBG-DR Planning Grant for Gulf Beach and Welch's Point	Public Works	2016-2017	• CDBG-DR
GB-3	Implement recommendations from CDBG-DR Planning Grant for Gulf Beach and Welch's Point	Public Works	2017-2020	• USACE • City bond program
Bayview Beach Projects				
BB1	Support Army Corps dredging of Milford Harbor and placement of sand offshore from Bayview Beach	Office of the Mayor	2016-2018	• USACE
BB2	Execute CDBG-DR Project Grant to implement Bayview drainage system design: Install new stormwater system components, green infrastructure (rain gardens, etc.), and effective backflow protection on drainage outfalls	Public Works	2017-2019	• CDBG-DR
BB3	Install stormwater pumping station	Public Works	2020-2023	• FEMA HMA • City bond program
BB4	Pursue flood protection system (wall system) that protects from the current and future daily high tide; this will require gaining access to private properties	Public Works	2025-2030	• FEMA HMA • USACE • City bond program
Melba Street and Calf Pen Meadow				
MC1	Stabilize bridge scour at Melba Street over Calf Pen Meadow Creek	Public Works	2018-2019	• Capital improvement
MC2	Execute Carmen Road drainage projects	Public Works	2018-2019	• City bond program
MC3	Execute CDBG-DR Project Grant to elevate section of Beachland Avenue	Public Works	2016-2017	• CDBG-DR (existing grant)

	Action	Responsible Agency or Department	Timeframe	Funding Sources
MC4	As a pilot program in the city, in the long term consider retiring a section of Beachland Avenue between Chester and Melba Street and switch access to the homes on the east side of Beachland Avenue to Buckingham Avenue	Public Works, Economic and Community Development	2027-2030	• FEMA HMA (if combined with MC5 below) • NRCS
MC5	Acquire marshside properties on the west side of Beachland Avenue between Chester and Melba Street and convert to tidal wetlands	Public Works, Economic and Community Development	2027-2030	• FEMA HMA • NRCS
MC6	Execute CDBG-DR Planning Grant for Pelham Street	Public Works	2016-2018	• CDBG-DR
MC7	Implement recommendations from CDBG-DR Planning Grant for Pelham Street	Public Works	2019-2021	• USACE • Capital improvement
Point Beach Projects				
PB1	Install effective backflow protection on stormwater drainage systems	Public Works	2017-2019	• FEMA HMA • City bond program
PB2	Install stormwater pumping station	Public Works	2020-2023	• FEMA HMA • City bond program
PB3	Pursue flood protection system (wall system) that protects from the current and future daily high tide; this will require gaining access to private properties	Public Works	2025-2030	• FEMA HMA • USACE • City bond program
PB4	As a pilot program in the city, promote home elevations to a future base flood elevation	Economic and Community Development	2020-2025	• FEMA HMA • CDBG or CDBG-DR
Morningside and Hillside				
MH1	Replace the failing revetment at the condos on Point Beach Road using a hybrid green/gray technology that will not increase wave energy at adjacent properties	Public Works, Economic and Community Development	2018-2020	• Future CDBG-DR grants • Combine with association funds
MH2	Execute CDBG-DR Project Grant for Morningside Revetment	Public Works	2016-2018	• CDBG-DR
MH3	Monitor condition of granite revetment along Hillside Avenue and repair as needed	Public Works	2018-2028	• Operating budgets
Burwells Cove and Woodmont				
BW1	Execute Rock Street drainage project	Public Works	2017-2018	• City bond program
BW2	Execute CDBG-DR Planning Grant for Crescent Beach	Public Works	2016-2018	• CDBG-DR (existing grant)

	Action	Responsible Agency or Department	Timeframe	Funding Sources
BW3	Implement recommendations from CDBG-DR Planning Grant for Crescent Beach	Public Works	2018-2019	• Capital improvement program
Sanitary Sewer Systems				
SS1	Pursue flood protection system for Beaverbrook WWTP	Public Works	2025-2028	• FEMA HMA • Capital improvement program
	Elevate or floodproof pumping stations:			
SS2	Kinlock Street	Public Works	2018-2028	• Capital improvement program
SS3	East Broadway	Public Works	2018-2028	• Capital improvement program
SS4	Rogers Ave	Public Works	2018-2028	• Capital improvement program
SS5	Oldfield Lane	Public Works	2018-2028	• Capital improvement program
SS6	Carmen Road	Public Works	2018-2028	• Capital improvement program
SS7	Anderson Ave	Public Works	2018-2028	• Capital improvement program
SS8	West Mayflower	Public Works	2018-2028	• Capital improvement program
Miscellaneous Property Acquisitions				
PA1	Acquire properties at the ends of dead-end roads that extend into tidal wetlands, thereby reducing the risks faced by emergency management personnel. Examples include the north ends of finger roads extending from East Broadway in Silver Beach.	Public Works, Economic and Community Development, and Emergency Management	2017-2030	• FEMA HMA • NRCS
PA2	Acquire individual properties citywide as owners approach the city for grant assistance and convert to open space.	Economic and Community Development	Annual outreach in April of each year (HMA applications are due in June or July each year)	• FEMA HMA

Implementation Strategy Table Legend:

CR – Citywide Regulatory
PP – City Promotion of Property Protection
MP – Milford Point
WW – Wildemere and Walnut Beaches
GB – Gulf Beach
BB – Bayview Beach
MC – Melba Street and Calf Pen Meadow
PB – Point Beach
MH – Morningside and Hillside
BW – Burwells and Woodmont
SS – Sanitary Sewer Pumping Stations and Wastewater Treatment Plants
PA – Miscellaneous Property Acquisitions

5.2 Funding Sources

As the appropriations related to Hurricane Sandy are exhausted in 2016 and 2017, the city will need to look toward the existing traditional state and federal funding sources as well as new and emerging funding sources to adapt to coastal hazards and become more resilient. Examples are described below.

New and Emerging Sources of Funding

Connecticut Institute of Resilience and Climate Adaptation (CIRCA) Municipal Resilience Grant Program

During each application cycle, up to $100,000 is available from CIRCA. Project proposals should develop knowledge or experience that is transferable to multiple locations in Connecticut and have well-defined and measurable goals. Additionally, preference is given to those projects that leverage multiple funding sources and that involve collaboration with CIRCA to address at least one of the following priority areas:

- Develop and deploy natural science, engineering, legal, financial, and policy best practices for climate resilience;
- Undertake or oversee pilot projects designed to improve resilience and sustainability of the natural and built environment along Connecticut's coast and inland waterways;
- Foster resilient actions and sustainable communities – particularly along the Connecticut coastline and inland waterways – that can adapt to the impacts and hazards of climate change; and
- Reduce the loss of life and property, natural system and ecological damage, and social disruption from high-impact events.

Milford recently won a CIRCA grant for dune restoration at Walnut Beach, demonstrating that the city has an ability to access this funding source. The city should continue to access CIRCA grants as applicable projects are advanced from this plan.

Northeast Regional Ocean Council (NROC)

NROC is a state/federal partnership that facilitates the New England states, federal agencies, regional organizations, and other interested regional groups in their efforts to address ocean and coastal issues from a regional perspective. NROC builds capacity of New England communities through training and a

small grants program to improve the region's resilience and response to impacts of coastal hazards and climate change. Milford won a grant from NROC in 2013 for development of its CRS Maintenance Plan. The city should continue to access NROC grants as applicable projects are advanced from this plan.

National Oceanic and Atmospheric Administration (NOAA) Regional Coastal Resilience Grants

NOAA is committed to helping coastal communities address increasing risks from extreme weather events, climate hazards, and changing ocean conditions. To that end, NOAA's National Ocean Service is providing funding through competitive grant awards through the Regional Coastal Resilience Grants program. Awards are made for project proposals that advance resilience strategies, often through land and ocean use planning; disaster preparedness projects; environmental restoration; hazard mitigation planning; or other regional, state, or community planning efforts. Successful proposals demonstrate regional coordination among project stakeholders, leverage resources (such as funds, programs, partnerships, and others), and create economic and environmental benefits for coastal communities. Project results are evaluated using clear measures of success, with the end goal being improved preparation, response, and recovery.

Eligible applicants include nonprofit organizations; institutions of higher education; regional organizations; private (for profit) entities; and local, state, and tribal governments. Award amounts typically range from $500,000 to $1 million for projects lasting up to 36 months. Cost sharing through cash or in-kind matches is expected. Applicants must conduct projects benefiting coastal communities in one or more of the 35 U.S. coastal states or territories.

Because the Regional Coastal Resilience Grants program favors regional approaches to resilience problems, the city should pursue future funds with a group of municipalities (such as the Council of Governments) or with the State of Connecticut.

Regional and National Design Competitions

Although the Rebuild By Design (RBD) competition and National Disaster Resilience Competition (NDRC) awards were announced in the last 3 years and the competitions are complete, they have provided a new model for screening and selecting resilience grant awardees in the United States. The city should keep abreast on future design competitions and consider pursuing these competitions as an individual applicant (if eligible), with a group of municipalities, or directly as an active participant with the State of Connecticut.

Traditional Sources of Funding

U.S. Department of Housing and Urban Development (HUD)

Community Development Block Grant (CDBG)

The Connecticut Department of Housing administers the CDBG program in Connecticut. The CDBG program provides financial assistance to eligible municipalities in order to develop viable communities by providing affordable housing and suitable living environments, as well as expanding economic opportunities, principally for persons of low and moderate income. It is possible that the CDBG funding program could be applicable for floodproofing and elevating residential and nonresidential buildings, depending on eligibility of those buildings relative to the program requirements.

CDBG Disaster Recovery (CDBG-DR)

After disaster declarations, and when funds are appropriated to HUD and the Connecticut Department of Housing, the City of Milford should continue to apply for CDBG-DR grants. The city has clearly been capable of securing CDBG-DR grants; several ongoing and upcoming resilience projects are funded by this program.

Natural Resources Conservation Service (NRCS)

The NRCS provides technical assistance to individual landowners, groups of landowners, communities, and soil and water conservation districts on land use and conservation planning, resource development, stormwater management, flood prevention, erosion control and sediment reduction, detailed soil surveys, watershed/river basin planning and recreation, and fish and wildlife management. Financial assistance is available to reduce flood damage in small watersheds and to improve water quality. Two major programs are described below.

Emergency Watershed Protection Program (EWP)

Through the EWP program, the U.S. Department of Agriculture's NRCS can help communities address watershed impairments that pose imminent threats to lives and property. Most EWP work is for the protection of threatened infrastructure from continued stream erosion. NRCS may pay up to 75% of the construction costs of emergency measures. The remaining costs must come from local sources and can be made in cash or in-kind services. No work done prior to a project agreement can be included as in-kind services or part of the cost share. EWP projects must reduce threats to lives and property; be economically, environmentally, and socially defensible; be designed and implemented according to sound technical standards; and conserve natural resources.

Watersheds and Flood Prevention Operations

This program element contains two separate and distinct programs, "Watershed Operations" and "Small Watersheds." The purpose of these programs is to cooperate with state and local agencies, tribal governments, and other federal agencies to prevent damages caused by erosion, floodwater, and sediment and to further the conservation, development, utilization, and disposal of water and the conservation and utilization of the land. The objectives of these programs are to assist local sponsors in assessing conditions in their watershed, developing solutions to their problems, and installing necessary measures to alleviate the problems. Measures may include land treatment and structural and nonstructural measures. Federal cost sharing for installation of the measures is available. The amount depends upon the purposes of the project.

Federal Emergency Management Agency (FEMA)

Pre-Disaster Mitigation (PDM) Program

The Pre-Disaster Mitigation Program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 U.S.C. 5133. The PDM program provides funds to states, territories, tribal governments, communities, and universities for hazard mitigation planning and implementation of mitigation projects prior to disasters, providing an opportunity to reduce the nation's disaster losses through predisaster mitigation planning and the implementation of feasible, effective, and cost-efficient mitigation measures. Funding of predisaster plans and

projects is meant to reduce overall risks to populations and facilities.

Hazard Mitigation Grant Program (HMGP)

The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster.

HMGP is available only in the months subsequent to a federal disaster declaration. Because the state administers HMGP directly, application cycles will need to be closely monitored after disasters are declared.

Flood Mitigation Assistance (FMA) Program

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FEMA provides FMA funds to assist states and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the NFIP. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities.

One limitation of the FMA program is that it is generally used to provide mitigation for structures that are insured or located in Special Flood Hazard Areas (SFHAs).

U.S. Army Corps of Engineers (USACE)

The U.S. Army Corps of Engineers provides 100% funding for floodplain management planning and technical assistance to states and local governments under several flood control acts and the Floodplain Management Services (FPMS) Program. Specific programs used by USACE for mitigation are listed below.

Section 205 – Small Flood Damage Reduction Projects

This section of the 1948 Flood Control Act authorizes USACE to study, design, and construct small flood control projects in partnership with nonfederal government agencies. Feasibility studies are 100% federally funded up to $100,000 with additional costs shared equally. Costs for preparation of plans and construction are funded 55% with a 35% nonfederal match. In certain cases, the nonfederal share for construction could be as high as 50%. The maximum federal expenditure for any project is $7 million.

Section 14 – Emergency Streambank and Shoreline Protection

This section of the 1945 Flood Control Act authorizes USACE to construct emergency shoreline and stream bank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and nonprofit public facilities such as churches, hospitals, and schools. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $1.5 million.

Section 208 – Clearing and Snagging Projects

This section of the 1954 Flood Control Act authorizes USACE to perform channel clearing and excavation with limited embankment construction to reduce nuisance flood damages caused by debris and minor shoaling of rivers. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $500,000.

Section 205 – Floodplain Management Services

This section of the 1950 Flood Control Act, as amended, authorizes USACE to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of floodprone structures. When funding is available, this work is 100% federally funded.

In addition, USACE also provides emergency flood assistance (under Public Law 84-99) after local and state funding has been used. This assistance can be used for both flood response and postflood response. Corps assistance is limited to the preservation of life and improved property; direct assistance to individual homeowners or businesses is not permitted. In addition, USACE can loan or issue supplies and equipment once local sources are exhausted during emergencies.

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Appendix A
Existing Resources and Capabilities

Community Coastal Resilience Plan

City of Milford, Connecticut

Existing Resources and Capabilities

Introduction

The initial step in the Milford Coastal Resiliency Project is a review of exisiting programs, plans, capabilities, and other projects that relate to, address, or are otherwise pertinent to the city's pursuit of a resilient coastal community.

Resources evaluated by Milone & MacBroom, Inc. (MMI) included:

- Milford Hazard Mitigation Plan
- Milford Plan of Conservation and Development
- Milford Zoning Regulations
- Milford Code of Ordinances
- Milford Harbor Management Plan
- TNwC Salt Marsh Advancement Zone Assessments
- FEMA New Haven County Flood Insurance Study and FIRM Panels
- Milford CRS Maintenance and Improvement Plan
- Individual Drainage, Flood Mitigation, and Roadway Resilience Projects
- Individual HMGP- and CDBG-DR-Funded Projects

The intent of this memorandum is to summarize the contributions of each of these programs towards the Milford Coastal Resiliency Plan.

Existing Resources

Milford Hazard Mitigation Plan

The City of Milford's effective Hazard Mitigation Plan Upate is dated August 12, 2013.

The plan identifies 31 severe repetitive loss[1] (SRL) properties following Tropical Storm Irene, located predominantly in the Field Court, Point Beach, and Hillside neighborhoods. Post Sandy, the number of SRL properties increased to 46. Following Storm Irene, the number of repetitive loss properties[2] (RLP) was 164, located in some of the same neighborhoods as the SRL properties, as well as in the Melba Street, Broadway, and East Broadway neighborhoods. Following Storm Sandy, the number of repetitive

[1] The FEMA National Flood Insurance Program (NFIP) defines a severe repetitive loss property as one which has had one of the following occur within a ten year period:

(a) at least four NFIP claim payments over $5,000 each, with the total amount exceeding $20,000

(b) at least two separate claim payments with the total amount exceeding the market value of the building

[2] FEMA defines a repetitive loss property as one which has had at least two separate claim payments of over $1000 each within a ten year period.

loss properties increased to 519 structures, including six commercial properties: three of which are subject to riverine flooding along the Wepawaug River and the other three subject to coastal damage.

As noted in the plan, the history of coastal flooding in Milford has led to a series of flood prevention and property protection projects to be completed along the city's coastline. These projects have included revetments, groins, jetties, and beach nourishment projects.

Section IV.C identifies 35 potential hazard mitigation projects according to hazard type. For this review we focused on projects that address flooding hazards or all hazards. These potential projects are summarized within Table 1 at the end of this memo.

Milford Harbor Management Plan

The Milford Harbor Management Plan (Harbor Plan) was created by the Milford Harbor Commission to guide management and regulation of the municipal waters of the city of Milford. The most recent edition was the fifth, in 2008.

The goals of this plan are to:

- Maintain compatible, equitable, and efficient utilization of the water surface
- Protect and encourage proper management of natural resources in and around Milford's waters
- Provide waterfront community facilities and services that are responsive to the public need
- Encourage water-dependent enterprises that offer employment and address community needs

The Harbor Plan addresses some of the risks that climate change and sea level rise pose to the recreational, economic, and natural resources of Milford's harbors. Vulnerabilaties and mitigation strategies addressed include those related to intertidal wetlands, natural and human-induced sedimentation within navigable waters, and viability of fisheries. The plan specifically points to Gulf Beach rejuvenation as a source of harbor-mouth shoaling problems.

The Nature Conservancy Salt Marsh Advancement Zone Assessment

Maintenance of healthy natural systems is often a cost-effective way to protect people and infrastructure from extreme weather and climate change into the future. As sea level rises, salt marshes will advance upslope and retreat from low-elevation areas. The Nature Conservancy (TNC) developed the Coastal Resiliency Program, in part, to help communities visualize and plan for a variety of future sea level rise scenarios and risks. Included in that program is an online tool to map future salt-marsh advancement.

The Salt Marsh Advancement Zone Assessment was written by TNC to assist communities with mapping future marsh locations and the current land uses at those locations. This information will help Milford understand which parcels are critical to ensure the continued existence of coastal natural resources in the area in the long term. Their analysis breaks future salt marsh extent down into a variety of categories to help with planning, including land that is or is not suitable for marsh habitats, land that is currently open versus developed, and land that is privately owned rather than owned by the city, state, or federal governments.

Plan of Conservation and Development: Milford 2012 – 2022

Milford's 10-year conservation and development policies, goals, and standards cover a wide range of topics such as transportation routes, land-use zoning, housing affordability, citizen health and welfare, and conservation and restoration of natural environments and ecosystems. The Plan of Conservation and Development (POCD) priorities include the long-term maintenance of open-space parcels and concentrating population growth around transportation hubs and routes. The POCD recognizes the current and future challenges of riverine and coastal flooding and erosion, storms, and sea-level rise. Shoreline neighborhoods are expected to become less viable over time, and the POCD encourages acquisition of properties when possible, as well as preparation for the inland migration of coastal residents. The POCD encourages expansion of city-owned land for the express purpose of protection of coastal and riverine floodplains and floodways and recognizes that more active protection of select priorities (such as wastewater treatment facilities) will have significant financial and ecological costs.

City of Milford, Connecticut Zoning Regulations

Milford's Zoning Regulations summarize the city's ability to manage development and construction activities within the city. Review of the documents show Milford's current regulatory capabilities with regards to mitigation of coastal hazards as well as where improvements may be possible to strengthen those capabilities.

Milford's Zoning Regulations describe requirements for development, construction, and improvement in hazardous areas. According to these regulations, structures within FEMA-mapped flood zones must conform to FEMA's minimum elevation or floodproofing standards. No "freeboard" requirements are stipulated.

A special Beach Erosion Zone (BEZ) district is also designated in these regulations. The BEZ is defined as any land area created by fill or engineering which is "located to the water side of the mean high watermark of Long Island Sound as it existed…on the date such project is begun." Construction of buildings and most other structures are prohibited in these areas. Importantly, this does not include naturally erosion-vulnerable areas, nor does it account for the inland migration of the mean high watermark with sea level rise.

Residential structures in Milford are limited to 35 feet in height .

Section 5.12 of the Zoning Regulations requires that all construction, alteration, or land use taking place within the "Coastal Boundary" submit a Coastal Site Plan Review. "Coastal Boundary" Is defined by Section 22a-94 of the Connecticut General Statutes. This requirement gives the city a broad mandate to manage activities in the coastal zone. Exceptions to the requirement for a Coastal Site Plan Review are numerous, and include construction or minor modification of buildings and incidental structures such as fences and walls, walkways and driveways, terraces, decks, pools, docks, underground utilities, essential aboveground utilities, and septic systems.

Community Rating System Maintenance and Improvement Plan

The FEMA (Federal Emergency Management Agency) Community Rating System (CRS) Manual is meant to help communities improve their disaster resiliency and sustainability, integrate a "Whole Community" approach to their emergency management, promote natural and beneficial functions of floodplains, and increase understanding of risk. Participation in the CRS program has the added benefit of reducing flood insurance premiums for landowners. The Milford CRS Maintenance and Improvement Plan is aimed at keeping the city in the CRS program and improving its resilience over time while simulteneously improving the city's rating in the CRS program. Part of this requires addressing ongoing climate change and sea level rise. This plan points to specific ongoing CRS-relevant activities and suggests additional activities that the city can implement in order to improve resilience in the face of rising seas as well as increase its CRS rating and further reduce insurance premiums.

Relevant Publications

Analysis of Shoreline Change in Connecticut

A 2014 study titled "Analysis of Shoreline Change in Connecticut" was performed through a cooperative effort of the Connecticut Department of Energy & Environmental Protection (CT DEEP), the Connecticut Sea Grant (CT Sea Grant) and the University of Connecticut Center for Land Use Education and Research (UCONN-CLEAR). Results show long-term growth of Milford's coastline by between 0 and 20 centimeters per year, on average. This long-term trend will be taken into consideration with regards to future predictions of sea level rise and coastline recession. In addition, site-specific information will be used as necessary to inform individual resilience actions and intiatives. For example, proposed projects should be designed to address the trends in immediately adjacent areas.

North Atlantic Coast Comprehensive Study

The U.S. Army Corps of Engineers (USACE) published their report, "North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk" (NACCS), in 2015 following widespread damage from Hurricane Sandy. The report uses results of the study to guide North Atlantic communities through the process of building coastal-storm resilience from identifying stakeholders and partners for collaboration to monitoring program effectiveness over the long term.

Region-specific analyses provide information on risks and vulnerabilities specific to particular areas. This process begins with assessment of current and projected flooding conditions and delineation of vulnerable areas. Population density and infrastructure, social vulnerability, and environmental and cultural resources are characterized within those flood-vulnerable zones to develop a weighted "exposure index." Risk is then calculated within the study regions as a function of exposure index and probability of flooding.

The entire Milford coastline is classified by this study as being a "high exposure" area, putting many state and local roadways, thousands of structures, wastewater treatment facilities, and a major rail line at high risk.

The NACCS also assesses the applicability of a variety of general adaptation options to certain coastal types. The coast of Milford is split into sections, and relevant options for each section are noted. No

structural options are suggested for the area of the Charles E Wheeler Wildlife Area on the western edge of the city, including Milford Point Road, and structural protection is discouraged, while floodproofing existing structures and acquisition and relocation are suggested. Beach and dune nourishment, floodproofing, and acquisition and relocation are all applicable to the Laurel, Wildemere, and Walnut Beach areas, as well as to the Silver Beach neighborhood. Floodproofing and acquisition, but no coastal protection projects, are suggested for the neighborhoods of Bayview Beach and surrounding areas. Beach nourishment, dune nourishment, floodproofing, and acquisition are all determined to apply to the area of Point Beach.

The main report is supplemented by appendices that quantify storm surge and wave heights as well as economic and social impacts. An associated report focuses on the "Use of Natural and Nature-based Features (NNBF) for Coastal Resilience."

The Connecticut Coastal Design Project

The Connecticut Coastal Design Project was an effort coordinated by The Nature Conservancy's Coastal Resilience Program to create a dialogue between coastal engineers, regulatory agents, coastal geomorphologists, landscape design professionals, and natural resource managers around the implementation of environment and ecosystem supportive shoreline protection projects. The results from this project are summarized in "Workshop Summary of Findings Report on Non-Structural and Natural Infrastructure Alternatives: Current Opportunities and Constraints for Connecticut's Coast" (2015). This summary provides suggestions of types of natural shoreline protection measures, locations along the Connecticut Coast where certain measures can be expected to work best, obstacles that exist to implementation of these strategies, and methods of overcoming those obstacles.

The western part of Milford falls within the "Shoreline District B" designated by this project. This zone was identified as having the second-highest potential for installation of natural infrastructure projects (after district E, which runs from Guilford to Old Lyme). Milford Harbor eastward is within the project's district C, noted as having low suitability for natural infrastructure projects. The dune at Walnut Beach in Milford was identified as a feature that had historically been successful at mitigating flood hazards and which is a strong candidate for restoration after it was damaged by Hurricane Sandy. A salt marsh area at the Milford Head of Harbor, behind the Coast Guard auxiliary building, was noted as a good example of a natural shoreline.

Long Island Sound Comprehensive Conservation and Management Plan

The Long Island Sound Study (LISS) is a "Management Conference" comprised of state and federal representatives, established as part of a variety of Clean Water Act programs, with the goal of improving the water quality, habitat and wildlife diversity and abundance, and community sustainability and resiliency within Long Island Sound and its contributing watersheds. As part of this effort, the LISS produced a Comprehensive Conservation and Management Plan (CCMP) in 2015, updating previous plans. The CCMP is built around four themes: clean water and healthy watersheds; thriving habitats and abundant wildlife; sustainable and resilient communities; and sound science and inclusive management. These themes together incorporate the plan's underlying principles of resiliency to climate change, long-term sustainability, and environmental justice.

Milford's Charles Island, off of Silver Sands State Park, was listed as a critical bird nesting habitat in need of restoration and stabilization after Tropical Storm Irene and Hurricane Sandy.

Long Island Sound Resource and Use Inventory and Blue Plan

This bill, enacted on July 1, 2015, gives the Connecticut DEEP commissioner the responsibility and authority to coordinate with a University of Connecticut Subcommittee and a Long Island Sound Resource and Use Inventory and Blue Plan (LIS RUI-BP) Advisory Committee (both established by the bill) in the development of a Long Island Sound Resource and Use Inventory (LIS RUI or "Inventory") and a Long Island Sound Blue Plan (LIS BP or "Plan"). The Inventory will account for plants, animals, habitats, and ecologically significant areas within the sound as well as human uses including boating; fishing; hunting; aquaculture; energy facilities; shipping corridors; and power-, pipe-, and telecommunication-lines. The Blue Plan will build on this Inventory to establish a framework to guide Connecticut's future actions with regards to the Sound. The Plan will help establish goals and standards for planning and development, incorporate ecological, social, and economic needs and values, account for climate change, and serve as a basis for interstate cooperation.

A draft plan will be developed by March 1, 2019, and will likely be relevant to future resilience efforts in coastal municipalities. At the present time, Milford has not been specifically addressed during development of the Blue Plan.

Ongoing Studies

A number of concurrent coastal-resilience-related research efforts are taking place in the City of Milford at the same time as this project:

Southern Connecticut Regional Framework for Coastal Resilience

This project is funded by the National Fish and Wildlife Foundation through the Hurricane Sandy Coastal Resiliency Competitive Grants Program. The study focuses on green infrastructure and coastal resiliency options for 10 Connecticut municipalities. It is possible that the grant will result in a conceptual design for a natural or green infrastructure project in Milford.

Wind and Flood Mitigation Trade-Offs

A Connecticut Sea Grant College funded study will examine the effects that elevating a home to avoid flood risks has on the vulnerability of that home to wind hazards. This research will produce multihazard risk maps to help communities, specifically the City of Milford and the Town of Fairfield, make decisions to build resiliency against the many threats posed by storms. This project, run by Wei Zhang and Christine Kirchhoff in the University of Connecticut Department of Civil and Environmental Engineering, is ongoing.

Municipal Resilience Planning Assistance Project

Researchers at the University of Connecticut (UConn) are investigating the vulnerabilities of Connecticut wastewater treatement infrastructure, roads, and public safety assets to flooding from rivers and storm surges now and with sea level rise. Funding for the study comes through the Community Development Block Grant Disaster Recovery (CDBG-DR) program. The $1,205,450 grant is administered by CT DEEP with UConn as a contractor. Through the research, CT DEEP will develop tools for municipalities to build resilience into their infrastructure systems as well as technical assistance programs to support those and existing resilience tools.

Transit Oriented Development Study

The Southern Connecticut Regional Council of Governments is studying "Transit Oriented Development" that focuses city growth around the Milford train station. This regional study supports Milford's POCD, which encourages concentrating population growth around transportation hubs and routes. Efforts to centralize and densify future development, especially around the downtown Milford area where the train station is located, may lead to decreased development closer to the coastline and other vulnerable areas.

Sea Level Rise

The University of Connecticut, with support from the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) are beginning a monitoring project to collect sea level data off the coast of Milford.

Beach Stabilization and Resiliency

Both "hard" and "green" stabilization options are being studied at a number of Milford Beaches under a series of grants through the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant Disaster Recovery program. These projects are as follows:

- $225,000 has been awarded to plan and design for increased resiliency at Crescent beach and the surrounding area through a three-step process.
- $275,000 will be used to determine the need for infrastructure upgrades at Gulf Street and Weltch's Point as well as to stabilize the shoreline and harden roads.
- Walnut and Wildemere beaches will be studied using $325,000 to help make hard and green infrastructure improvements in order to stabilize the shoreline.
- Additionally, a seawall and staircase will be replaced on Pelham street in order to reduce erosion and improve public access to beaches there. $150,000 has been awarded for this project.

Coastal Storm Awareness Program

Connecticut Sea Grant, New Jersey Sea Grant, and New York Sea Grant have awarded $1.4 million to social science research projects exploring communication of and response to coastal storm hazard information. Many of these projects will be relevant to Milford and other Connecticut communities, and some will directly involve them. Projects funded by this program include:

- *An Audience Segmentation Analysis of Connecticut Coastal Residents to Support Storm Preparedness – Yale University*
    - CT residents will be surveyed about responses to risk warnings to give emergency planners and responders a better connection to the audiences they serve. Analysis will take into account demographic and social-cultural characteristics.
- *Best Practices in Coastal Storm Risk Communication – Rutgers, the State University of New Jersey*
    - Coastal residents will be surveyed to test the effectiveness of messaging methods including personalization, storm probability formats, and social media messaging.

More information is available at www.nyseagrant.org/csap.

Coastal Resource Preservation

Connecticut Sea Grant College is funding a project to explore the preferences of coastal residents with regards to coastal preservation in the context of sea level rise. Stephen Swallow of the UConn Department of Agricultural and Resource Economics is leading a multidisciplinary team of investigators that will survey Connecticut coastal residents on the topic. The goal is to determine whether people are more likely to support protective measures if they understand the value that an ecosystem presents to the public benefit, especially for mitigation of sea-level-rise-related hazards.

Results will give insight into alternatives and tradeoffs that are acceptable, and the extent to which residents will pay for adaptation measures on the coast. Associate Investigators include James O'Donnell and Jennifer O'Donnell, UConn Marine Sciences, and Christopher Elphick and Eric Schultz, UConn Ecology and Evolutionary Biology.

Regional Plan Association

The New York Regional Plan Association is using Milford as a case study for a report examining the impacts of and barriers to using grant funding for resilience projects.

Coastal Resilience Projects

Projects that address coastal hazards and build resilience, either directly or indirectly, are being pursued and implemented throughout the city of Milford. The most significant of those projects are summarized below.

TABLE 1

City of Milford Coastal Resilience Projects

Project	Description	Category	Action	Funding	Reduced Risks	Green Infr.
Milford Point Road	Milford Point road is being elevated between 1st Ave and Seaview Ave. Funding from CDBG-DR. Design completed in 2015. Elevated road will have lower risk of inundation during coastal flood events.	Hard Infrastructure--Road	Elevate	CDBG-DR $301,537 of $402,050	Road; Private Property	No
Laurel Beach Nourishment	Laurel Beach is periodically nourished with sand under a permit held by the Laurel Beach Association. Project represents future and ongoing beach nourishment events.	Natural Coastal Infrastructure--Beach	Nourish	Private Landowner	Private Property; Buildings	Yes
Wildemere Beach Groin	If Wildemere Beach is nourished (see next line), groins may be beneficial for maintaining sand where it is placed.	Shoreline Infrastructure--Groin	Create		Private Property; Buildings	No
Wildemere Beach Nourishment	Wildemere Beach is not nourished and is narrow or nonexistent at high tide. A wide beach similar to Laurel Beach is desired by residents and the city; this may reduce risk of damage during storm events, although it will not reduce inundation.	Natural Coastal Infrastructure--Beach	Nourish (New)		Private Property; Buildings	Yes
Walnut Beach Stormwater	East Broadway is narrow at Walnut Beach. The city may consider installing green infrastructure such as a bioswale if the road were to be widened. This could be accomplished with or without other Walnut Beach projects.	Stormwater Management--Rain Garden / Bioswale	Create		Ecosystems; Road	Yes

Project	Description	Category	Action	Funding	Reduced Risks	Green Infr.
Nettletown Road Restoration	Nettleton Road could be restored and connected to the end of East Broadway for improved egress. If elevated, it could also serve as part of a flood protection system (with the next line, new dunes at Walnut Beach)	Hard Infrastructure--Road	Create		Road; Critical Facility	No
Walnut Beach Dunes	Dunes created on the landward side of East Broadway, east of Viscount Drive, could serve as a part of a localized flood protection system to reduce risk of storm surge.	Natural Coastal Infrastructure--Dune	Create		Private Property; City Property	Yes
Silver Sands State Park Flood Protection	The city has raised the possibility of a flood protection system within Silver Sands State Park with a goal of protecting properties to northeast. A specific layout has not been envisioned.	Natural Coastal Infrastructure--Flood Protection System	Create		Buildings; Private Property	No
Silver Sands State Park Tide Gate	The tide gate in Silver Sands State Park will be replaced by the State of Connecticut. This will improve tidal flushing while continuing limited flood protection.	Shoreline Infrastructure--Tide Gate	Replace		Ecosystems; City Property	No
Home Acquisition - Caroline St	FEMA has obligated funding for acquisition of the property and conversion to open space adjacent to the tidal marsh. This project has been abandoned (January 2016)	Natural Coastal Infrastructure--Building	Acquire / Demolish	Hazard Mitigation Grant Program (HMGP)	Buildings; Ecosystems	Yes
Home Elevation - East Broadway	Elevation of homes has occurred and will continue to be the preferred alternative for the section of East Broadway east of Silver Sands State Park. This includes the 13 finger roads extending from East Broadway toward the tidal marsh.	Hard Infrastructure--Building	Elevate	Private Landowner	Buildings; Private Property	No

Project	Description	Category	Action	Funding	Reduced Risks	Green Infr.
Home Acquisition - Blair St	FEMA has obligated funding for acquisition of the property and conversion to open space near the tidal marsh. This project has been abandoned (January 2016)	Natural Coastal Infrastructure--Building	Acquire / Demolish	HMGP	Buildings; Ecosystems	Yes
Gulf Beach Breakwater	City received CDBG-DR grant to reconstruct the groin at Gulf Beach, restoring the 210-ft length. Project may stabilize sand migration at the beach.	Shoreline Infrastructure--Groin	Replace in Kind	CDBG-DR $503,500 of $503,500	City Property; Road	No
Bayview Beach Nourishment	Bayview Beach is an area that has been identified as potentially benefiting from beach nourishment to reduce risk of damage from coastal storms. May serve as one component of resilience projects for the Bayview neighborhood.	Natural Coastal Infrastructure--Beach	Nourish (New)		Private Property; Buildings	Yes
Bayview Beach Drainage	Drainage systems among Bayview Beach streets will be upgraded to prevent road flooding using a combination of bonds and CDBG-DR funds. Will serve as one component of resilience projects for the Bayview neighborhood.	Stormwater Management--Stormwater Infrastructure	Enhance / Modify	CDBG-DR: $1,326,150 of $1,768,200	Road; Private Property	Hybrid (some infiltration systems proposed)
Calf Pen Meadow Creek Bridge	Bridge at Bayshore Drive / Melba Street appears to be experiencing scour. A hybrid or gray solution should be pursued to reduce further risk to the bridge.	Hard Infrastructure--Bridge	Mitigate Scour		Road; Ecosystems	Hybrid
Calf Pen Meadow Creek Sediment Removal 1	This sediment removal project represents a large area that was originally obligated for funding by NRCS. The sediment removal was reportedly desired to help restore tidal conveyance in the creek. NRCS instead funded a small project.	Sediment Removal	New Area	NRCS Not Funded	Road; Private Property	No

Project	Description	Category	Action	Funding	Reduced Risks	Green Infr.
Calf Pen Meadow Creek Tide Gate	A tide gate is desired to allow tidal flushing but reduce frequency of flooding of properties upstream of Melba Street. The project was partly funded by CDBG-DR.	Shoreline Infrastructure--Tide Gate	Create	CDBG-DR $638,250 of $851,000	Buildings; Private Property	No
Beachland Avenue	The city will elevate Beachland Ave from 1.5 ft to 2 ft above high-tide elevation. This project was funded by CDBG-DR. Design was completed in 2015. The road routinely floods during the highest monthly tide, and the new elevation will improve egress.	Hard Infrastructure--Road	Elevate		Road; Private Property	No
Carmen Road Drainage	The city will utilize bonds to fund drainage projects in this area near Calf Pen Meadow Creek. The drainage projects will reduce the frequency of road flooding.	Stormwater Management--Stormwater Infrastructure	Enhance / Modify	Municipal Bond	Road; Private Property	No
Point Beach Drainage	The city will utilize bonds to fund drainage projects in this area. The drainage projects will reduce the frequency of road flooding.	Stormwater Management--Stormwater Infrastructure	Enhance / Modify	Municipal Bond	Road; Private Property	No
Point Beach Drive Condos	The coastal bank is rapidly eroding in front of the condominium complex as the existing concrete block revetment slumps and fails. This also places adjacent properties at risk. Green or hybrid bank protection should be considered immediately.	Natural Coastal Infrastructure--Bank Protection	Replace with Other		Private Property; Buildings	Hybrid
Morningside "Revetment"	The coastal bank is eroding in front of residential properties where protection is absent. This also places adjacent properties at risk. CDBG-DR funding has been obligated for a wall / revetment, but hybrid bank protection could be considered.	Natural Coastal Infrastructure--Bank Protection	Create	CDBG-DR $780,480 of $780,480	Private Property; Buildings	Hybrid

Project	Description	Category	Action	Funding	Reduced Risks	Green Infr.
Hillside Avenue Revetment	Some of the greatest storm damages in Milford occurred along Hillside Avenue. The granite block revetment is at a low elevation and the city is concerned about its condition. This project is a placeholder for future repairs.	Shoreline Infrastructure--Revetment	Replace in Kind		Private Property; Buildings	No
Rock Street Drainage	The city will utilize bonds to fund drainage projects in this area. The drainage projects will reduce the frequency of road flooding.	Stormwater Management--Stormwater Infrastructure	Enhance / Modify	Municipal Bond	Road; Private Property	No
Woodmont Beach Nourishment	Woodmont Beach is periodically nourished with sand. This project represents future and ongoing beach nourishment events.	Natural Coastal Infrastructure--Beach	Nourish		Private Property; Buildings	Yes
Wepawaug River Sediment Removal	The city desires removal of sediment from various reaches of the Wepawaug River in the interest of increased flood conveyance.	Sediment Removal	New Area		City Property; Private Property	No
Rain Gardens - Wepawaug River Watershed	The city desires installation of rain gardens in the Wepawaug River watershed to reduce stormwater runoff to the river.	Stormwater Management--Rain Garden / Bioswale	Create	Potential for Section 3.19 funding plus city in kind services match through the Southwest Conservation District	Ecosystems; City Property	Yes
Home Acquisition - Melba St	NRCS considered acquisition of this property with conversion to open space immediately adjacent to the creek. It is not currently funded, but the house is frequently flooded.	Natural Coastal Infrastructure--Building	Acquire / Demolish		Buildings; Ecosystems	Yes
Calf Pen Meadow Creek Sediment Removal 2	This sediment removal project represents a limited area that was funded by NRCS. The sediment removal was desired to help restore tidal conveyance in the creek. NRCS did not fund a larger desired project.	Sediment Removal	New Area	NRCS	Road; Private Property	No

Project	Description	Category	Action	Funding	Reduced Risks	Green Infr.
Calf Pen Meadow Creek Marsh Restoration	NRCS will reportedly fund the restoration and protection of approximately 40 acres of tidal marsh associated with Calf Pen Meadow Creek.	Natural Coastal Infrastructure--Tidal Marsh	Restore (Direct Repair)	NRCS	Ecosystems; Private Property	Yes
Calf Pen Meadow Creek Marsh Acquisition	NRCS will acquire seven privately owned parcels of tidal marsh associated with Calf Pen Meadow Creek.	Natural Coastal Infrastructure--Tidal Marsh	Acquire	NRCS	Ecosystems; Private Property	Yes
Beaverbrook WWTP Protection	A floodwall system is believed necessary to protect the Beaverbrook Wastewater Treatment Plant from coastal flooding.	Shoreline Infrastructure--Flood Protection System	Create		Critical Facility; City Property	No
Beaverbrook WWTP Land Acquisition	Privately owned parcel near Beaverbrook Wastewater Treatment Plant was intended for acquisition by the city, but transfer did not occur. Purchase may contribute to green open space.	Natural Coastal Infrastructure--Tidal Marsh	Acquire		Ecosystems; City Property	Yes
Pelham Street	This project is an undermined seawall on city land with a bluff located behind. Design of a revetment has been funded.	Shoreline Infrastructure--Revetment	Create	CDBG-DR $150,000 of $150,000	Private Property; Buildings	No
Crescent Beach Nourishment	Crescent Beach is periodically nourished with sand. Project represents future and ongoing beach nourishment events.	Natural Coastal Infrastructure--Beach	Nourish		Road; Public Access	Yes
Home Acquisition - Cooper Ave	NRCS has obligated funding for acquisition of the property and conversion to open space near the tidal marsh. (Property may already be vacant; Jan 2016)	Natural Coastal Infrastructure--Building	Acquire / Demolish	NRCS	Buildings; Ecosystems	Yes
Home Acquisition - Tremont St	NRCS has obligated funding for acquisition of the property and conversion to open space near the tidal marsh. (Property may already be vacant; Jan 2016)	Natural Coastal Infrastructure--Building	Acquire / Demolish	NRCS	Buildings; Ecosystems	Yes

Project	Description	Category	Action	Funding	Reduced Risks	Green Infr.
Eisenhower Park	Retrofit existing property by incorporating rain garden, bioswales, and wet meadow depressions to control floodwaters and preserve natural habitat as well as upstream flow along the Wepawaug River	Stormwater Management--Infiltration Galleries	Create	Potential for Section 3.19 funding plus city in kind services match through the Southwest Conservation District	Ecosystems; City Property	Yes
Grove Circle Park	Retrofit existing park property and adjacent streets(parking area and Low elevation area within floodplain regrade to higher elevation and incorporate green/natural techniques to control flooding and runoff from roads and drainage and coastal drainages	Stormwater Management--Rain Garden / Bioswale	Create	Potential for Section 3.19 funding plus city in kind services match through the Southwest Conservation District	Building; City Property	Yes
Margaret Egan Center Green Infrastructure	Retrofit existing property behind Egan center (parking area and Egan center park) Low elevation area within floodplain regrade to higher elevation and incorporate green/natural techniques to control flooding and runoff from roads and drainage and coastal drainages	Stormwater Management--Rain Garden / Bioswale	Create	Potential for Section 3.19 funding plus city in kind services match through the Southwest Conservation District	Building; Ecosystems	Yes
Silver Sands State Park Green Infrastructure	This project will focus on coastline restoration and construction of boardwalk with green/natural infrastructure over salt and tidal marshes across and grassed parking area	Stormwater Management--Rain Garden / Bioswale	Create	DEEP, CT State Parks	Public Access; Ecosystems	Yes
Walnut Beach Dune Restoration	All Habitat, an environmental company, will improve an existing sand dune, mostly through removal of invasive plants and planting of native ones.	Natural Coastal Infrastructure / Dune	Enhance	CT Inst. for Resilience & Climate Adaptation	Public Access; Ecosystems	Yes
Gulf Street & Welch's Point Road Study	Project will determine needed infrastructure upgrades and will stabilize the shoreline and harden nearby roads against erosion.	Shoreline Infrastructure / Road	Study	CDBG-DR $275,000 of $275,000	Road	Hybrid

Project	Description	Category	Action	Funding	Reduced Risks	Green Infr.
Crescent Beach Study	Project contains three phases that will increase resiliency on Crescent Beach and the surrounding area to protect the community against future storms.	Natural Coastal Infrastructure—Beach	Study	CDBG-DR $225,000 of $225,000	Public Access; Ecosystems	Hybrid
Walnut and Wildemere Beach Study	Risks specific to these beaches will be studied. Methods for stabilization and resiliency will be planned and designed.	Natural Coastal Infrastructure—Beach	Study	CDBG-DR $325,000 of $325,000	Public Access; Ecosystems	Hybrid

NRCS = Natural Resources Conservation Service

Conclusion

Milford has a great variety of capabilities in its existing city plans and regulations, local and regional studies, and planned or ongoing coastal protection projects.

Most of the relevent municipal planning documents recognize sea level rise and coastal storms as a key issue in need of consideration. The Hazard Mitigation Plan identifies at-risk locations, tracks mitigation projects, and suggests additional possibilities. The Plan of Conservation and Development encourages the protection of and acquisition of additional open space to protect development and assist in the continued existence of tidal marshland. The Milford Harbor Management Plan also addresses future sea level change, and covers the topic of sediment flow and dynamics which is so important to Milford's beaches and residents.

Milford's Zoning Regulations include many requirements to protect property from flooding, but sea level rise and climate change are not explicitly included. Some flexibility is given to the city to implement stricter requirements within the Coastal Boundary.

Many local and regional research efforts can also be considered capabilities because they add the base of knowledge in Milford with regard to future conditions, vulnerabilities, and adaptation options. The TNC Salt Marsh Advancement Zone Assessment will help the city plan for long-term sustainability of this ecosystem. The CT DEEP Shoreline Change study points to specific erosion risk zones and can inform development of sediment management projects. The NACCS results provide suggestions with regards to prioritizing areas for protection and choosing applicable adaptation projects. Other studies, many still ongoing, cover a wide range of topics such as nonstructural adaptation approaches, maintaining healthy aquatic and shoreline habitats, the balance between flood and wind protection, developing high-resolution sea level rise projection, and the feasibility of a variety of specific local adaptation plans.

As part of building resilience, it is essential that the City of Milford monitor the projects and plans listed in this memo, as well as others that are developed over time, and ensure collaboration and communication between these efforts.

2619-09-8-m416-milfordtask1memo

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Appendix B
Sea Level Rise and Regional Vulnerabilities

COMMUNITY COASTAL RESILIENCY PLAN

CITY OF MILFORD

Sea Level Rise and Regional Vulnerabilities

1 Introduction

The City of Milford is partnering with the Towns of Branford and Madison to utilize funding from the United States Department of Housing and Urban Development (HUD) Community Development Block Grant (CDBG). This particular grant falls under the category of "Recovery Eligible Activities" and aims to address vulnerabilities observed after Superstorm Sandy by developing Coastal Resiliency Planning at the municipality level.

The stated purpose of this grant is to increase social, economic, and ecological resilience in the face of sea level rise, more frequent and severe storm surges, coastal flooding, and erosion. Extra emphasis is placed on benefiting underserved, low-to-moderate income populations and their communities.

Risks and vulnerabilities in the City of Milford were determined through review of other City documents such as the Milford Hazard Mitigation Plan, discussion with City representatives, public meetings, an online survey, and utilization of The Nature Conservancy's Coastal Resilience Mapping Portal.

This risk and vulnerability memo is one step toward developing a community Coastal Resilience Plan.

2 Sea Level Rise

2.1 Introduction

Although erosion and shoreline change have long been recognized as coastal hazards nationwide, it is only recently that sea level rise has been viewed as a hazard to be considered while planning for resilience. Indeed, continued increases in the rate of sea level rise will increase the incidence, severity, and adverse effects of flooding, erosion, and shoreline change. Consider the following:

- A continued increase in the rate of rising sea levels will inundate low areas, increase erosion of beaches and tidal marshes, increase the incidence of flooding from storm surges, and enable saltwater to advance upstream and intrude further into estuaries and aquifers.
- Future sea level rise could result in the disappearance of a large percentage of Milford's tidal wetlands unless they can advance as quickly as the rising level.
- Saltwater advancing upstream along estuaries can alter the point at which sedimentation leads to the creation of shoals and other features.

- FEMA's coastal base flood elevations will progressively rise along with sea level. This means that the 100-year and 500-year flood levels will affect lands and structures that are currently at unaffected elevations.
- As sea level rises, storm surges from hurricanes and nor'easters will reach further inland as they are starting from a higher base level.
- As sea level rises, drainage systems become less effective. Rainstorms will have the potential to cause greater flooding.

In its landmark 2001 report, the IPCC projected that global sea level may rise nine to 88 centimeters (0.30 - 2.89 ft) during the 21st century. According to the February 2007 update report by the IPCC, these predictions have been refined using six global climate models to project a more narrow range of sea level rise of 28 to 43 cm (0.92 to 1.41 ft) in the 21st century.

NOAA Technical Report OAR CPO-1, entitled Global Sea Level Rise Scenarios for the United States National Climate Assessment (December 2012) was prepared in partnership with USGS and the U.S. Army Corps of Engineers. This report is the current reference for sea level rise planning in the United States. The report states that "We have very high confidence that global mean sea level will rise at least 0.2 meters (8 inches) and no more than 2 meters (6.6 feet) by 2100."

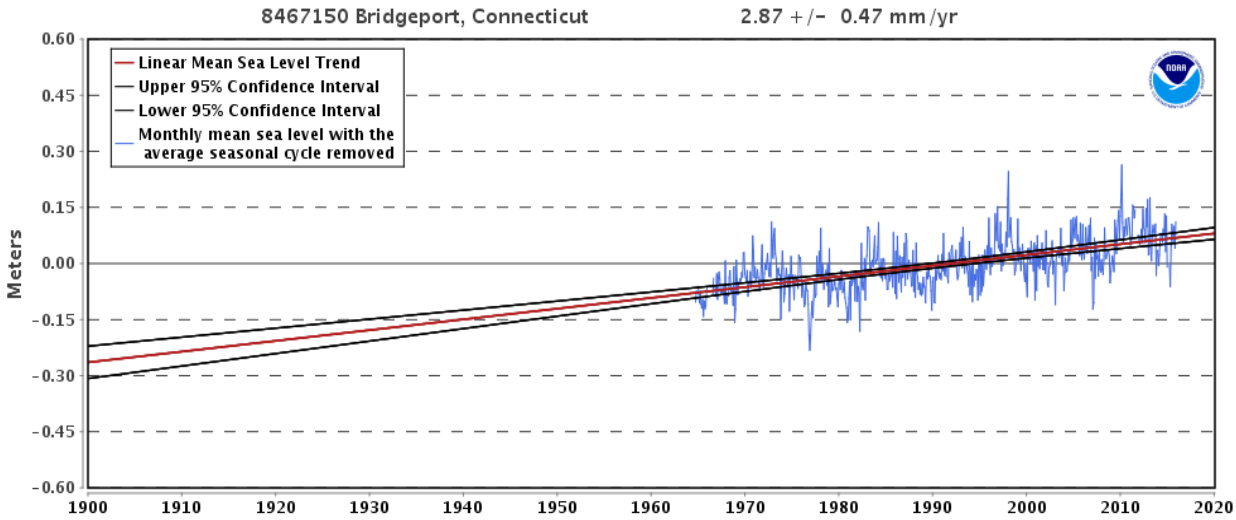
Sea level rise is not consistent around the world, and is affected by local variations in currents, temperature, and changes in land surface elevation. It has long been expected that the rate of sea level rise in Connecticut will be slightly higher than the global projections due to the effects of regional subsidence. However, more recent studies have asserted that changes in ocean circulation will increase the relative sea level rise along the Atlantic coast even more. Specific trends in Milford are discussed in the following two sections.

2.2 Existing Conditions and Historic Rise

A single tide gauge was operated by the National Oceanic and Atmospheric Administration (NOAA) within Milford from October 1987 to March 1988. The gauge was located at the mouth of the Wepawaug River in Milford Harbor south of High Street. According to data collected by this gauge (available online at tidesandcurrents.noaa.gov), the mean sea level (MSL) in Milford Harbor is negative (-) 0.23 feet, or 0.23 feet below the North American Vertical Datum of 1988 (NAVD88). The average maximum elevation of high tide ("mean higher-high water, or MHHW") is 3.48 feet above the MSL, or 3.25 feet elevation (NAVD88). These values will vary along Milford's coastline, and have likely changed since 1988, as discussed below.

The nearest operational long-term NOAA gauge to Milford is the tide gauge in Bridgeport, CT. Based on tide gauge data collected at that station between 1964 and 2014, MSL has been increasing at a rate of 2.87 millimeters (0.11 inches) per year, which is equivalent to a rise of 0.94 feet over 100 years (see Figure 1 below). Another station in New London, CT, has measured an increase of 2.58 mm/yr, or 0.85 feet-per-100-years, based on measurements since 1938.

Figure 1



2.3 Sea Level Rise

2.3.1 Sea Level Rise Projections

The U.S. Army Corps of Engineers hosts a sea level projection web tool ("Sea-Level Change Curve Calculator") at http://www.corpsclimate.us/ccaceslcurves.cfm. The calculator provides sea level rise projections using U.S. Army Corps of Engineers and NOAA projections at existing tidal gauges. The nearest gauge to Milford is the tide gauge in Bridgeport. Calculated sea level rise for this gauge is depicted in the following table and graph. In each case, the base year is 1992. Rates are "NOAA Low, NOAA Intermediate Low, NOAA Intermediate High, NOAA High, USACE Low, USACE Intermediate, and USACE High" as follows:

- NOAA Low and USACE Low: This curve uses the historic rate of sea-level change as the rate of change moving forward.
- NOAA Intermediate Low and USACE Intermediate: This curve projects future sea level rise based only on ocean warming and the local rate of vertical land movement. Ocean warming leads to increases in sea level rise because water expands as it heats. As ocean temperatures increase, the oceans rise to accommodate this natural expansion. This is generally considered an optimistic rate of sea level rise, meaning it is a best case scenario that minimizes future risk.
- NOAA Intermediate High: This is the projected rate of sea level rise assuming both ocean warming and a moderate rate of melting of the arctic ice sheets. The increase is higher because the water expansion is exacerbated by the addition of new water from the melted ice sheets. The rate of ice sheet loss is considered the biggest unknown in climate change analysis, which is why two alternate scenarios (Intermediate High and High) are provided for ice sheet loss.

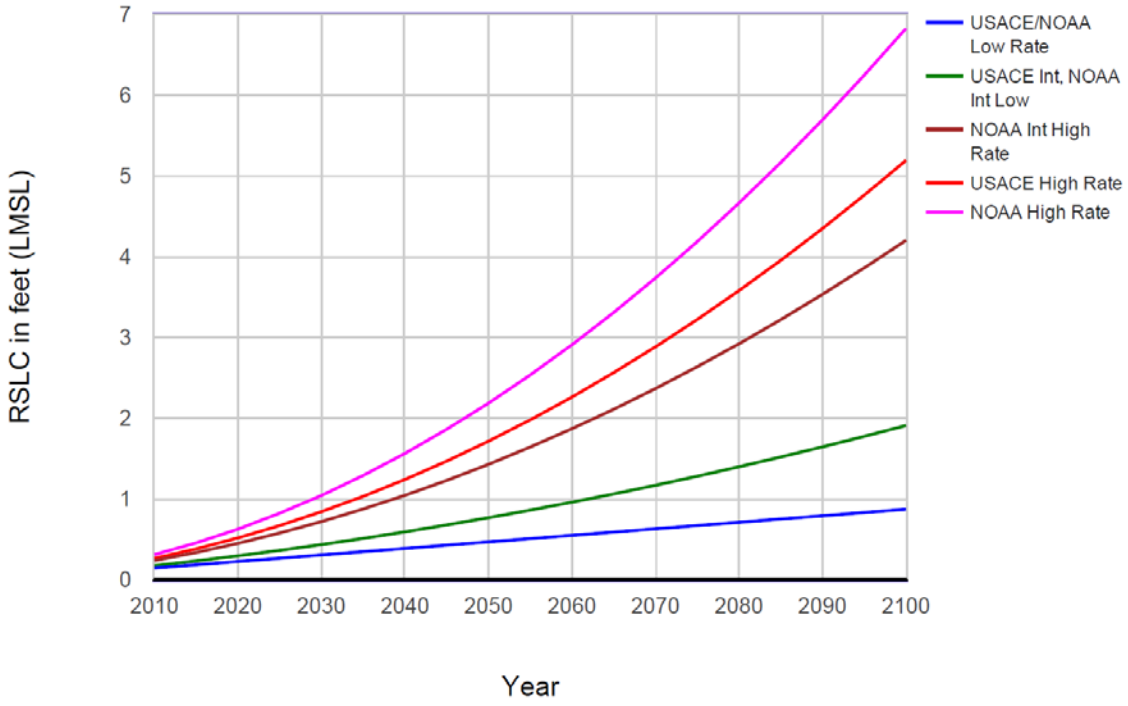
- USACE High: This curve is computed from the modified National Research Council's "Curve III" considering both the most recent IPCC projections and modified NRC projections with the local rate of vertical land movement added.
- NOAA High: The red line represents the largest increase in sea level rise based on heating of the oceans and a maximum loss of the ice caps. NOAA suggests that this highest scenario is considered an appropriate planning tool for critical facilities that have a long life cycle such as major highways, power plants, and the like.

Table 1

Gauge 8467150, Bridgeport, CT NOAA's Regional Rate: 0.00807 feet per year Values expressed in feet relative to the 1992 Local Mean Sea Level (LMSL)					
Year	USACE Low NOAA Low	USACE Int NOAA Int-Low	NOAA Int-High	USACE High	NOAA High
2010	0.14	0.17	0.24	0.27	0.31
2015	0.19	0.23	0.34	0.38	0.46
2020	0.23	0.30	0.45	0.52	0.63
2025	0.27	0.36	0.58	0.67	0.82
2030	0.31	0.44	0.72	0.84	1.04
2035	0.35	0.51	0.88	1.03	1.29
2040	0.39	0.59	1.05	1.24	1.56
2045	0.43	0.68	1.23	1.47	1.86
2050	0.47	0.77	1.43	1.72	2.19
2055	0.51	0.86	1.64	1.98	2.54
2060	0.55	0.96	1.87	2.26	2.91
2065	0.59	1.06	2.11	2.57	3.31
2070	0.63	1.17	2.37	2.89	3.74
2075	0.67	1.28	2.64	3.22	4.19
2080	0.71	1.40	2.92	3.58	4.67
2085	0.75	1.52	3.22	3.96	5.17
2090	0.79	1.65	3.54	4.35	5.70
2095	0.83	1.78	3.86	4.76	6.25
2100	0.87	1.91	4.21	5.20	6.83

Figure 2

Relative Sea Level Change Projections
Gauge 8467150, Bridgeport, CT



The ranges calculated in Figure 1 and Table 1 are quite wide, but even the low projections show that sea level rise will continue throughout the century. The USGS has demonstrated that sea levels along the mi-Atlantic and northeast coasts of the United States are already rising three to four times faster than the global average since 1990. This heightens the need for resilience planning in Milford.

2.3.2 Sea Level Rise Viewer Tools

Several sea level rise viewer tools are available for assessing future sea levels in the Milford area including the Connecticut Coastal Hazards Viewer at http://ctecoapp1.uconn.edu/ctcoastalhazards/, NOAA's popular tool at http://csc.noaa.gov/digitalcoast/tools/slrviewer, and The Nature Conservancy's (TNC) Coastal Resilience Mapping Portal at http://coastalresilience.org/. The various viewer tools can be used for decision support and local or regional planning, in addition to public education and outreach.

The Coastal Resilience Mapping Portal

The Coastal Resilience program for New York and Connecticut is a collaborative effort led by TNC in partnership with NOAA's Coastal Services Center (CSC), The Association of State Floodplain Managers (ASFPM), The Earth Institute of Columbia University (TEI), NASA's Goddard Institute for Space Studies (GISS), Pace University's Land Use Law Center (LULC), The University of Southern Mississippi (USM), and the University of California at Santa Barbara (UCSB). The

Coastal Resilience Mapping Portal is the sea level rise viewer produced by this collaboration. The tool is an interactive decision support instrument that explores predicted flood extents in the future under different sea level rise scenarios and storm conditions. The visual information is intended to inform development and conservation decisions.

Sea level rise projections for Long Island Sound were generated under a contract between TNC, TEI, and GISS in 2010-2011. Projections are generalized to apply to the decade-long time periods of “2020s,” “2050s,” and “2080s.” Each decade is paired with three sea level rise scenarios: "high," "medium," and "conservative.” The sea level rise magnitudes are derived from models of three different emissions scenarios and seven global climate change models, coupled with historic tide gauge data, subsidence rates, and several other variables (Columbia/NASA).

Those nine sea-level rise projections are combined with modeled surge effects under three sets of conditions: no storm (in other words, only the impacts of sea level rise), Category 2 hurricane, and Category 3 hurricane. The result is a set of 27 different possible views, as listed below in Table 2.

Table 2

Future Flood Scenarios Mapped by the Coastal Resilience Tool

Decade	Condition	Sea Level Rise Estimates*	Elevation (ft, NAVD 88)
2020s	No Storm	Conservative	3.3
		Medium	3.3
		High	3.7
	Category 2	Conservative	9.4
		Medium	9.4
		High	9.8
	Category 3	Conservative	12.4
		Medium	12.4
		High	12.8
2050s	No Storm	Conservative	3.8
		Medium	3.9
		High	5.2
	Category 2	Conservative	9.9
		Medium	10.0
		High	11.3
	Category 3	Conservative	12.9
		Medium	13.0
		High	14.3
2080s	No Storm	Conservative	4.5
		Medium	4.7
		High	7.3
	Category 2	Conservative	10.6
		Medium	10.8
		High	13.4
	Category 3	Conservative	13.6
		Medium	13.8
		High	16.4

*High = emissions scenario A2 + 3.28 feet (1 meter)
Medium = emissions scenario A2
Conservative = emissions scenario A1B

The Coastal Resilience mapping portal was used to evaluate different parts of Milford in the 2020s, 2050s, and 2080s. In general, the "medium" projections were utilized for making planning-level decisions, whereas the "conservative" and "high" projections were used for comparison purposes.

2.3.3 Wave Setup and Runup Modeling

Sea level is often described as a single elevation for an area, but this ignores variations caused by the movement of water. The average sea level, without accounting for factors such as waves, wave setup, or wave runup, is called the **stillwater** elevation. Waves cause sea level to fluctuate above and below the stillwater elevation, which for the purposes of planning create an effective water surface elevation that is higher than sea level. As waves approach the shoreline, the average level of water inside the surf zone increases. This is known as **wave setup**. After waves break on the shore, the momentum of the wave pushes water further up the shoreline, such that when the water finally stops and begins to recede, it is at a higher elevation than wave setup. This is called **wave runup**. Wave setup and runup can sometimes push water over a coastal barrier (**overtopping**), even if that barrier is significantly higher than the stillwater elevation.

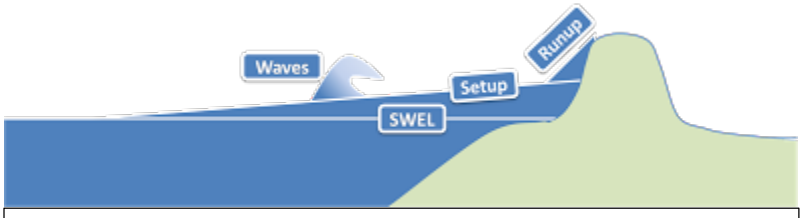


Figure 3:
Conceptual representation of stillwater elevation (SWEL), wave setup, and wave runup.

The significance of wave setup and runup is related to the topography of the coastline, and requires more extensive analysis than what is provided by TNC's CRMP tool. Two products that include this level of analysis were reviewed for this study.

Coastal Hazard Analysis Modeling Program

The Coastal Hazard Analysis Modeling Program version 2.0 (CHAMP 2.0) is a method developed by FEMA for performing analyses of wave-related hazards, including the effects of wave height and wave runup. This program was used as part of the preliminary New Haven County Flood Insurance Study (FIS) issued August 10, 2015[1], and results are available in database form. These data include the 1%-annual-chance stillwater elevations, wave setup elevations, wave heights and wave periods, coastal structure (revetments or seawalls) failure analyses, and runup analysis (if applicable). Another FEMA modeling tool called Wave Height Analysis for Flood Insurance Studies 4.0 (WHAFIS) was applied using CHAMP to calculate overland wave height propagation and establish base flood elevations.

The results of the wave modeling data were reviewed for a number of FEMA coastal transects within Milford, based on their proximities to known high-hazard areas. The primary hazard (overtopping, overland wave propagation) impacting each area was determined based on the

[1] CHAMP 2.0 was used to perform modeling of coastal hazards in the 2013 New Haven County FIS. Results from that study were brought into the 2015 FIS without change.

final mapping methodology used in the preliminary New Haven County DFIRMs and summarized in Table 10 of the FIS.

A detailed description of the FIS data and analysis techniques ("Coastal Summary_NewHaven.pdf) can be found submitted as part of the Technical Support Data Notebook (TSDN) package along with the preliminary New Haven FIS (8/10/2015).

The Advanced Circulation Model (ADCIRC)

On October 29, 2012, the remnants of Hurricane Sandy made landfall near Brigantine, NJ, and due to its size brought a catastrophic storm surge into the New Jersey and New York coastlines. As part of the extensive recovery effort, the North Atlantic Coast Comprehensive Study (NACCS) was authorized by the Disaster Relief Act of 2013 (Public Law 113-2) on January 29, 2013. The study area was the Atlantic Ocean coastline, back-bay shorelines, and estuaries within portions of the United States Army Corps of Engineers (USACE) North Atlantic Division. The NACCS numerical modeling and statistical analysis effort used the ADCIRC Model to generate a tremendous amount of storm forcing condition data, model results, and statistical analysis products, for the coastal regions from Virginia to Maine. The USACE maintains all of this information within the Coastal Hazards System (CHS), a national, coastal storm-hazard data storage and mining system.

ADCIRC total water level output data for this study area was extracted from the CHS and reviewed.

Model Comparison

The total water levels from the New Haven County FIS were based on the results of a local tide gauge analysis. The NACCS total water levels were based on simulations of tropical and extratropical storms using a coupled wave and surge model. Both studies include a wave setup component at the 1%-annual-chance storm water level.

In many cases the results between the two recent studies are similar, however there are instances where the water levels are significantly different at return periods (10%, 2%, and 0.2% annual-chance) where the NACCS values include a wave setup component and the FEMA data do not. It is recommended that the NACCS figures be used for planning purposes.

Results of wave setup and runup modeling is presented in section 4.3.

3 Risk, Vulnerability, and Resilience

In the context of natural hazards such as flooding, risk is commonly defined as the product or the sum of vulnerability and frequency (risk = vulnerability X frequency or risk = vulnerability + frequency). Thus, if an event has (1) a low frequency and (2) very few people, structures, or infrastructure are vulnerable to the effects of that event, then the risk is assumed to be low. If an event has a high frequency and many people, structures, or components of infrastructure are vulnerable to the effects of that event, then the risk is assumed to be high. Either low frequency

coupled with high vulnerability or high frequency coupled with low vulnerability will produce moderate risk.

In the context of coastal hazards and the need for developing coastal resilience, risk will change over time because the frequency will increase. Coastal storms are believed to be increasing in frequency, and flooding will increase in frequency as sea level rises. Thus, even if coastal vulnerabilities in Milford remain static, risks will increase.

Therefore, Milford is at a crossroads with regard to reducing risk. Vulnerabilities can remain static and risk can increase, or vulnerabilities can be reduced to hold risk at bay. If vulnerabilities can be reduced even further, than risks could be lowered in the face of rising sea level and increased coastal storms, leading to increased resilience. The least desired combination of all would be the development of increased vulnerabilities while frequencies increase, because risks could rise faster than expected. An example of a policy that would increase vulnerability would be the deterioration of old and inadequate drainage systems in low-lying areas. An example of a project that would retain static vulnerability would be the repair of damaged seawalls in a neighborhood like Point Beach. An example of a method to reduce vulnerability would be to improve the height and strength of walls in a neighborhood like Point Beach, or to elevate homes.

The Community and Regional Resilience Initiative (CARRI, 2011) uses a "Resilience Loss Recovery Curve" to illustrate the process of increasing or decreasing community resilience.

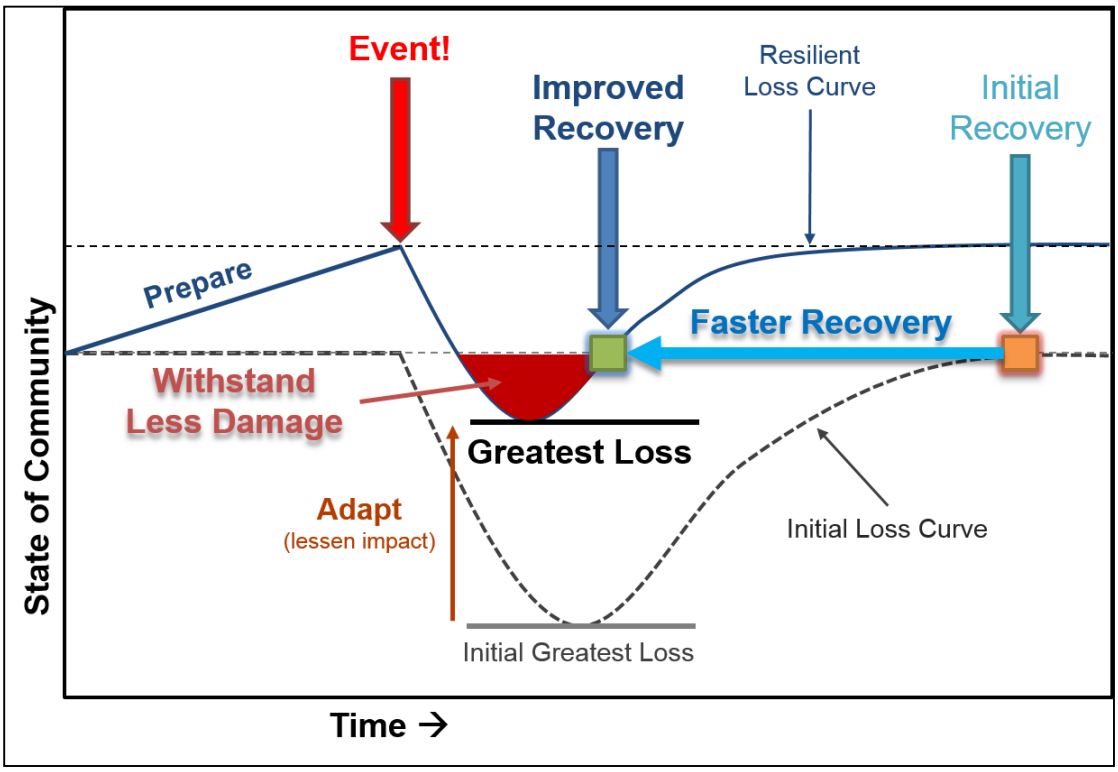


Figure 4 – Resilience Loss Recovery Curve, based on CARRI, 2011.

The Resilience Loss Recovery Curve helps explain how community function is affected by an acute disturbance such as an earthquake or hurricane, and depicts response and recovery curves. Community functions decline (blue and pink areas) as communities respond to a disaster. A more resilient community can more quickly restart local services (utilities, businesses, schools) and chart a path to a "new normal." The more resilient community incurs some losses (blue) but avoids additional losses (pink), because it has taken informed measures (anticipating threats, developing disaster response plans and recovery strategies, longer-term land use policies) in advance to minimize the impact of the disturbance (i.e., planning and mitigation).

Resilient communities may find opportunities to transform themselves and grow. Thus, a resilient community's "new normal" may be a higher level of function (solid blue, upper line) or it may be able to return to a level of function existing before the disturbance (dashed gray, lower line). Ultimately, this cycle repeats itself both before and after each disturbance resulting in opportunities to incrementally increase resilience and comprehensively reduce losses over time.

4 Vulnerabilities

Coastal hazards can impact the City of Milford in a variety of ways, from direct injuries to residents, to damage to transportation infrastructure and utilities, to reduced economic activity following a storm event. Similarly, the types and degrees of vulnerabilities varies from one location in the city to another.

In this chapter, specific vulnerabilities to Milford are summarized both by the *type* of vulnerability and by the *locations* of these vulnerabilities.

4.1 Vulnerabilities by Type

4.1.1 Social

Social vulnerabilities to coastal hazards are focused mainly on three groups of people: residents, the business community, and visitors. These social vulnerabilities are directly linked to economic vulnerabilities, described in the next section.

Residents

Residents of Milford comprise the greatest group of people with vulnerability to coastal hazards and thus increased risk as sea level rises. More frequent coastal storms, storm surges, and flooding can cause a wide range of outcomes from minor property damage to injury and loss of life. Even the indirect outcomes of increased flooding can cause a range of problems from the slight inconvenience of waiting for low tide to traverse a key intersection, to being unable to mobilize an ambulance to the home of a person in need of medical attention. Specific regions of Milford with vulnerable properties are described in section 3.1.2 and in more detail in section 3.2. Critical facilities, as well as routes to and from those facilities, that are vulnerable to storms, are described in 3.1.3 and 3.1.5.

Business Community

Social vulnerabilities to coastal hazards in Milford are not limited to residents. Social vulnerabilities can be found among the business community. Many people who do not live in Milford are employed in the city or own a business in the city. As such, they have significant fiscal or emotional investment in Milford. Increased coastal hazard risks could cause interruptions in employment, leading to loss of income and insurance; or interruptions in business continuity, leading to failure of businesses and loss of services that were provided by shuttered or failed businesses. These are all significant social issues, leading to distress for business owners and employees as well as residents. Vulnerable businesses and industries are described further in 3.1.2 and 3.3.

Visitors

Many people who neither live nor work in Milford have a great love of the community and visit often, from boaters and kayakers to hikers and cyclists. More frequent coastal storms, storm surges, and flooding can adversely impact the amenities and natural resources that draw these visitors from out of town, leaving them with fewer options for recreation in Milford. Examples range from a flooded restaurant that can no longer be visited by patrons, to an eroded beach that can no longer accommodate the level of visitors that it previously supported.

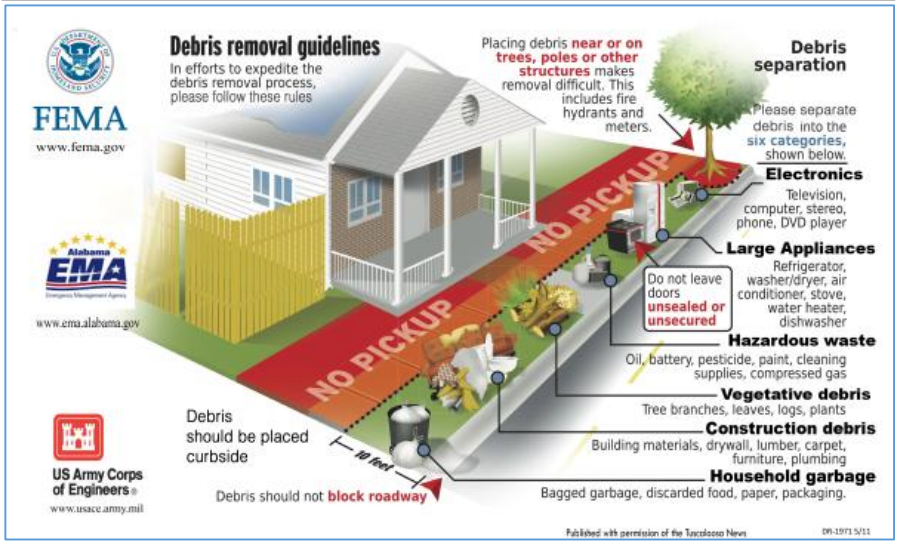
4.1.2 Economic

Residential Properties

Residential properties are directly vulnerable to coastal hazards with regard to flooding and wave action. Waves can destroy a residential structure in very little time. Floodwaters cause massive damage to the lower levels of homes, destroying heating and other equipment, furniture, important papers, and possessions. Wet and damp conditions trigger the growth of mold and mildew in flooded buildings, contributing to allergies, asthma, and respiratory infections. Gasoline, pesticides, sewage, and other aqueous pollutants can be carried into areas and buildings by floodwaters and soak into soil, building components, and furniture.

The costs to clean up a home after flooding can range from less than $10,000 to more than $100,000 depending on the damage. The amount of debris produced by flooding can be staggering. The graphic to the right (courtesy of FEMA) demonstrates the types of debris that can be generated, all requiring disposal and replacement.

Figure 5

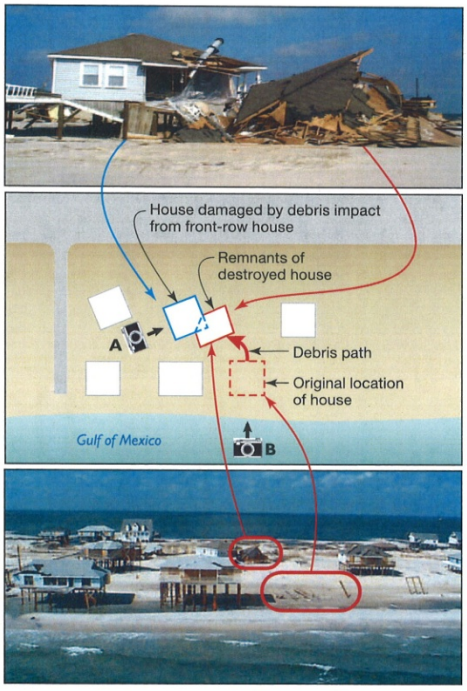


The land surrounding homes is also vulnerable to coastal hazards. Vehicles, pools, landscaping, and outbuildings can be washed away or destroyed. Erosion can alter the ground surface. Animals can be forced out of their natural habitats and into closer contact with people. Wells and septic systems can be damaged or rendered useless as discussed in Section 3.1.4 below.

Figure 6 (courtesy of FEMA) illustrates another type of vulnerability. Debris from a damaged home can be moved by floodwaters or a storm surge and damage a nearby home.

The indirect vulnerabilities to residential properties can be as bad as the direct vulnerabilities. Although a home may be situated above current and future flood elevations, access to the home may be increasingly cut off by flood waters associated with storms or even from normal high tides. Floodwaters can prevent emergency egress by blocking streets, deteriorating municipal drainage systems, and diverting municipal staff and resources. This can leave a home vulnerable to fire or other damage, leading to further economic losses.

Figure 6



Milford's overall tax base is heavily dependent on residential properties, and coastal properties make up a very large percentage of the residential tax base. The loss of a home leads directly to the loss of the taxes collected from the property.

Many of the homes in the near-shore densely populated areas such as Fort Trumbull, Welches Point, Morningside, Woodmont, and even Wildemere, are not at high risk to inundation due to sea level rise, but they are at risk to coastal hazards such as waves and winds, increased damage from storms as sea level rises, and increased frequency of isolation as roads are flooded.

On the other hand, homes in the neighborhoods around Milford Point, Cedar Beach, Laurel Beach, Walnut Beach, Silver Beach, Field Court, Melba Street, Point Beach, and Burwells Beach, may need to address the actual encroachment of sea water under non-storm conditions. Many of those areas already have to manage high tide flooding on a monthly basis. Geographic differences are examined in Section 4.2 of this report.

<u>Commercial/Industrial Businesses</u>

Non-residential commercial and industrial properties are directly vulnerable to coastal hazards with regard to flooding and wave action just as the residential properties described above. Waves can destroy a structure and floodwaters can cause damage. Increased flood frequency and increased flood elevations can inundate assets, equipment, and vital records such as products/merchandise and IT systems on the lower levels of a building; and damage HVAC equipment such as air conditioning units, boilers, furnaces, etc. Wells and septic systems can be damaged or rendered useless as discussed in Section 3.4 below.

A review of FEMA payments to small businesses after federal disaster declarations is quite revealing. Millions of dollars are funneled toward getting businesses back on their feet after floods.

Naugatuck Avenue is an important commercial corridor in Milford, with future redesign and improvements of the area highlighted in the City's 2012 Plan of Conservation and Development (POCD). This plan also references a proposal by the Yale Urban Design Workshop that the public beach in this neighborhood be developed into an entertainment pier. Walnut Beach, at the coastal end of Naugatuck Ave, is a specific area for which redevelopment is encouraged. Much of this area already lies within a Category 2 Storm Surge flood zone, and coastal properties may be at risk under projected sea level rise conditions.

Route 162 near Gulf Pond is also listed in the POCD as an area for focused future economic development. Sea level rise projections show flooding of the road and four or five structures on a daily basis by 2020, with flooding affecting about 15 structures by 2080. A Category 2 storm will cause extensive flooding this area.

The Downtown area includes many restaurants and retail businesses, and much of it is located within the Wepawaug River floodplain. Adjacent Milford Harbor contains several water-dependent businesses such as marinas. Projected sea-level-rise and storm surge impacts on this area are relatively minor in extent, but should still be considered, both because of the potential combined effects of a storm surge and riverine flood, and because of the density of economic development here.

The industrial districts of Milford border I-95, and are mostly outside of vulnerable areas.

The tax base, employment, tourist draw, and potential for future growth, provided by businesses along Naugatuck Avenue and other busy thoroughfares are very important to Milford. The economic implications could include the need to repair damaged facilities, pay for lost wages, and reestablish the areas as tourist destinations.

Water-Dependent Commercial/Industrial Businesses

Water-dependent businesses in Milford include the Milford Yacht Club, Port Milford, Spencer's Marina Inc., Milford Boat Works, and Milford Landing Marina. The Milford Yacht Club is considered a business in this report because it employs people. These businesses will have vulnerabilities that are similar to the commercial and industrial properties described above, but may have higher overall risk by virtue of the fact that they are typically located at the water's edge. Milford does not consider any of its water-dependent businesses to be critical facilities. Though few in number, the water-dependent businesses have an important positive economic impact in the City.

Tourism

Section 3.1.1 described the social vulnerabilities associated with visitors of the City of Milford, many of whom are supporting the tourism industry. More frequent coastal storms, storm surges, and flooding can adversely impact the amenities and natural resources that draw these visitors from out of town, leaving them with fewer options for recreation in Milford. Examples range from flooded restaurants that can no longer be visited by patrons, to eroded beaches that can no longer accommodate the level of visitors that it previously supported.

4.1.3 Infrastructure

With higher sea level or storm surges, roadways may become flooded or inundated more frequently, drainage systems in the roads may become ineffective, and culverts may become ineffective due to poor capacity or because they are situated at an improper elevation relative to rising sea level.

State Roads and Bridges

There are two State roads in Milford that are vulnerable to future sea level-rise and flooding:

- Route 162 / New Haven Avenue
- Route 736 / Buckingham Avenue, Edgefield Avenue, Merwin Avenue

City Roads and Bridges

Significant sections of City roads are vulnerable under a range of future scenarios some of the most significant roads at risk include:

- Naugatuck Avenue
- Milford Point Road
- Seaview Avenue
- Broadway Street
- East Broadway Street
- Viscount Drive
- Surf Avenue
- Rogers Avenue
- Gulf Street
- Old Field Lane
- Field Court
- Bayshore Drive
- Melba Street
- Point Beach Drive
- Beach Avenue
- Seabreeze Avenue
- Anderson Avenue

Small bridges and culverts are located at many locations.

Railroads

In general, the railroad line through Milford has not historically flooded and the potential for it to flood is limited based on the future scenarios. This is because the grade is elevated above the adjacent tidal marshes and other low areas. The only section of track that appears threatened from future sea level rise and storm surges is at the crossing with Gulf Pond. Even there, projected flooding under Category 2 hurricane conditions in 2080s is not mapped as overtopping the tracks.

Stormwater and Drainage

As sea level rises, drainage systems become less effective. Rainstorms will have the potential to cause greater flooding because the stormwater will not as easily be collected and conveyed elsewhere. If the outfall of a drainage system falls below rising water levels in the future, its effectiveness will be limited.

Milford already experiences problems with inadequate storm drainage, with the most common issues occurring at Point Beach and Bayview Beach. As sea level rises, more areas will likely experience decreased drainage capacity and increased risk of flooding.

Tide Gates

Tide gates are somewhat sensitive to elevation and are therefore vulnerable to sea level rise and coastal hazards. The risk of coastal flooding upstream of a tide gate is directly related to the functionality of a tide gate. Therefore it can be difficult to quantify the overall risks associated with a tide gate that will not function as needed during future coastal hazard events or simply as sea level rises.

Seawalls and Bulkheads

The effectiveness of seawalls and bulkheads is directly related to their elevations and construction. Seawalls and bulkheads will become more vulnerable to coastal storms over time as sea level rises. In turn, the properties and structures protected by seawalls and bulkheads will become more vulnerable. The increased vulnerability and increased frequency of storms will cause risk of failure and risk to protected properties to increase over time.

Other Municipal and Institutional Facilities

The Milford Library is presently located within the coastal flood hazard zone as mapped by the TNC tool (under present-day Category-2 storm conditions and greater), and is mapped as being at the edge of the floodplain associated with the Wepawaug River. Milford City Hall lies within the Wepawaug River's floodplain, straddling Zone AE and Zone X (0.2% annual-chance storm).

The Milford Animal Control facility is located at the eastern edge of Silver Sands State Park. Portions of the property are mapped as being within daily high tide zones by the 2020s, and by

the 2080s sections of building will be vulnerable as well. This facility already must be evacuated during some storm events, and future storm surge conditions under sea level rise scenarios will exacerbate the problem.

4.1.4 Utilities

Public Water Systems

Public water supply in Milford is supplied by the South Central Connecticut Regional Water Authority (RWA). Sources of supply are not located in coastal flood hazard or hurricane surge zones; therefore coastal hazard risks are low.

It is conceivable that portions of the system installed in some coastal neighborhoods are close to sea level. The positive pressure maintained in a water system will prevent salt water from entering pipes. However, it is possible that salt water intrusion to fresh groundwater – or into areas that are currently above the groundwater table – could lead to corrosion of pipes. Vulnerability is likely low, but risk could increase over time as sea level rises.

Private Water Supplies

Individual private wells are vulnerable to sea level rise and coastal hazards in two important ways:

- Increased flooding and inundation can contaminate a well by allowing surface water to enter the wellhead or travel downward along the casing, rendering the well unusable until it can be disinfected and flushed.
- Rising sea levels can shift the fresh groundwater/salt water interface inland where it can intersect with wellbores that are currently landward of the interface.

If private wells are not relocated inland and elevated, or replaced by public water systems, then risks will increase over time. Because the City is fully supplied by the RWA, this risk is minimal.

Subsurface Sewage Disposal Systems (septic systems)

Unlike many shoreline communities in Connecticut, Milford does not rely on subsurface sewage disposal systems (septic systems) for sanitary wastewater treatment. Any of these systems that do exist in the City are vulnerable to sea level rise and coastal hazards in two important ways:

- Increased flooding and inundation can flood a system and render it unusable, filling the septic system and galleries and making it impossible for waste to drain away from a home or business. The system can break out and cause contamination at the ground surface.
- Rising sea levels can decrease the vertical separation between the top of the groundwater table and the bottom of the septic system, decreasing the travel time for pathogens and the adsorptive capacity of the unsaturated zone, causing increased groundwater pollution.

Public Wastewater Management

The City of Milford is served by two Wastewater Treatment Facilities. The Housatonic Treatment Plant is located on the east bank of the Housatonic River at the end of Bic Drive. It is not at risk of inundation from less than a Category 3 Hurricane, and is not considered vulnerable. The Beaver Brook Treatment Plant is located next to the Charles E Wheeler Wildlife Area at the mouth of the Housatonic River, off Deerwood Avenue. It is projected to be safe from daily high tide through projected 2080s sea level conditions, but risks flooding during Category 2 storms.

A significant vulnerability to Milford's wastewater system lies within its wastewater pumping stations. Many of these pumping stations lie at low elevations, and risk failure during future high tides or storm events. Table 3 summarizes the vulnerabilities of Milford's coastal pumping stations. The column titled "SFHA" indicates which FEMA-designated Special Flood Hazard Area each station falls within, if any. The other columns indicate the degree of confidence given by TNC's Coastal Resiliency Mapping Tool that each station will be inundated under future conditions (Daily, Category 2 Storm event ("Cat 2"), Category 3 Storm event ("Cat 3"). The "medium" projection was used for this table. Cells are color-coded for emphasis.

Table 3

Pump Station Location	Likelihood of Flooding											
	Present Day			2020s			2050s			2080s		
	SFHA	Cat 2	Cat 3	Daily	Cat 2	Cat 3	Daily	Cat 2	Cat 3	Daily	Cat 2	Cat 3
Pumpkin Delight Road	No	No	No	No	No	No	No	No	No	No	No	No
Holly Street	No	No	No	No	No	No	No	No	No	No	No	No
Naugatuck Ave.	No	No	No	No	No	No	No	No	No	No	No	No
West Ave.	AE	No	No	No	No	No	No	No	No	No	No	No
Kinlock Street	AE	Med	High	Low	Med	High	Low	High	High	Low	High	High
West Mayflower Place	AE	No	Med	No	No	Med	No	Low	Med	No	Low	High
East Broadway	AE	Med	High	Low	High	High	Low	High	High	Low	High	High
Cricklewood	No	No	No	No	No	No	No	No	No	No	No	No
White Oaks Terr.	No	No	No	No	No	No	No	No	No	No	No	No
Captains Walk	AE	Low	Low	No	Low	Med	No	Low	High	No	Low	High
Adams Ave.	AE	Low	High	No	Low	High	No	Med	High	No	Med	High
Buckingham Ave.	No	Low	Med	No	Low	Med	No	Low	Med	No	Low	High
Roger's Ave.	No	High	High	Low	High	High	Low	High	High	Low	High	High
Oldfield Lane	AE	High	High	Low	High	High	Med	High	High	High	Med	High
New Haven Ave.	No	Low	Med	No	Low	Med	No	Low	Med	No	Low	High
Gulf Pond	AE	Low	High	No	Low	High	No	Med	High	No	Med	High
Welch's Point	No	Low	Low	No	Low	Med	No	Low	Med	No	Low	Med
Carmen Road	AE	Med	High	Low	High	High	Low	High	High	Low	High	High
Morningside	VE	No	No	No	No	No	No	No	No	No	No	No
Rock Street	AE	Med	High	No	Med	High	No	Med	High	No	High	High
Flax Mill Road	AE	No	No	No	No	No	No	No	No	No	No	No
Old Gate Lane	No	No	No	No	No	No	No	No	No	No	No	No
Roses Mill Road	X500	No	No	No	No	No	No	No	No	No	No	No
Kurt Volk	AE	No	No	No	No	No	No	No	No	No	No	No
Live Oaks	AE	No	Low	No	No	Med	No	No	Med	No	No	Med
Crowley Ave.	No	No	No	No	No	No	No	No	No	No	No	No
Milford Point	No	No	Low	No	No	Med	No	No	Med	No	No	Med
Sailor's Lane	VE	Low	Med	No	Low	Med	No	Low	Med	No	Low	High
Mathews Street	AE	Low	Med	No	Low	High	No	Low	High	No	Low	High
Viscount Dr.	AE	Low	High	No	Low	High	No	Med	High	No	Med	High
Ryder's Woods	X500	No	No	No	No	No	No	No	No	No	No	No
Watrous Lane	X500	No	No	No	No	No	No	No	No	No	No	No
Housatonic Plant	No	No	No	No	No	No	No	No	No	No	No	No
Beaverbrook Plant	AE	Low	Med	No	Low	High	No	Low	High	No	Low	High
Post Road	AE	No	No	No	No	No	No	No	No	No	No	No
Anderson Ave.	AE	Low	Med	No	Low	High	No	Low	High	Low	Med	High
Zion Hill	No	No	No	No	No	No	No	No	No	No	No	No
Wanda Road	AE	No	Low	No	No	Low	No	No	Low	No	No	Med
Ford Street	No	No	No	No	No	No	No	No	No	No	No	No

The following is a list of the locations of Milford's most vulnerable pumping stations:

- Kinlock Street
- East Broadway (at Silver Sands State Park)
- Captain's Walk
- Adams Avenue
- Rogers Avenue
- Oldfield Lane
- Gulf Pond
- Carmen Road
- Rock Street
- Sailor's Lane
- Mathews Street
- Viscount Drive
- Beaverbrook Plant
- Anderson Avenue

Electricity

The greatest threats to the electrical grid associated with increased coastal hazards are wind-related. These are not directly addressed in this report. However, increased incidence and duration of flooding can reduce the capability of Milford's energy provider United Illuminating Company (UI), to respond to outages caused by downed wires and blown transformers. For example, a utility crew could have difficulty traversing a flooded intersection to reach a coastal neighborhood where downed wires have caused a loss of power. Risks will increase over time, as the vulnerability of overhead power lines is unlikely to decrease without a concerted effort to bury electrical lines.

In addition, it is possible that increased flooding and sea level rise can affect low-lying or buried electrical lines directly. Locations of buried utilities are not documented in a manner that allows for a rapid assessment of vulnerabilities to flooding.

Telecommunications

Wired telecommunications systems such as cable television and internet will have vulnerabilities and risks that are identical to those described above for electricity. Wireless telecommunications systems are dependent on towers, antennas, and satellites and therefore lack any direct vulnerability to coastal hazards (except for winds). However, the loss of electricity and a reduced capacity for United Illuminating Company to respond due to flooding could impact wireless telecommunications systems that require electricity to operate.

4.1.5 Emergency Services

Fire, Police, and Emergency Healthcare Facilities

None of Milford's fire or police stations are located in coastal hazard zones. The West Side Fire Station is located off of Naugatuck Avenue, Fire Headquarters are on Route 162 in Milford Center, and the East Side Fire Station is at the corner of Route 162 and Settlers Ridge Road. There are also stations near Fort Trumble, Point Beach, and north of Route 95. Milford Police Headquarters are on Route 1 near Milford Center. Milford Hospital is west of the city center on Route 162.

The vulnerabilities of Milford's emergency response services do not lie in direct threats to the structures, but rather in the vulnerabilities of the routes to and from those facilities. The areas east of Gulf Pond – Knobb Hill, Bayview, Point Beach, Morningside, Burwells Beach, and Woodmont, for example – risk being cut-off from the *most direct* routes to and from Milford Hospital and Police Headquarters if Route 162 is flooded, though other roads would be available for travel. Inundation of Route 736 would further isolate Point Beach and Morningside from emergency services.

Shelters and Evacuation Routes

Emergency shelters are considered to be an important subset of critical facilities as they are needed in emergency situations. City officials have designated four buildings as community shelters. All shelters appear to be outside any future flood scenario, though one of the roads to the Joseph A Foran High School shelter may be flooded in a 2050s category 2 Hurricane scenario. Because the buildings are unaffected, overall risk is low.

As described in the previous section, some sections of the City risk being isolated from emergency services during flood events. This is also true for access to emergency shelters and general evacuation routes. The layout of the city is such that even if major roads are impassable, other routes should remain open for most residents. Areas of the City vulnerable to isolation include Milford Point, Silver Beach, Knobb Hill, and Welches Point under only the most extreme (2080s category 3 storm) scenarios, and the Morningside neighborhood (everything east of Calf Pen Meadow Creek) under 2050s category 2 storm conditions. If the Calf Pen Meadow Creek crossings of route 736/Buckingham Avenue and Pond Point Avenue are both rendered impassible, this very large piece of the city could be inaccessible. This is an important secondary risk in the context of sheltering and emergency services.

4.1.6 Natural Systems

Tidal Wetlands

Milford's tidal marshes, more broadly known as tidal wetlands, are undergoing a transformation as sea level rise, erosion, altered tidal flushing, invasive species, and "sudden marsh dieback" collectively work toward degrading the marshes from all sides. These issues are often

interrelated, but this report focuses on the loss of marshes due to sea level rise and increased coastal hazards.

Some of the notable tidal wetland systems in Milford include the Charles E. Wheeler Wildlife Area, the Silver Sands State Park and Charles Island Natural Area Preserve, Gulf Pond, Calf Pen Meadow, and Oyster River. Numerous other pockets of marshes are found throughout the city.

Subsidence or drowning of tidal wetlands will occur as a result of sea level rise because they can no longer accumulate peat fast enough to stay above sea level. In Connecticut, the effect depends on location. Sea level rise appears to be altering the zonation of plant communities in southeastern Connecticut, where the tidal range averages 0.75 meters (approximately two feet). Studies have documented that at least two marsh systems are currently not keeping up with sea level rise. On Connecticut's western shore, with a tidal range of up to two meters (approximately six feet), extensive areas of low marsh vegetation have been drowned (e.g., Five-Mile River, Norwalk).

One effect of sea level rise is the tendency for marsh systems to migrate landward where they are able to do so. In developed areas where seawalls, lawns, and other structures are at the existing edge of the marsh, landward movement will be limited. The basic assumption is that some high marshes will become low marshes. Many marshes will be submerged by the 2020s. In the 2050s scenarios, uplands will be wet. In the 2080s, water will have moved past marshes. Although it is believed that some marshes will be able to advance, a net loss is anticipated. In some cases, marshes may advance into City-owned and private property.

Other Coastal Landforms

Several of Connecticut's coastal landforms are found in Milford and are vulnerable to coastal hazards in different ways.

- Rocky Shorefronts are shorefronts composed of bedrock, boulders, and cobbles that are highly erosion resistant and are an insignificant source of sediments for other coastal landforms. Milford has many rocky shorefronts, and these landforms are already resilient to coastal hazards. Homes that sit atop rocky shorefronts are seldom subject to coastal wave action and will not be subject to daily inundation due to sea level rise.
- Beaches and Dunes are beach systems including barrier beach spits and tombolos, barrier beaches, pocket beaches, land contact beaches and related dunes and sandflats. In general, beaches are dynamic areas abutting coastal waters that are characterized by sand, gravel, or cobbles. These areas are vulnerable to coastal hazards and sea level rise, and the risks of erosion and loss of beaches and dunes will increase over time. This is true for both small natural beaches and the larger maintained beaches.
- Intertidal Flats are very gently sloping or flat areas located between high and low tides composed of muddy, silty, and fine sandy sediments and generally devoid of vegetation. Milford's intertidal flats are sensitive to the tidal cycle and tidewater elevations, and therefore are vulnerable to coastal hazards and sea level rise. Although the risk of losing

these flats will increase over time, new flats will likely form where beaches and tidal wetlands were once located.

- An Estuarine Embayments is a protected coastal body of water with an open connection to the sea in which saline sea water is measurably diluted by fresh water including tidal rivers, bays, lagoons, and coves. Estuaries are sensitive to the tidal cycle and tidewater elevations, and therefore are vulnerable to coastal hazards and sea level rise. Like the tidal wetlands lining these estuaries, the estuaries will need to migrate inland to keep up with rising sea level. Much of this migration will not be readily visible, because the salt water/freshwater mixing zone will simply move upstream into the rivers.

4.2 Vulnerabilities by Region

The following sections summarize the hazards presented by current and future daily-high-tide and hurricane conditions to different neighborhoods and areas of Milford. The expected extent of flooding from sea level rise and storm surge effects was determined using The Nature Conservancy's Coastal Resilience Mapping Portal, as described in section 2.3.2. It is important to note that these projections are predictions of future conditions based on currently available data. The most immediate projections (those of conditions in the 2020s) have the highest level of confidence, which uncertainty increasing farther in the future. In each map, the darkest blue indicates the highest level of confidence, and the lightest indicates the lowest level.

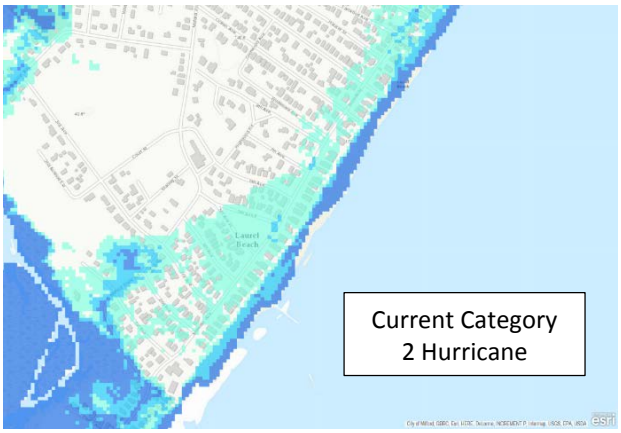
Milford Point / Cedar Beach

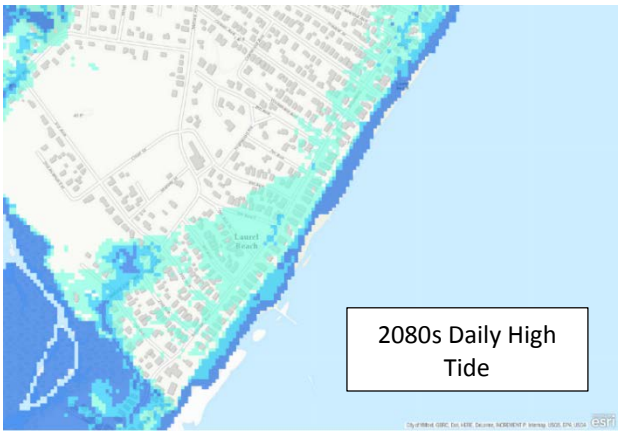
This residential neighborhood lies on a sand spit southeast of the Charles E Wheeler Wildlife Area ("Wheeler") and east of the mouth of the Housatonic River. The neighborhood is within a FEMA Flood Insurance Rate Map (FIRM) designated coastal VE zone (velocity zone, or high hazard zone). As such, all of the homes here are required to be elevated above flood levels. For this reason, the structures themselves are relatively protected from coastal inundation. The neighborhood's roads are expected to flood often under future sea level rise scenarios, however, causing access issues. The structures may also be vulnerable to higher flood elevations with sea level rise.

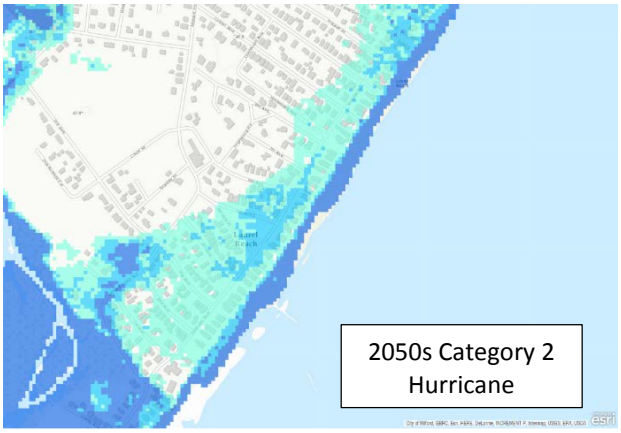
Laurel Beach

Projections show Laurel beach experiencing minor inundation issues during daily high-tide during the 2020s decade. Milford Point Road may be flooded during exceptionally high tides at its southern extent. Other impacts will be limited to the beach. By the 2080s, vulnerable areas in this neighborhood will have expanded. The section of Milford Point Road affected by daily high tide flooding will extend northward to 2nd Ave, where a significant section of an open-space parcel will also be flooded regularly. Very high tides may also inundate sections of Broadway Street near Wildwood and Fairwood Avenues. Daily flooding may also impact around 9 structures in the southern section of the neighborhood.

Under current conditions, a Category Two Hurricane is expected to inundate much of Milford Point Road up to 3rd Ave, most of the neighborhoods between Milford Ave and the Sound from 3rd to 7th Avenues, and homes on either side of Broadway Street moving northward. Over 150 structures would be impacted. In the 2020's, a storm of the same size will impact a slightly larger area, adding around 15 structures to the overall number at risk. By the 2050's, a category 2 storm will flood most of the properties on 1st, 2nd, and 3rd avenues that were previously expected to remain unflooded. The extent of flooding along the rest of Broadway Street along Laurel Beach will extend a couple of houses inland. Around 42 additional structures are projected to be impacted.







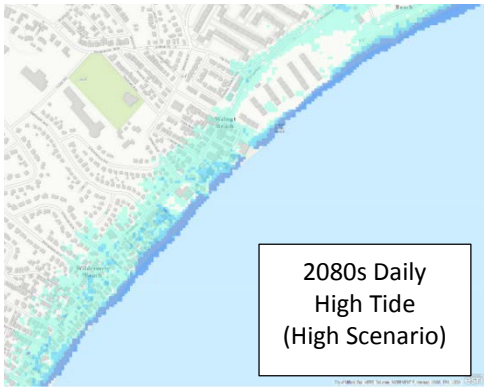
Under High sea-level-rise projections, daily high tide flooding in the 2080s will impact an area similar to that affected by a present-day Category 2 Hurricane.

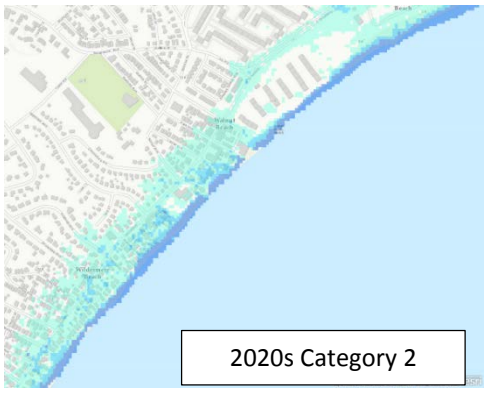
There is one sewer-pumping station off of 1st Ave that is vulnerable to storm surge and 2080s high tide. The neighborhood between 8th and Wood Ave is Low-to-Moderate-Income. Many of the homes is these neighborhoods are not elevated. Many seaside homes do not have seawalls, but do have fairly significant areas of beach in front of them. During 2050s hurricane surges, and possible during daily high tide flooding by the 2080s, inundation

of Milford Point Road could isolate much of the Laurel Beach neighborhood, as well as the entire Smith's Point peninsula to the south.

Wildemere Beach

In the 2020s, the corner of Wildwood Ave and Broadway, and a small section of Ann Street (on the coastal-side of Broadway farther north), may be inundated during high tide. Additionally, 2020s projections show the inland migration of the ocean reaching the edges of a handful of beachside homes, already protected by seawalls, between Smith Ave and Bridgewater Ave. By the 2080s, Bittersweet Ave, Kirkside Ave, Smith Ave, and much of the rest of the short Ann Street, are expected to be flooded on a day-to-day basis. Around fifteen structures are expected to experience regular flooding, including those between Smith and Bridgewater, and the three beach-side homes between Stowe and Laurel.





During a category 2 Hurricane under current conditions, the entire area on the beach-side of Broadway, from Naugatuck Ave south to Laurel Beach, is expected to be inundated. Flooding extends three or four parcels inland from Broadway as well. To the north, all of East Broadway is expected to be flooded, impacting an apartment complex between East Broadway and Shwecky Beach Way, at the corner of Joy Road. Most of the other apartment complexes in this neighborhood are not projected to experience flooding. Using the Medium sea-level-rise scenario, category 2 storm conditions will not be significantly different in the 2020s than today. By 2050, however, inundation extent is projected to have increased such that four of the larger apartment buildings along the Walnut Public Beach will be impacted, as well as a number of smaller townhouses on the inland side of East Broadway. Generally, **flooding is expected to move inland by two or three additional parcels** all along Broadway. Over 250 structures of various sizes are projected to experience some degree of inundation.

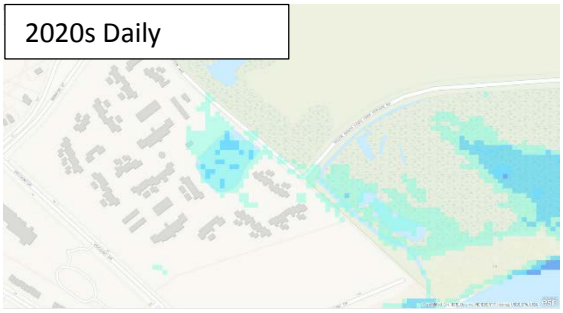
There are about 55 repetitive-loss-properties in this area, with five of them being severe-repetitive-loss. A sewer-pumping station in the northeast corner of the neighborhood, at the Walnut Beach parking lot, is vulnerable to storm surge and 2080s daily high tide. The neighborhood between 8th and Wood Ave is Low-to-Moderate-Income.

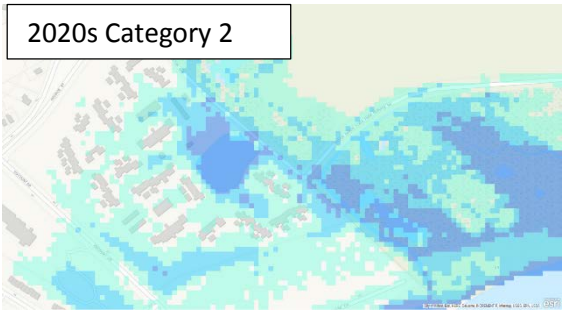
Walnut Beach

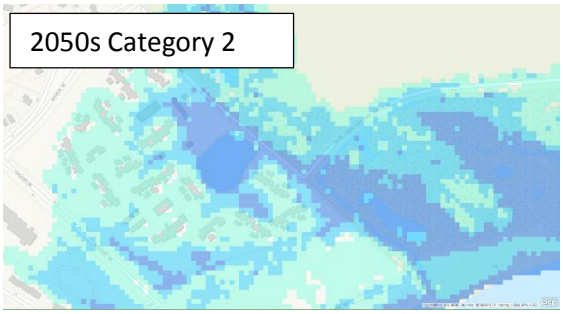
A large condominium complex east of Viscount Drive is at risk of inundation from a wetland in Silver Sands State Park, east of the closed Nettleton Road. In the 2020s, flooding from high tide may impact the low-lying recreational areas of this complex (the pond, pool, and tennis courts). By the 2080s, daily flooding is projected to entirely cover the tennis courts, pool, and one parking lot, as well as two different sections of the complex driveway and one building that appears to be some sort of office.

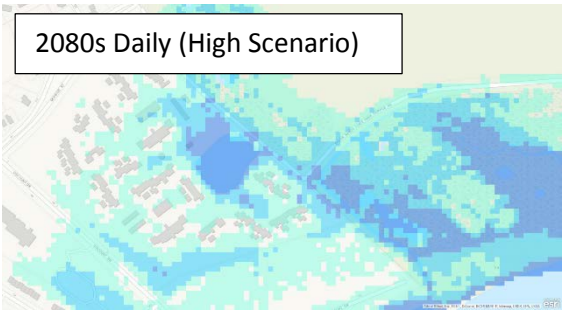
A present-day category 2 hurricane should flood much of the complex, with the exception of the section to the northwest. The Coastal Resilience Mapping Tool shows pockets of unflooded areas around most of the buildings in the complex indicating they may be constructed on slightly higher ground, and may be somewhat protected. By the 2050s the unflooded pockets will disappear, and inundation will extend into all but the most northerly section of the complex.

Using the highest sea level rise scenario, daily high tide inundation will have a similar extent as a present-day category 2 hurricane.









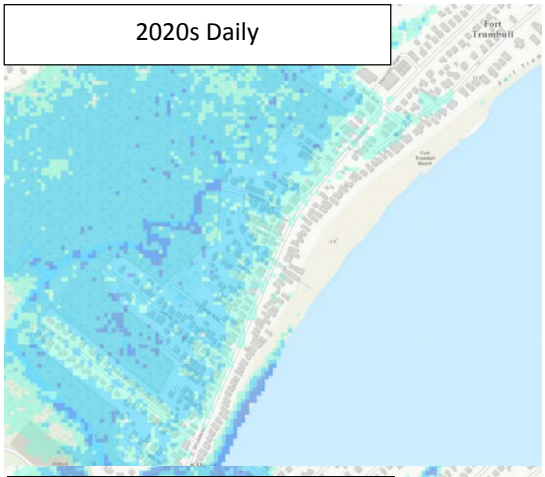
Silver Beach

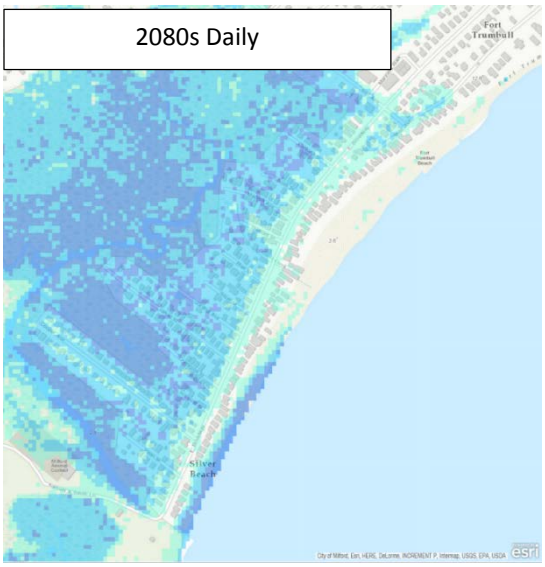
By the 2020's, this entire neighborhood is projected to experience daily flooding on the inland side of East Broadway, impacting over 200 homes, including many located along the finger roads north of East Broadway. Most of the road itself should remain free of water, except the intersection with Surf Avenue and a few other isolate spots in the neighborhood. Most of the beach in the southern edge of the neighborhood, near the tide gate, will be underwater at high tide. In the 2080s, all of East Broadway is also expected to be inundated daily, as are many of the homes on the beach-side of the road, especially along Shell Avenue.

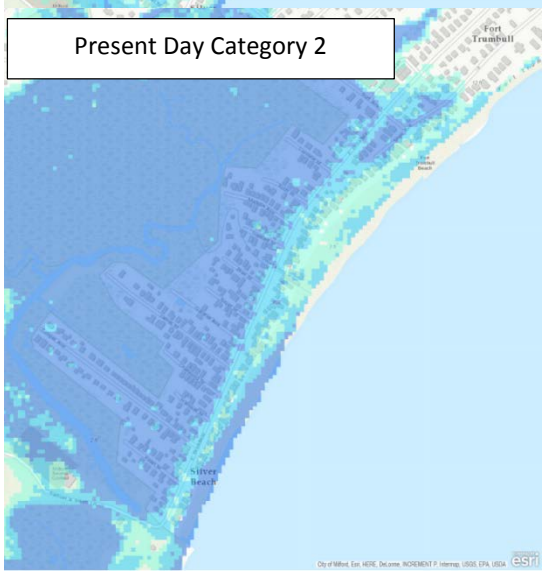
The Milford Animal Control facility is also located in this area. By the 2080s sections of building will be vulnerable to daily high tide flooding. This facility is already vulnerable to storm surge flooding, and must be evacuated during some storm events. This exacerbates challenges related to sheltering of household pets during emergency events.

The entire peninsula will become inundating under present-day Category 2 storm conditions. Confidence levels increase in the 2020s and 2050s, but there are no areas left for the inundation zone to expand.

Most of the properties in this neighborhood are repetitive loss properties (RLP). Homes are not consistently elevated, though many are. The neighborhood is served by public utilities. A Sewer Pump Station at the eastern edge of Silver Sands State Park will be vulnerable to high tide flooding as soon as the 2020s. The tidegate under East Broadway controls drainage for the entire tidal wetland associated with Great Creek, located northeast of Silver Sands State Park.







Fort Trumbull

This neighborhood marks the western edge of Milford Harbor. It lies at a relatively high elevation and is not vulnerable to coastal inundation, even under 1% annual-chance storm wave setup and runup conditions. The neighborhood is fronted to the south by Trumbull Avenue, which is currently protected by a seawall and riprap, but which is vulnerable to erosive forces.

Downtown

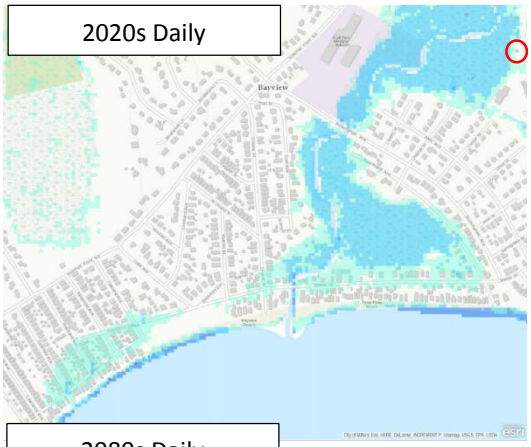
Downtown here is defined roughly as the area between State Route 162 to the south and State Route 1 to the North along the Wepawaug River. Coastal flood hazards are typically limited to the southern limit of this area, just south of Route 162 around the Milford Library and Wilcox Park. However, some key sections of downtown Milford are located within the FEMA mapped floodplain of the Wepawaug River, including structures that fall within the 0.2% annual-chance flood zone, the 1% annual-chance flood AE zone, and even the mapped floodway. These structures are vulnerable to flooding from that source.

Gulf Beach and Welches Point

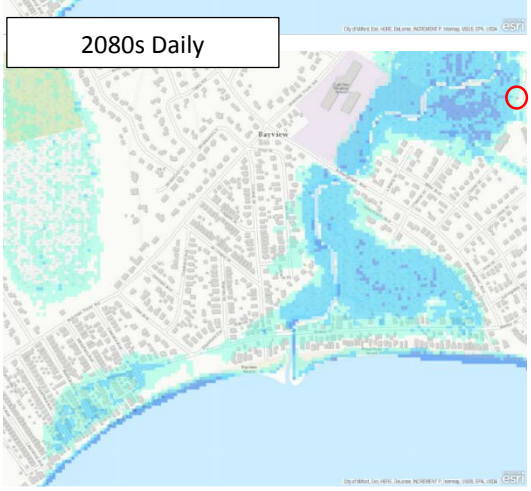
This neighborhood to the east of the mouth of Milford Harbor and Gulf Pond is located at a relatively high elevation, and is not vulnerable to future increases in daily high tide due to sea level rise. A key vulnerability that does exist here is Gulf Beach Road, which runs right along the shore for much of the neighborhood. Erosive forces are a concern here, and the road is protected by rip-rap. Higher sea level will increase this hazard. Gulf Beach itself is also vulnerable to sea level rise. Beach nourishment is an ongoing project at this site, as described in Appendix A.

Bayview and Calf Pen Meadow Creek

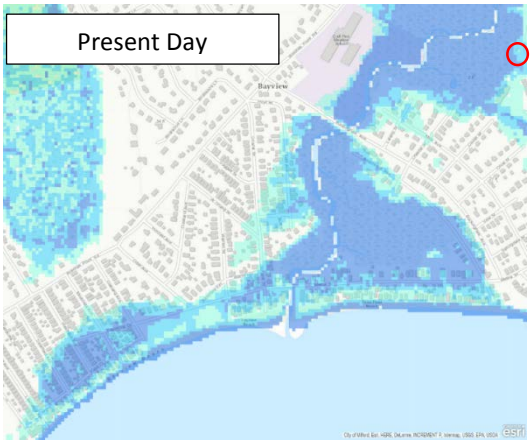
There are two main sections of the Bayview neighborhood impacted by future sea levels and storms: the Field Court area and the Melba Street area. 2020s daily high tide is projected to flood Field Ct, Bayshore Dr., and most of the structures between those roads, as well as homes on the beach side of Field Ct and the homes between Deerfield Ave and Westland Ave, as far inland as Bayshore Dr. At Melba St, the road itself and the homes on the inland side of the road are projected to experience inundation by the 2020s. By the 2080s, the first row of houses to the north of Bayshore Dr, and all of the houses on the beach side of Field Ct, will be flooded daily. At Melba St, flooding will expand to impact homes south of Warren Dr and on both the eastern and western edges of the Calf Pen Meadow Brook wetland north of Melba Street.



Under Category 2 Storm conditions at present-day sea level, flooding extends southwest to 1st Ave, covers homes inland of Bayshore Dr. along the roads entire length, north along Orland Street to West Orland St, and along both sides of East Ave and Beachland Ave. All of the homes on the beach side of Melba St, which have not been flooded under the other listed scenarios, are flooded under current category 2 conditions. Inundation extends even further by the 2050s and 2080s, but not significantly.



Most of the homes on Melba St are RLP, and are also elevated. Both of these neighborhoods are served by public utilities, so neither drinking water wells nor septic systems are at risk. Sixty-three homes in the Bayshore Dr. neighborhood are RLP, and 12 of those are severe RLP. Homes are largely elevated. Oceanside homes in both neighborhoods are fronted by some beach, and often are fronted for protected by seawalls. A sewer pumping station is located in the northeast section of this area, off of Carriage Ln and adjacent to the Calf Pen Meadow wetland (circled in red, below). It is vulnerable to 2080s high tide and storm surges in all scenarios. Buckingham Ave is a fairly significant connecting road that is vulnerable to storm surge.



Point Beach Neighborhood

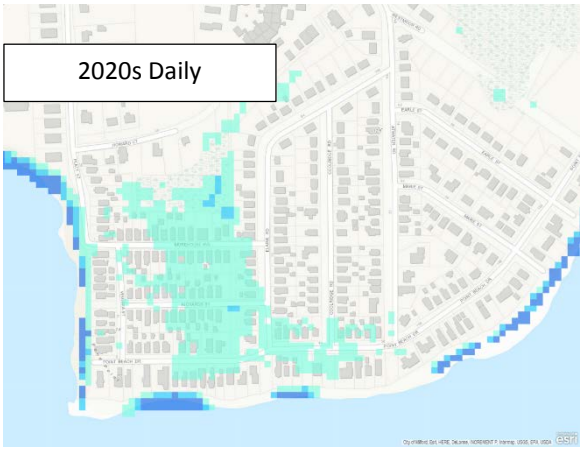
This neighborhood is characterized by a fairly steep-sided "bowl" shape, with the lowest-elevation land surface towards the center, surrounded by higher-elevation areas. The effect this has is to confine flooding to an area that remains relatively constant even under increasing sea level scenarios and storm surge conditions.

2020's high tide is predicted to flood a swath of homes from the wetland north of Morehouse Ave down to Point Beach Drive, as well as homes on both sides of Point Beach Drive eastward to Atwater Road. Approximately 60 homes are expected to be impacted by inundation under these conditions. The area affected by daily high tide expands by the 2080s to reach Virginia Street to the west and Elane Road to the East, as well as to a number of homes north of Morehouse Ave. Under present day conditions, a Category 2 Storm will inundate the beaches to the west and south of the neighborhood that remain unflooded under the previously listed scenarios. The area of flooding also extends farther north at the eastern extent, along Atwater Road, while not expanding significantly farther east. Category 2 Storm flood extents are not predicted to expand much in this neighborhood with increased sea level rise in the 20s and 50s, due to the neighborhood's "bowl" shape as described in the previous paragraph.

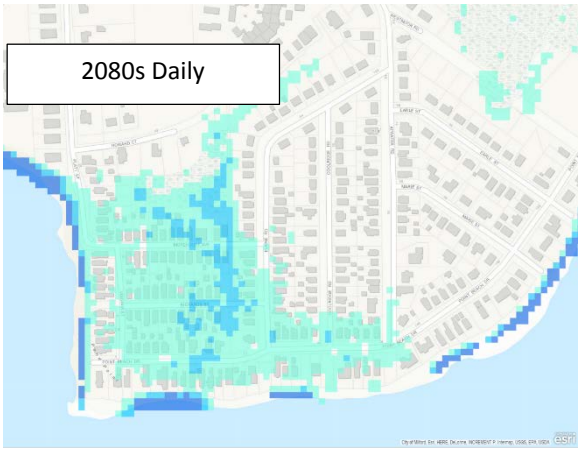
Elevated Home
Point Beach Drive

Most, but not all, of the homes in this neighborhood are elevated. The neighborhood is served by public utilities, so neither drinking water wells nor septic systems are at risk. Seventy-seven of the homes in this neighborhood are repetitive-loss properties. Three of those are severe-repetitive loss. All of the beach-side homes have seawalls that offer some degree of protection from wave action and high water. This neighborhood is classified as low-to-moderate income.

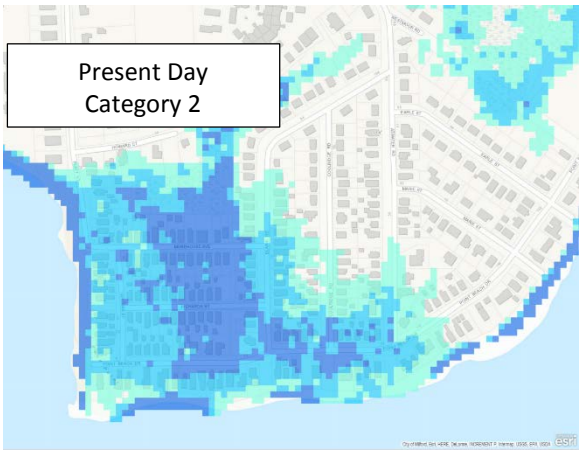
Elevated Home next to Unprotected Home Morehouse Ave



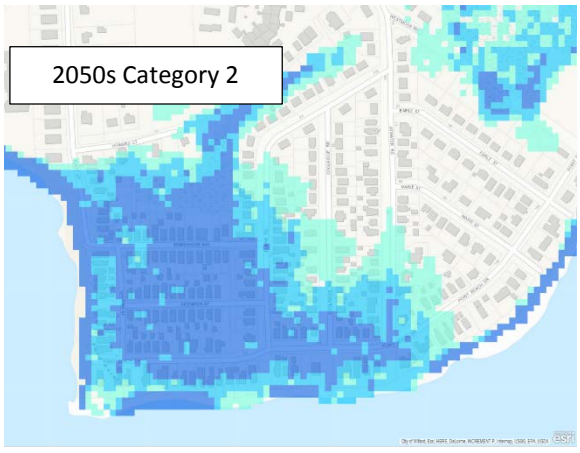
2020s Daily



2080s Daily



Present Day Category 2



2050s Category 2

Morningside

Similar to Fort Trumbull, this neighborhood is higher in elevation and fronted by a road (Morningside Drive). The area is not vulnerable to flooding, but the wall- and riprap-protected road may be vulnerable to erosion.

Hillside

The Hillside neighborhood is also higher in elevation and protected from flooding, but private residences front the Sound, rather than a public road. These homes may be vulnerable to wave setup and runup, as well as to erosion.

Burwells Beach

This neighborhood is lower in elevation, fronted by a cove and backed by a tidal wetland. Inundation from both pose a threat under future sea level rise conditions, although vulnerabilities are low until the 2080s. The road (Merwin Avenue / State Route 736) may be more vulnerable to future flooding than the homes.

Woodmont

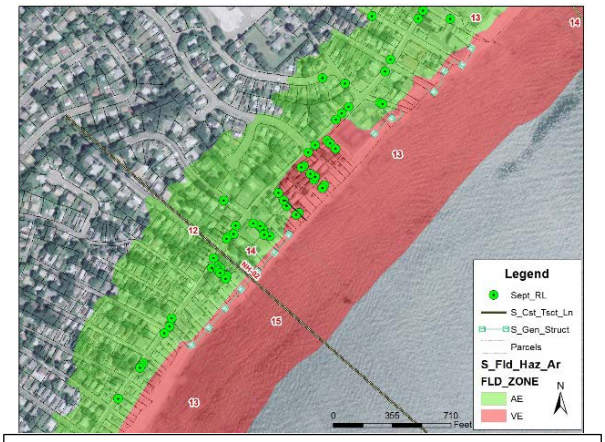
The southern edge of Woodmont (including Anchor Beach and Crescent Beach) consists of waterfront homes built on high bedrock outcrops, which are not vulnerable to inundation or erosion. The small pockets of beach in the area are susceptible to sea level rise and erosion even under present day conditions. The eastern edge of Woodmont has a wide nourished beach, and is not projected to be vulnerable to inundation under future sea level rise scenarios.

4.3 Wave Setup and Runup Hazards

Recall that wave setup and runup can increase the height of floodwater above the "stillwater" elevation, and that the extent of those effects are related to the topography of the coastline at a particular location. The TNC Coastal Resilience Mapping Portal is not able to capture these details, so further analysis was performed with wave modeling software used by FEMA and USACE, as described in section 2.3.3.

These modeling tools determine the effects of waves through analysis of topographic transects. There are five FEMA topographical transects along the Milford coastline that are at or near locations with significant concerns about coastal hazards. These are located at Wildemere Beach, Walnut Beach, Silver Beach, Melba Street, and just east of Point Beach. It is important to note that the conditions at a given transect may not reflect those at adjacent properties. Further analysis would be required to verify or correct the results for areas currently without transects.

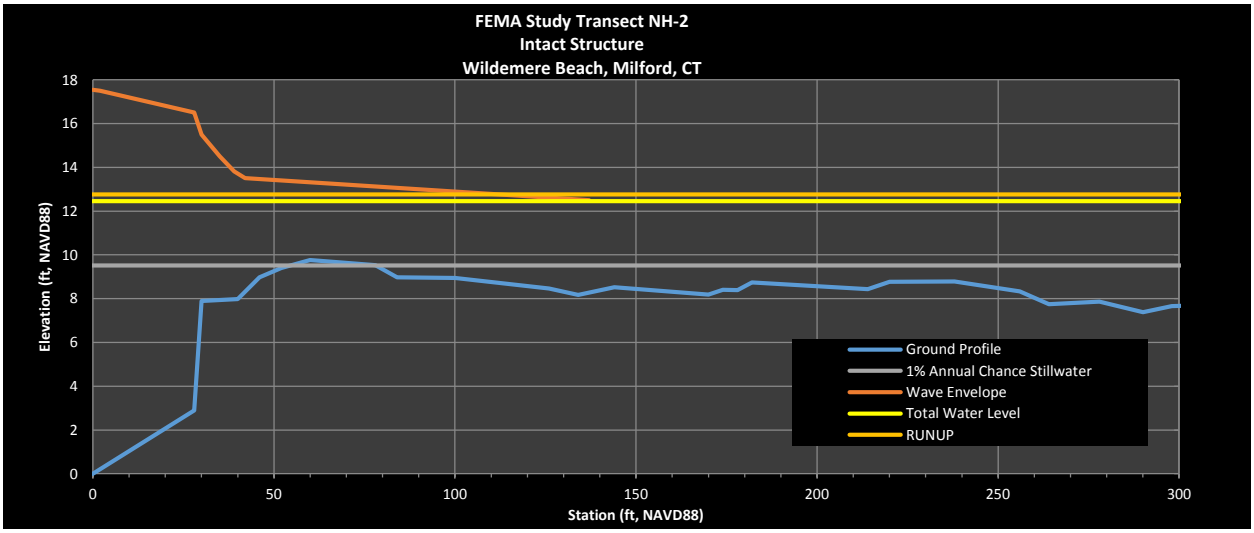
Wildemere Beach (FEMA transect NH-02)



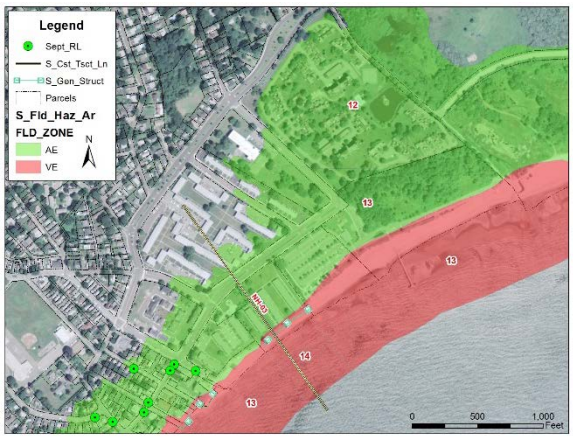
Wildemere Beach FEMA transect and DFIRM

This transect shows a fairly steep rise in the ground surface moving inland from Long Island Sound, followed by a vertical jump where the transect crosses an intact, six-foot vertical concrete bulkhead. The land surface peaks at about 10 feet NAVD-88 and slopes gently inland, dropping to 8 feet elevation after a distance of 200 feet. While the 1%-annual chance storm stillwater elevation is below the ground surface, both of the models described in section 2.3.3 (the FEMA and the USACE model) show setup and runup overtopping the wall and the maximum land elevation, inundating inland areas.

Study	Annual-Chance Storm (elevation values in feet NAVD88)				
	10%	2%	1%	1 % with setup	0.2%
FEMA Coastal Hazard Analysis Program	7.4	8.9	9.5	11.72	10.8
USACE Advanced Circulation Model (all values include wave setup)	8.4	10.1		11.1	14.1



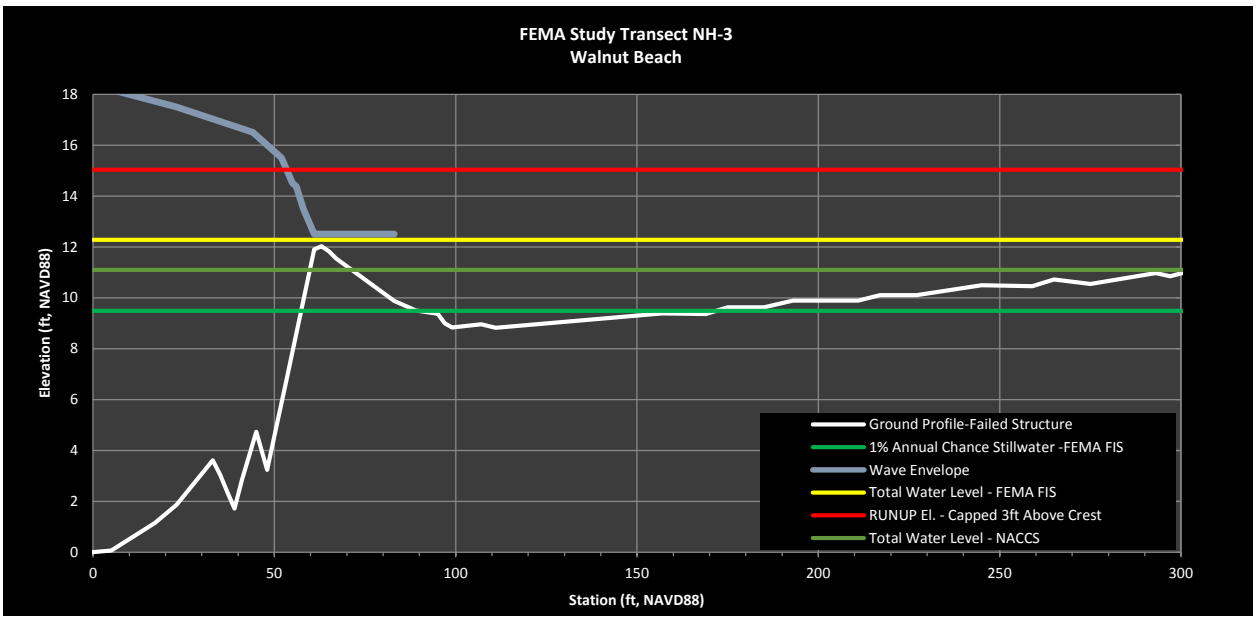
Walnut Beach (FEMA transect NH-03



Walnut Beach FEMA transect and DFIRM

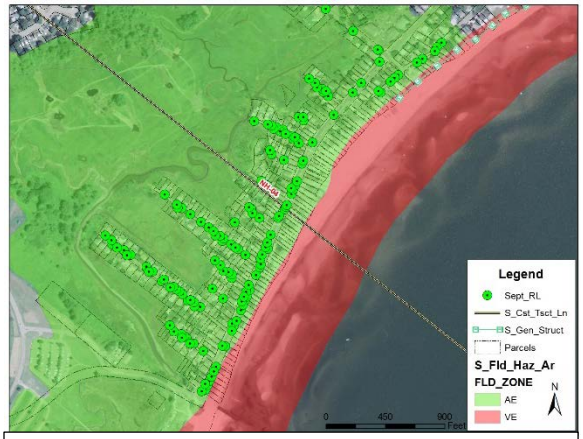
The Walnut Beach transect reflects a sandy beach backed by a shore protection structure[2]. Ground surface elevations rise quickly to 12 feet elevation (NAVD-88), then drop quickly again down to 9 feet elevation. Inland from that the ground surface rises gently. The beach and protection structure are expected to defend against most wave action, but overtopping due to runup is expected by the FEMA model under 1%-annual-chance storm conditions. The USACE ADCIRC model shows runup reaching 11.1 feet, just below the top of the shore protection, under the same conditions.

Study	Annual-Chance Storm (elevation values in feet NAVD88)				
	10%	2%	1%	1 % with setup	0.2%
FEMA Coastal Hazard Analysis Program	7.4	8.9	9.5	12.3	10.8
USACE Advanced Circulation Model (all values include wave setup)	8.4	10.1		11.1	14.1



[2] The FEMA transect describes a structure that is failing or has failed at this transect, however this report in no way assumes that failure of a structure has occurred, nor is any property with a failed structure identified.

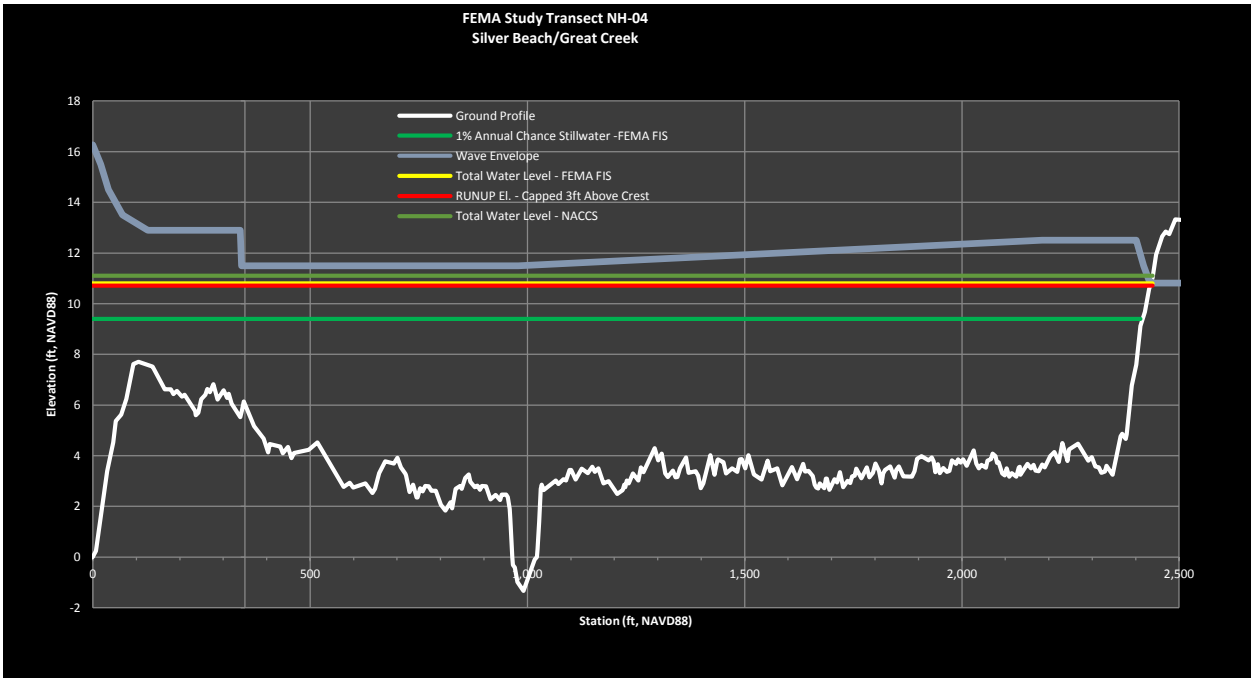
Silver Beach (FEMA transect NH-04)



Walnut Beach FEMA transect and DFIRM

This transect is especially long, extending from the shoreline, up a steep beach with no protective structures, over a high land elevation of less than 8 feet NAVD-88, down and across the tidal wetland associated with Great Creek, and up again on the far side to meet Mayflower Place. It shows extensive low-lying coastal zone before Mayflower Place which is inundated by the 1%-annual-chance storm stillwater elevation. Wave setup and runup, and wave height, add a couple extra feet of elevation to the flood water level, though wave height is tempered by the beach and wetland. Wave action is modeled as increasing over the Great Creek wetland, but not significantly enough to impact Mayflower Place. The most significant hazard in this area is high water and wave action on the shorefront.

Study	Annual-Chance Storm (elevation values in feet NAVD88)				
	10%	2%	1%	1 % with setup	0.2%
FEMA Coastal Hazard Analysis Program	7.4	8.8	9.4	10.8	10.8
USACE Advanced Circulation Model (all values include wave setup)	8.4	10.1		11.1	14.1

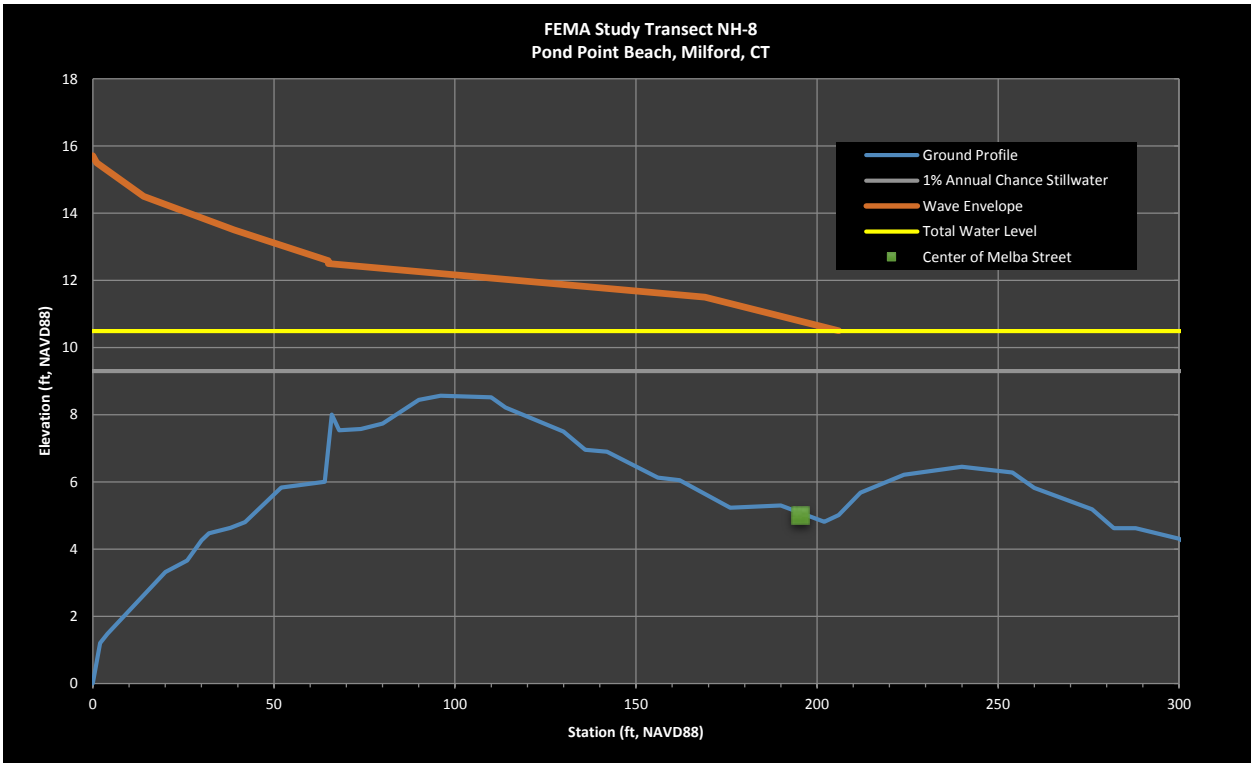


Melba Street (FEMA transect NH-08)

Melba Street and Point Beach FEMA transects

The transect here shows a gradual rise up the shoreline, a short vertical concrete wall, and a peak land elevation of over 8 feet NAVD-88. Elevation drops off inland of this peak, reaching a minimum at Melba Street of about 5 feet, rising again to over 6 feet, and then dropping off a final time as the transect reaches the Calf Pen Meadow Creek tidal wetland. Storm surge stillwater elevation during a 1% annual-chance storm dominates as a hazard here, along with wave action that is modeled as reaching the inland side of Melba Street.

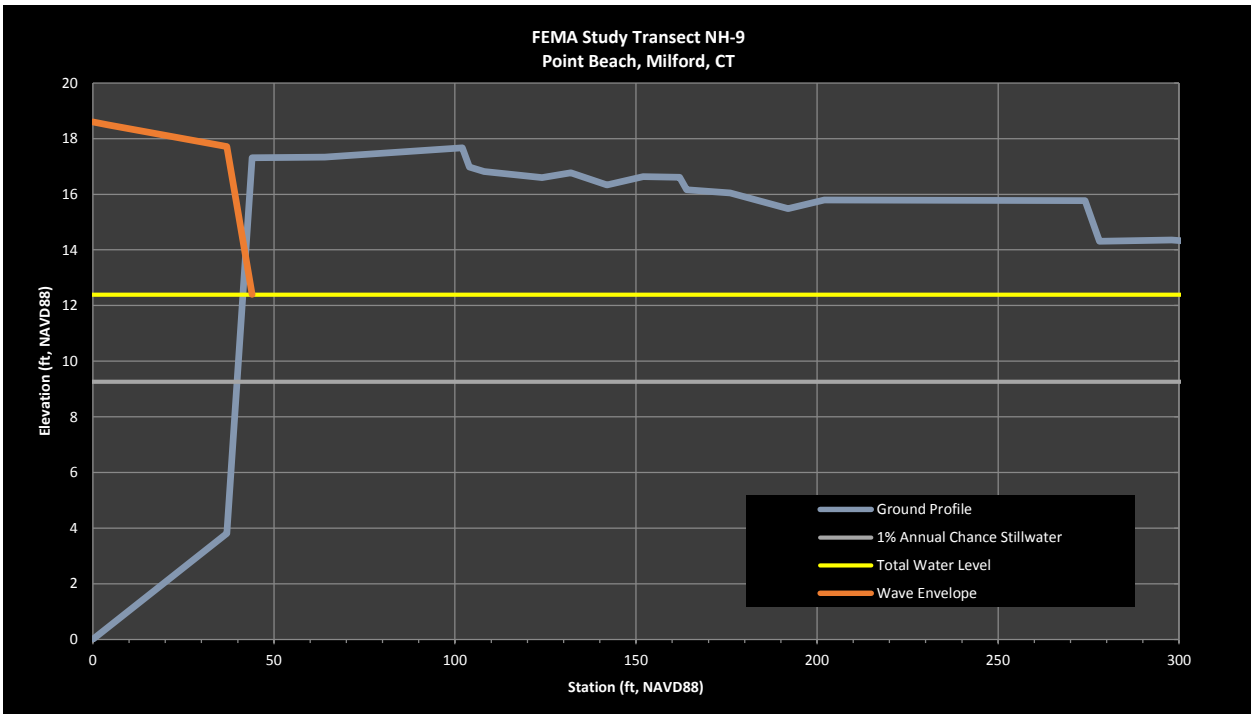
Study	Annual-Chance Storm (elevation values in feet NAVD88)				
	10%	2%	1%	1 % with setup	0.2%
FEMA Coastal Hazard Analysis Program	7.2	8.6	9.3	10.5	10.6
USACE Advanced Circulation Model (all values include wave setup)	8.4	10.1		11.1	14.1



East of Point Beach (FEMA transect NH-09)

This area is not as vulnerable to coastal hazards, as can be seen in the transect. A vertical concrete bulkhead rises to over 17 feet elevation (NAVD-88) here. This steep wall pushes water upward during a 1% annual-chance storm, creating a high wave setup, and creating waves that rise to about the same elevation as the wall. Nevertheless, the models do not show overtopping or inundation at this site.

Study	Annual-Chance Storm (elevation values in feet NAVD88)				
	10%	2%	1%	1 % with setup	0.2%
FEMA Coastal Hazard Analysis Program	7.3	8.7	9.3	12.4	10.5
USACE Advanced Circulation Model (all values include wave setup)	8.4	10.1		11.1	14.1



4.4 Vulnerabilities from Wind

Wind is another coastal hazard, and one about which residents have expressed concern. Hazards include direct damage to a property, secondary damage from windblown debris, and loss of infrastructure functioning due to downed powerlines or other related impacts.

Wind hazards tend to be greater where structures are not protected by topography, vegetation, or other structures. This condition characterizes shorefront properties. Hazards can be compounded by the proximity of poorly-designed structures or other debris sources. Additionally, the severity and frequency of storms is expected to increase in the future as climate continues to change, which will be reflected in increasing risk presented by high winds. Detailed analysis of wind patterns to determine specific areas of high vulnerability is beyond the scope of this project. For the purposes of this plan, wind hazards are assumed to be nearly uniform along Milford's coast.

The best way to protect a home or business from wind hazards is to ensure they are built to highest possible code. The best way to protect the community is to ensure such codes are enforced uniformly to prevent the secondary effects caused by damaged homes providing wind-blown debris.

5 Conclusion

Milford's coastal neighborhoods are diverse and each will be faced with a combination of vulnerabilities with sea level rise and the increased incidence and severity of coastal storms. Risks include both stillwater inundation, and wave setup and runup. Coastal communities such as Milford are also susceptible to wind related hazards.

Among the greatest threats to Milford's shoreline are erosion or drowning of beaches, inundation of low-lying areas with poor drainage systems, and flooding of properties surrounding tidal wetlands. These risks are anticipated to increase over time due to sea level rise and climate change, and may be compounded by continuing trends of increased development and population growth. High winds during storm events, which are also predicted to increase with climate change, may put further pressure on vulnerable coastal communities.

To build resiliency to increasing hazards, Milford should review the most feasible and prudent alternatives for adaptation.

2619-09-8-j116-milfordvulnerabilities

Appendix C
Review of Options for Coastal Resilience

MILONE & MACBROOM

COMMUNITY COASTAL RESILIENCE PLAN

CITY OF MILFORD, CONNECTICUT

Review of Options for Coastal Resilience

1 Evolution of Options for Coastal Resilience

Coastal adaptation strategies include both planning (nonstructural) and structural-related modifications. Nonstructural measures include preparedness, emergency response, retreat, and regulatory and financial measures to reduce risk. Structural measures include dikes, seawalls, groins, jetties, temporary flood barriers, and the like. Ideally, the measures that are taken should be robust enough to provide adequate protection and flexible enough to allow them to be adapted to changing future conditions. Such robustness and flexibility typically require a combinations of methods rather than one solution.

Structural measures can be site-specific, "neighborhood-scale," or large-scale structures that protect multiple square miles of infrastructure. Site-specific measures pertain to floodproofing a specific structure on a case-by-case basis. Neighborhood-scale measures apply to a specific group of buildings that are adjacent to each other. Large-scale structures might include large dike and levee systems or tide gates that can prevent tidal surge from moving upstream.

1.1 The IPCC Approach

The Intergovernmental Panel on Climate Change (IPCC) published the landmark paper "Strategies for Adaptation to Sea Level Rise" in 1990. This was one of the earliest reports to list the three traditional categories of adaptation "to protect human life and property." The following descriptions of these three types of adaptation are taken from the report:

- Retreat involves abandonment of the coastal zone with no effort to protect the land from the sea. This choice can be motivated by excessive economic or environmental impacts of protection. In extreme cases, entire areas may be abandoned.
- Accommodation means that people continue to use the land at risk but do not attempt to prevent the land from being flooded. This option includes erecting emergency flood shelters, elevating buildings and roads, or growing flood- or salt-tolerant crops.
- Protection can involve building structures such as sea walls and dikes, restoring dunes, and planting vegetation to protect the land from the sea so that existing uses can continue.

1.2 The NOAA Approach

In 2010, the National Oceanic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management published the manual *Adapting to Climate Change: A Planning Guide for State Coastal Managers*. NOAA's seven categories of "Climate Change Adaptation Measures" and their subcategories are:

1. *Impact Identification and Assessment*
   - Research and Data Collection

- Monitoring
- Modeling and Mapping

2. *Awareness and Assistance*
- Outreach and Education
- Real Estate Disclosure
- Financial and Technical Assistance

3. *Growth and Development Management*
- Zoning – regulate land use, development, building features, setbacks, shore protection, etc.
- Redevelopment Restrictions – provide safer options in the wake of property loss or damage.
- Conservation Easements – legal agreement with a landowner to restrict development.
- Compact Community Design – high density development creates opportunities to guide development away from sensitive and hazard-prone areas.

4. *Loss Reduction*
- Acquisition, Demolition, and Relocation – the most effective way to reduce losses
- Setbacks – keep structures away from a property's most vulnerable areas.
- Building Codes – regulations to improve the ability of structures to withstand hazard events
- Retrofitting
- Infrastructure Protection
- Shore Protection Structures – protect existing development, allowing it to stay in place.

5. *Shoreline Management*
- Regulation and Removal of Shore Protection Structures – to protect the natural shoreline
- Rolling Easements – as the sea rises, the easement moves or "rolls" landward.
- Living Shorelines – stabilization techniques that use plantings and organic materials
- Beach Nourishment
- Dune Management
- Sediment Management – placing, trapping, or diverting sediment.

6. *Coastal Ecosystem Management*
- Ecological Buffer Zones – provide a transition zone between a resource and human activity.
- Open Space Preservation and Conservation
- Ecosystem Protection and Maintenance – wetland migration is an important aspect of this.
- Ecosystem Restoration, Creation, and Enhancement

7. *Water Resource Management and Protection*
- Stormwater Management
- Water Supply Management

1.3 Current Approaches Including Green Infrastructure and Gray/Green Hybrids

In the context of natural and green infrastructure (see text box below), opportunities to reduce risks may include environmentally friendly beach stabilization, restoring dunes, restoring tidal wetlands, oyster reef creation/enhancement, improving the hydrology of coastal areas,

improving/removing infrastructure, and living shoreline techniques. In some cases, a combination of green and hardened infrastructure ("hybrid approaches") may be appropriate.

There have been numerous developments in the State of Connecticut over the past 3 years to address concerns of shoreline stabilization in a changing environment and climate. Public Act 12-101 set forth initiatives to address sea level rise, revise the regulatory procedures applicable to shoreline protection, and promote living shorelines. As a component of the Act, two terms which have been integral to the interpretation of Coastal Management Act (CMA) flood and erosion control structure policies were defined and expanded for the first time:

1. *"For the purposes of this section, '**feasible, less environmentally damaging alternative**' includes, but is not limited to, relocation of an inhabited structure to a landward location, elevation of an inhabited structure, restoration or creation of a dune or vegetated slope, or living shorelines techniques utilizing a variety of structural and organic materials, such as tidal wetland plants, submerged aquatic vegetation, coir fiber logs, sand fill, and stone to provide shoreline protection and maintain or restore costal resources and habitat."*

2. *"**Reasonable mitigation measures and techniques**" includes, but is not limited to, provisions for upland migration of on-site tidal wetlands, replenishment of the littoral system and the public beach with suitable sediment at a frequency and rate equivalent to the sediment removed from the site as a result of the proposed structural solution, or on-site or off-site removal of existing shoreline flood and erosion control structures from public or private shoreline property to the same or greater extent as the area of shoreline impacted by the proposed structural solution."* [CGS section 22a-92, as amended].

Typical Definitions of Green Infrastructure (GI)

Environmental Protection Agency (EPA): GI uses vegetation, soils, and natural processes to manage water and create healthier urban environments.

American Rivers: GI is an approach to water management that protects, restores, or mimics the natural water cycle. GI is effective, economical, and enhances community safety and quality of life. GI incorporates both the natural environment and engineered systems to provide clean water, conserve ecosystem values and functions, and provide a wide array of benefits to people and wildlife. GI solutions can be applied on different scales, from the house or building level, to the broader landscape level. On the local level, GI practices include rain gardens, permeable pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting systems.

The Nature Conservancy: GI solutions are planned and managed natural and semi-natural systems which can provide more categories of benefits, when compared to traditional gray infrastructure. GI solutions can enhance or even replace a functionality that is traditionally provided by man-made structures. GI solutions aim to build upon the success that nature has had in evolving systems that are inherently sustainable and resilient. GI solutions employ ecosystem services to create more resource-efficient systems involving water, air, and land use.

These changes have introduced the application of living shoreline approaches. Due to potential regulatory implications of what the definition of a living shoreline might entail, the Connecticut Department of Energy & Environmental Protection (CTDEEP) has developed a working definition

of "living shoreline" through research of other coastal states, NOAA, and the University of Connecticut (UConn). The current working definition of living shorelines according to CTDEEP is:

> *"A shoreline erosion control management practice which also restores, enhances, maintains or creates natural coastal or riparian habitat, functions and processes. Coastal and riparian habitats include but are not limited to intertidal flats, tidal marsh, beach/dune systems, and bluffs. Living shorelines may include structural features that are combined with natural components to attenuate wave energy and currents."*

With the legislative and regulatory changes coupled with the influx of funding after Hurricane Sandy, the time is ripe in Connecticut for considering natural and green infrastructure risk reduction methods along the shoreline. This may include reevaluating some traditionally controversial techniques such as creating beaches, dunes, and tidal marsh front where they are not currently present due to decades of erosion.

Although living shorelines can broadly include tidal marshes, beaches, dunes, bioengineered coastal banks, and shellfish reefs, this memo will address most of these approaches by name (beaches, dunes, bioengineered coastal banks, and shellfish reefs) and reserve the term "living shoreline" for a created or restored tidal marsh.

1.4 Approach Summary

Elements of *protection, retreat*, and *accommodation* are found in several of the NOAA categories and subcategories of adaptation. For example, Growth and Development Management actions can be used to manage retreat or accommodation, whereas Shoreline Management may include methods of protection as well as removing protection. NOAA notes that these adaptation measures are organized into categories that describe their primary purpose but, in many cases, they serve multiple purposes and could fit into multiple categories (e.g., acquisition could fit under Growth and Development Management, Coastal and Marine Ecosystem Management, and Shoreline Management in addition to Loss Reduction).

Preservation of the economic, aesthetic, and ecological values of natural coastline features and processes can be incorporated into all of the adaptation approaches discussed above. In fact, often such features provide protection themselves. Green infrastructure and other environmentally friendly approaches to adaptation provide security to communities while maintaining or enhancing the natural systems that attracted people to the coastline in the first place.

The EPA publication "Rolling Easements" (Titus, 2011) provides the most current comprehensive description of rolling easements[1] and all the adaptation measures found in this broad collection of techniques. As noted by Titus in this publication, accommodation is viable in many communities but no longer considered sustainable for the long term; eventually, protection or

[1] The term "rolling easements" encompasses a broad set of tools that can be used ensure that wetlands and beaches are able to naturally migrate inland without being stopped by shore protections or development. The term is covered in detail in section 2.4.4.

retreat will be the default. This is an important concept because communities will need to understand that there is a limit to how far into the future accommodation will be practical. Many of the recent and current trends in adaptation planning (circa 2008 to the present) appear to be taking this into account.

2 Specific Adaptation Options

The following is a list of the most common and effective adaptation measures that are available to a typical Connecticut coastal municipality. There may be additional options not listed here. Measures may fit into many of the categories listed previously or into only one. Measures specifically relevant to Milford are described in Section 3.

2.1 Protective Infrastructure

2.1.1 Hard Shoreline Protection

Hard shoreline protection generally includes long-lasting structures parallel to the shoreline:

- Seawalls are engineered barriers that protect land from waves and flooding
- Levees are engineered berms that protect land from flooding
- Bulkheads are engineered structures that retain soil and reduce erosion
- Revetments protect against erosion by dissipating wave energy. They may be constructed of piles of large stones (riprap), mesh cages of smaller rocks (gabions), or other materials.

Additional hard protections that are not necessarily parallel to the shoreline or that are parallel but offshore may include jetties, groins, breakwaters, and the like. These reduce the energy of wave and currents, often for the purpose of managing sediment.

Hard coastal structures will be a part of Connecticut's developed shorefront many years into the future. Hard structures will protect many miles of shoreline roads, the state's numerous water-dependent uses, and many thousands of private properties. While the regulatory climate will only rarely allow the construction of new hard structures, existing structures will need to be repaired or replaced as needed. Modifications may be prudent in some cases. However, opportunities for natural and green infrastructure are often negligible in these settings. Likewise, hybrid solutions are unlikely to be pursued. Municipalities and property owners will continue to choose the methods that have been used for decades to define the edge of the shoreline, prevent erosion, and control wave energy.

2.1.2 Soft Shoreline Protection

Soft shoreline protection aims to defend against inundation and wave power through management of beach sediment and dunes.

- Beach Replenishment involves importing sand to an eroding or eroded beach from sediment-rich areas, such as a harbor undergoing dredging. The slope and width of a beach affects wave setup and runup, and can have a direct impact on flood elevations. Overall, beaches can reduce flood risks and erosion hazards while creating public recreation opportunities, aesthetic value, and in the right conditions support unique habitats (climatetechwiki.org). Unlike hard shoreline protection measure, beach replenishment avoids addition of potentially dangerous hard debris to the high-energy coastal area.

Almost every shoreline municipality in Connecticut has at least one managed beach that is periodically nourished with sand. Examples include Short Beach in Stratford, Laurel Beach in Milford, Ocean Avenue Beach in West Haven, and Hammonasset Beach in Madison. Likewise, almost every shoreline municipality has a handful of beaches where nourishment is desired by municipal officials and/or residents.

- Dune Management stabilizes these natural flood barriers to protect against surges while maintaining important natural resources. The Federal Emergency Management Agency (FEMA) describes dunes as "important first lines of defense against coastal storms" that can "reduce losses to inland coastal development." The Lake Huron Centre for Coastal Conservation lists the benefits of dunes as including shore protection, water purification, biological diversity, erosion control, and acting as a source of sediment for natural beach replenishment.

2.1.3 Bank Protection and Stabilization

Coastal banks in Connecticut are not protected in a continuous uninterrupted manner. There are many locations where protection is absent and erosion is taking place. Some erosion may be tolerable, providing sand for the state's beaches. However, there are many locations where the unprotected banks occupy gaps in otherwise protected shorefronts. Because hard structures are present updrift and downdrift from these gaps, they may be eroding at a different pace than they would naturally.

Unprotected coastal banks that are moderately eroding could be left untouched. However, unprotected coastal banks that are significantly eroding may represent some of our most interesting opportunities. Green and hybrid approaches could be considered for these settings, incorporating native vegetation and local earthen materials whenever possible.

2.1.4 Living Shorelines

Living shorelines protect from erosion while enhancing habitat and water quality and preserving the natural processes and connections between riparian, intertidal, and subaqueous areas. Projects may utilize a variety of structural and organic materials including, but not limited to, tidal wetland plants, submerged aquatic vegetation, coir fiber logs, sand fill, and stone.

There are two basic types of living shoreline that meet this definition:

- Nonstructural techniques use natural elements such as vegetation, fill, and coir logs to trap sediment and reduce wave energy.
- Hybrid techniques incorporate nonstructural approaches for erosion control in combination with more traditional approaches, such as a rock structure, to support vegetation growth. Hybrid techniques are typically applied in areas of higher wave energy.

  One example of a living shoreline that has been constructed in Connecticut in the last few years is a reef ball project near Lords Point in Stratford. The reef ball rows were installed in the intertidal zone and are believed to be trapping sediment on the landward side of the intertidal zone, thus supporting new marsh grasses.

2.2 Community Infrastructure Protection

2.2.1 Stormwater Management

Many low-lying storm drain inlets in Milford (such as those in the Field Court neighborhood) sometimes "surcharge" (have seawater flow backwards through them) during high-tide events. This can lead to flooding in areas that otherwise would be protected from coastal waters. It is important to note that the challenge of preventing flooding in low-lying coastal areas includes preventing the inflow of seawater as well as enabling the drainage of runoff flowing downhill from upland areas. This challenge is exacerbated by high sea levels that prevent simpler "gravity flow" methods of drainage. Reducing this type of flood risk requires either: a) pumping the stormwater out with enough force to overcome elevated seawater, or b) preventing the seawater from entering the system. Stormwater pump stations are feasible (and becoming more common with increasing sea levels) but are costly to construct and operate, and represent an ongoing maintenance burden. Preventing seawater from entering the gravity system reduces flood frequency with limited capital and operating expenses.

One step in preventing seawater infiltration into storm drainage systems is the installation of gaskets at pipe joints to make the pipes watertight. Gasketed piping is common in water supply and sewer systems and readily available on the market.

Perhaps more important is placing a flap gate or duck bill structure on the pipe outlet. A traditional flap gate is shown below. These are typically made of steel or aluminum and open under the force of water building up in the pipe behind the gate. A duck bill is shown to the right. Either device can work for Milford.

Stormwater Flap Gate

Duck Bill Flap Gate

2.2.2 Roads and Transportation

Roadway alterations may include elevation, abandonment, reevaluation of emergency routes, and developing alternative egress. These are described below.

- Roadway Elevation – ensures viability despite rising flood levels. While a practical approach, private properties often remain at lower, floodprone elevations. A higher road surface can then impede drainage of floodwaters off properties.
- Roadway Abandonment – it may be acceptable to abandon some roads as the cost of elevation or maintenance becomes excessive.
- Alternative Egress – likely developed in connection with road abandonment or reevaluation of emergency access. New roads would have to be built along undeveloped right-of-ways.
- Reevaluation of Emergency Access – some emergency routes may be abandoned (without abandoning the associated road), and alternate, nonvulnerable routes determined.

Currently, road elevation projects are planned for Milford Point Road near Seaview Avenue, and Beachland Avenue adjacent to Calf Pen Meadow Creek. Elevation of the currently unused Nettleton Road at Walnut Beach is also under consideration.

2.2.3 Water and Wastewater

Some coastal communities will face serious problems related to water supply and sanitary wastewater disposal as sea level rises and groundwater rises accordingly. Adaptation methods may include retrofits to pumping stations, hardening of Wastewater Treatment Plants, and extension of sewer and water systems.

Water Supply Adaptation:
Milford is served by the South Central Connecticut Regional Water Authority (RWA), and its water is sourced from surface reservoirs that are not vulnerable to the effects of rising seas and saltwater intrusion. The positive pressure maintained in a water system will prevent salt water from entering pipes in low elevation areas where that may be a concern. Therefore, Milford's water supply is not vulnerable, and significant adaptation is not currently necessary. Options for areas that may still rely on individual private wells are listed below but not described in detail. See the Milford Vulnerability and Risk Assessment Memo for more information about vulnerabilities of the city's water resources.

Private Water Supply Adaptation Options:

- Individual Water Treatment Systems
- Development of Community Systems – in underserved locations
- Extension of Public Water System – to properties not currently served
- Vacating Property – in extreme situations where properties may be rendered unusable

Wastewater Treatment Adaptation:
The City of Milford is served by two Wastewater Treatment Facilities, so vulnerabilities inherent to private septic systems are not a significant concern. Vulnerable aspects of the municipal

system include the low-elevation treatment facilities themselves, the sewer pumping stations that are also often located at relatively low elevations, and sewer pipe infrastructure.

Wastewater Infrastructure Adaptation Options:

- New Construction/ Reconstruction – municipal treatment facilities, or septic systems where relevant, should be constructed at elevations that consider sea level rise.
- Retrofits – steps to protect a facility without relocating it include, but are not limited to:
  - Construction of floodwalls or berms around structures
  - Floodproofing of structures or specific components
  - Elevation of structures or specific components
  - Protection of electrical supply and systems through elevation, floodproofing, and backup generators
  - Hardening of and preventing sedimentation or backflow at facility outfall
  - Protection of access to facilities through road elevation
  - Protect records, files, and personnel
  - Enable facilities to be operated remotely
- Harden Pumping Stations – steps include, but are not limited to:
  - Elevation of station or components
  - Floodproofing station without elevating
  - Use of submersible pumps to allow for continued operation during flooding
  - Providing standby power in case supply is cut off by flooding or storm activity
  - Setting station up for rapid repair, rather than attempting to prevent all damage
  - Installation of backflow prevention

2.3 Property Protection

The National Flood Proofing Committee (NFPC) defines floodproofing as "any combination of structural or nonstructural changes or adjustments incorporated in the design, construction, or alteration of individual structures or properties that will reduce flood damages." Proper floodproofing measures can reduce flood vulnerability; however, the only way to entirely prevent damage is to relocate the structures (i.e., retreat).

Floodproofing measures permitted for residential structures are more limited than those available to commercial buildings. The following section summarizes approaches to floodproofing that may be used individually or in combination for most commercial buildings. The only options available to residences are relocation or elevation.

2.3.1 Structure and/or Critical System Elevation

Elevating a structure requires raising the lowest floor so that it is above the target design level. Almost any structurally sound small building can be elevated. Design standards vary in FEMA V zones vs. AE zones. The process becomes more difficult and virtually impossible with a large building that has slab on grade, is constructed out of block or brick, has multiple stories, or is connected to adjacent buildings. Elevation can also create unattractive and hard-to-manage areas below the buildings. Elevation has gained much wider acceptance in recent years as a means of managing coastal buildings, particularly in residential areas. In commercial buildings,

elevation to more than a few feet above street level makes for uninviting and hard-to-access retail space, so its viability is somewhat limited.

Elevation is the only measure, other than relocation, that can be used to bring a substantially damaged or substantially improved residential structure into compliance with the community's floodplain management ordinance. It is also permitted in FEMA-mapped velocity zones.

2.3.2 Wet Floodproofing

Modifying the operations and use of existing structures to allow flooding to occur while minimizing property damage is considered "wet floodproofing." Under this scenario, all contents (including utilities) are removed from below the flood elevation, and openings in the building wall are either maintained or increased in size to allow water to readily enter the lower floors. The openings allow the hydrostatic pressure inside and outside the building to equalize, reducing the potential for structural failure. All construction materials that may be inundated may be flood resistant to avoid deterioration and mold.

2.3.3 Dry Floodproofing

Dry floodproofing entails making a structure watertight by sealing walls and, often, floors. Openings such as doors, windows, and vents need to be fitted with removable barriers that can be installed manually or deployed automatically during flood events. The structure being made watertight must be able to withstand the significant hydrostatic pressure that will be exerted on it during a flood event. Dry floodproofing is more often used on nonresidential structures and also requires implementation planning.

2.3.4 Permanent Ringwalls, Floodwalls, and Levees

Ringwalls, floodwalls, and levees are located away from the structure to be protected and are designed to prevent the encroachment of floodwaters. It is possible to install barriers on a neighborhood scale to protect multiple buildings. A well-designed and constructed barrier prevents floodwater from exerting hydrostatic or hydrodynamic forces on buildings, as well as from wetting structures. This avoids the need for retrofits or cleanup. Floodwalls and levees may have openings for access. These can be sealed using automatically closing barriers or manually installed barriers that depend on human intervention when flooding is predicted.

Levees are earthen embankments of compacted soils. They require large amounts of land area, since, for structural purposes, they are typically constructed to be five to six times wider than they are tall. Floodwalls are constructed of a variety of materials and do not require large amounts of space for construction. They typically are not viable in areas of very deep flooding.

2.3.5 Temporary Barriers

Temporary flood barriers are erected manually only when flooding is imminent. These systems have a lower capital cost than a floodwall or the self-closing barriers described above, but they require human intervention prior to flooding, generating a risk that the installation is not completed and the structures are not protected.

2.3.6 Structure Relocation or Abandonment

Relocating a structure is the most dependable method of reducing flood risks. The method involves moving the structure out of the floodplain away from potential flood hazards. Costs and new sites are usually major concerns associated with building relocation.

Owners of highly vulnerable properties may wish to sell their property, thereby avoiding the costs of continued protection and maintenance. The opportunity for the City of Milford to assist residents in this situation should be embraced when it arises, and state and federal grant funding is available to aid in such purchases.

2.4 Regulatory Tools

Many of the options listed in this section can be accomplished through, or complemented by, a variety of regulatory tools. Following is a fairly comprehensive summary for consideration.

2.4.1 Flood Damage Reduction Code Modification

In Connecticut, municipalities have mainly one option for increasing the design standards associated with development in flood zones: modifying the municipal code, zoning regulations, and/or subdivision regulations.

There are several methods of increasing building standards to enhance coastal resilience within the framework of these codes and regulations. These are described below:

- *Freeboard* – Freeboard standards require structures to be elevated higher than the level that FEMA requires through the National Flood Insurance Program regulations. Milford already enforces a 1-foot freeboard standard which provides additional certainty that flood levels will not damage structures and addresses difficult-to-determine factors like wave height. The city could consider increasing its freeboard standard to 2 or more feet to further increase structure safety.
- *Building Height Standards* –Liberal height standards can help achieve other resiliency goals, such as structure elevation. It is important to consider the relationship between city residential building height regulations, flood-protection elevation standards, and the economic and social impacts that an exceptionally high structure could have on a neighborhood.
- *Applying V Zone Standards in A zones* – This requirement would cause a structure in the coastal A zone to be constructed per V zone standards, incorporating breakaway walls, certain pile foundations, and prohibitions on uses below the first floor. The application of more stringent codes not only protects a given structure; it also protects *nearby* structures from damage caused by collapsing or floating structures and debris.

2.4.2 Zoning Amendments and Other Regulatory Procedures

Zoning Regulation amendments may be used to help require freeboard and other increases in building standards. Other changes to Zoning Regulations and the Zoning Map that may be useful for increasing coastal resilience include:

- *Tidal Marsh Protection and Advancement* – Areas suitable for marsh advancement may be regulated under a resource protection model of management.
- *Transfer of Development Rights* – such that developers continue to own coastal land, but development is relocated to less sensitive areas
- *Flexible Development Process* – Clustered development, planned residential development, and open-space subdivision procedures allow development consistent with coastal resiliency.
- *Land Conservation for Marsh Advancement* – Protect land through conservation easements, "rolling easements," and other arrangements. Property would remain privately owned.
- *Green Infrastructure for Private Property and Homeowner Development* – Provide incentives for property owners implementing green infrastructure improvements.
- *Water Dependent Uses* – Allow commercial water-dependent uses in residential areas to compensate property owners for loss of value due to restricted development opportunities.
- *Expedited Permits for Reconstruction after Emergency Events* – for work which meets new standards of coastal resiliency

2.4.3 Zoning Map Overlays

Milford may wish to adopt a zoning overlay district that is delineated using a line of future daily inundation or a future storm of a given hurricane category/intensity. Any of the planning periods of the coastal resilience tool could be used (2020s, 2050s, or 2080s). Once adopted, the city could enact any number of requirements for development or redevelopment within the overlay, including freeboard and application of V zone standards in coastal A zones. Other possibilities may include variable setbacks and buffers or restrictions on what types of renovations or expansions may be permitted for existing buildings.

2.4.4 Rolling Easements

The term "rolling easements" encompasses a broad set of tools that can be used ensure that wetlands and beaches are able to naturally migrate inland without being stopped by shore protections or development. Rolling easements can be thought of as a combination of the principles of "accommodation" and "retreat." Because it is unrealistic to prevent development of low-lying coastal lands that could eventually be submerged by a rising sea, an alternative is to allow development with the conscious recognition that the land will be abandoned if and when the sea rises enough to submerge it. From now until the land is threatened, valuable coastal land can be put to its highest use; once the land is threatened, it will convert to wetland or beach as if it had never been developed.

According to Titus (*2011*), "usually, a rolling easement would be either (a) a law that prohibits shore protection or (b) a property right to ensure that wetlands, beaches, barrier islands, or access along the shore moves inland with the natural retreat of the shore."

Regulatory Rolling Easements

- Local zoning that restricts shore protection
- Regulations that prohibit shore protection by state coastal or wetland programs, or require removal of structures standing on the beach or in the wetlands
- Building-permit conditions that require public access along the dry beach

- Building-permit conditions that require public access along the inland side of a new shore protection structure

Property Rights Approaches

- Affirmative easements that provide the public with the right to walk along the dry beach even if the beach migrates inland
- Conservation easements that prevent landowners from erecting shore protection structures or elevating the grades of their land
- Restrictive covenants in which owners are mutually bound to avoid shore protection and allow access along the shore to migrate inland
- Future interests that transfer ownership of land whenever the sea rises to a particular level
- Migrating property lines that move as the shore erodes, enabling waterfront parcels to migrate inland so that inherently waterfront activities can continue
- Legislative or judicial revisions and clarifications regarding the inland migration of public access along the shore and the rights of landowners to hold back the sea
- Transferable development rights that provide those who yield land to the rising sea the right to build on land nearby

The particular details associate with implementing the above rolling easements are too varied to fully describe in this report. As planning continues, Milford will need to determine whether and which rolling easements will be incorporated into its coastal resilience plan.

2.4.5 Property Acquisition

Coastal land acquisition should be pursued for both ecological protection and human use. Coastal land valuable for conservation includes lands with ecological significance, existing potential coastal recreation opportunities, and areas of exceptional or unique coastal conservation value. Important considerations are the proximity to other protected lands as well as providing areas for sea level rise and tidal wetlands migration. Sites to consider are undeveloped islands, intact areas of tidal marsh, undeveloped tidally influenced riverine systems, coastal woodlands, bird habitat areas (especially waterfowl areas), anadramous and diadramous fish run areas, and sites that have been shown to have habitat for federal or state listed threatened, endangered, or species of special concern.

Categories of Property Acquisition

Property acquisition will generally fall into four major categories:

- Open Space and Undeveloped Land – including tidal marsh advancement areas
- Damaged or Vulnerable Property
- Condemned Property – such as those where providing potable water and disposing of sanitary wastewater is not possible due to feasibility or expense.
- Inland Properties –to make up for the loss of lands due to sea level advancement.

2.5 Summary of Adaptation Options

Table 1: Summary of Adaptation Options

Measure	Summary	Benefits	Barriers to Implementation
Structural Measures			
Hard Shore Protection	Structure parallel to shore (seawall, levee, bulkhead, revetment)	• Long lasting • Effective	• False sense of security • Expensive maintenance • Ecosystem damage
Sediment Management Structures	Structures reduce wave energy and manage sediment	• Long lasting • Support natural processes	• Does not address stillwater inundation • Secondary Impacts
Soft Shore Protection	Replenish sediment and dunes	• Support natural processes • Support ecosystems • Aesthetic	• Regular maintenance • May not be long lasting
Bioengineered Banks	Natural elements reduce wave energy and trap sediment	• Support natural processes • Support ecosystems • Aesthetic	• Somewhat limited areas of applicability
Marsh Management	Creation/restoration of tidal marsh	• Reduce wave energy • Critical habitat	• Limited areas of applicability • Does not address stillwater inundation
Stormwater Management	Drain low areas while preventing backflow	• Support other protection methods	• May be expensive • Requires maintenance • Doesn't address direct hazards
Transportation Infrastructure	Elevate roads or create alternative egresses	• Protect emergency access and evacuation	• Elevation may increase hazards for neighbors
Elevation	Raise structure above flood level	• Reduce insurance premium • Open to residences • Permitted in V zones	• Harder to access • "Dead space" under structure • Difficult for some buildings
Wet Floodproofing	Abandon lowest floor, remove all contents	• Relatively inexpensive	• Extensive postflood cleanup
Dry Floodproofing	Waterproof structure, install barriers at openings	• Relatively inexpensive • Does not require additional land	• Manual barrier installation • Subject to storm predictions • Vulnerable to flow and waves
Floodwalls & Levees	Concrete or earthen barriers protection	• Prevent water contact • Avoid structural retrofits	• May require large area • Obstructs views
Temporary Flood Barriers	Plastic or metal barrier	• Prevent water contact • Relatively inexpensive	• Manual installation • Subject to storm predictions • Short term only
Relocation	Move structure to safer location	• All vulnerability removed • Open to residences	• Decreased value of new site • Expensive
Regulatory Tools			
Building Code	Increase standards for structures	• Protect new and improved construction	• Older structures often exempt
Zoning Regulations	Prevent hazardous development patterns	• Control degree of risk in hazardous areas	• Balance with economic pressures
Easements	Control activities on private land	• Work with landowners for mutual benefit	• Private landowner may not be willing partners

3 Options Relevant to Milford

3.1 Development of Milford-Specific Options

The comprehensive list of options presented previously includes adaptation measures that may be: technically, financially, or otherwise unfeasible for Milford to implement; not relevant to Milford's particular geography, geology, and hazard profile; or socially or politically unacceptable to Milford's citizens. To develop a suite of viable options for the city's consideration, coastal resilience projects undertaken by other communities were reviewed, local physical and political factors were considered, and options were discussed with Milford's municipal leaders and residents.

During the meeting on September 4, 2015 to commence this planning process, Milford representatives discussed elevation and strengthening of vulnerable roads, nourishment and dune creation on beaches, shore protection with seawalls and living shorelines, ensuring marsh advancement and public access in the future, improving drainage, and property acquisition.

A meeting of the Milford Hazard Mitigation Subcommittee took place on January 20, 2016 before a public meeting on January 28, 2016[2]. Property acquisition, drainage improvements, beach nourishment, and dune restoration were all reiterated as important efforts in the city. Additionally, protection of the Beaverbrook Wastewater Treatment Plant and retrofitting out-of-date and vulnerable pumping stations was discussed.

Based on these meetings and the additional considerations listed previously, the following categories and subcategories of options were presented to Milford residents at the public meeting on January 28, 2016:

- Transportation Options
  - Elevate Roads
  - Retire Roads
- Shoreline Management
  - Living Shorelines
  - Beach Nourishment
  - Sediment Management
  - Dune Management
  - Bioengineered Banks
- Shore Protection Structures
  - Seawalls
  - Bulkheads
  - Revetments
- Home Elevation
- Water Resource Management
  - Stormwater

[2] Two public meetings were held as part of this planning process, one on January 28, 2016, and another on March 29, 2016. Both meeting were held in the Milford City Hall.

    - Wastewater
    - Water Supply
- Retreat

The meeting was open to public discussion, and these and other options were discussed in more detail by attendees. Adaptation measures added during this discussion included:

- Revise building height-limit (i.e. view scape) regulations to avoid conflicts with home elevation
- Revise zoning regulations to allow for structure demolition and replacement with an upgraded structure (i.e. raze and rebuild)
- Remove invasive species in natural areas
- Construct jetties for sediment management
- Upgrade drainage infrastructure and prevent backflow through storm drains
- Install artificial reefs to trap sediment

Finally, feedback from the public about resilience options was solicited through an online survey. Respondents indicated they were in favor of construction of breakwaters or groins, beach nourishment, and dune restoration. Respondents also supported strengthening utilities, improving drainage, building seawalls and bulkheads, creating living shorelines, elevating coastal roads, and elevating homes. The suite of options most applicable to each of Milford's coastal neighborhoods is summarized in the following table:

Table 2: Adaptation Options for Milford Neighborhoods

Possible Options		Shoreline Protection					Structures & Infrastructure			Realignment		
		Hard Protection	Beach Nourishment	Dune Restoration	Hybrid Protection	Bioengineered Banks	Drainage Improvement	Road Elevation	Structure Elevation	Road Retirement	Alternate Route Development	Property Acquisition
Appropriate Neighborhoods	Milford Point / Cedar Beach		X	X				X	X			X
	Laurel Beach		X						X			
	Wildemere Beach	X	X	X	X	X			X			
	Walnut Beach		X	X				X			X	
	Silver Beach		X	X	X			X	X	X		X
	Fort Trumbull	X			X	X						
	Gulf Beach	X	X	X	X	X		X				
	Bayview Beach	X	X	X	X		X	X	X			
	Calf Pen Meadow		X				X	X	X	X		X
	Point Beach	X				X	X		X			X
	Morningside	X				X						
	Hillside Avenue	X					X	X	X			
	Burwells Beach		X					X	X			
	Woodmont	X	X		X	X			X			

3.2 Application of Adaptation Options in Milford

The following section summarizes some of the specific problem sites around Milford where different adaptation options may be relevant. Many of the sites are listed under multiple options, indicating that there are multiple approaches to resiliency at that location, or that the best option would be to implement multiple adaptation measures in unison. Milford is characterized by long areas of shoreline with private structures. This will present a challenge going forward because it will be difficult to achieve a unified approach in many locations.

3.2.1 Hard Shoreline Protection

Milford's shoreline is densely developed, and options in many neighborhoods will be limited to ensure basic protection of important assets. Some of this protection may be accomplished through shoreline management and protective structures.

Sections of the city with assets such as structures, roads, and other infrastructure located very close to the water may require hard shoreline protection. Such areas may include those that are not geographically conducive to softer shoreline protection, those without the space to implement other protection methods, those with high banks susceptible to erosion, or those with naturally hard or rocky shorelines where structures may be vulnerable to wave action.

These areas may include Trumbull Avenue, the Point Beach neighborhood, Morningside Drive, Hillside Avenue, and some of the southern shore of Woodmont.

Options for these areas include:

- Seawalls
- Bulkheads
- Revetments
- Dikes

Additional hard protections that are not necessarily parallel to the shoreline or that are parallel but offshore include the following:

- Jetties
- Breakwaters
- Groins

These reduce the energy of wave and currents, often for the purpose of managing sediment. Suitable sites for these types of shoreline protection include Wildemere Beach, Silver Beach, Wilcox Park, Bayview Beach, and Burwells Beach.

One specific possibility is the installation of groins or other sediment management structures at Wildemere Beach in order to restore a sandy beach in that area. A more extensive beach would mitigate wave action, potentially removing the FEMA "velocity zone" designation for some areas and lowering base flood elevations. This may qualify Wildemere Beach for a Flood Insurance Rate Map Letter of Map Revision.

3.2.2 Soft Shoreline Protection

Some sections of Milford are able to be served using soft shoreline protection, which is often more aesthetically acceptable and more supportive of natural systems and processes.

Areas where soft protection measures can be implemented include Cedar Beach, Laurel Beach, Wildemere Beach, Walnut Beaches, Silver Beach, Bayview Beach, the northern section of Point Beach, and Burwells Beach.

Currently, Laurel Beach is regularly nourished with sand under a CTDEEP permit, and groins aid in sediment management in that area. The adjacent Wildemere Beach is not nourished and not supported by groins, and, as a result, there is little or no beach at Wildemere at high tide. The difference between these neighboring beaches is also manifested in the FEMA flood insurance mapping. The velocity-zone (VE) at Laurel Beach is mapped along the shoreline and with a Base

Flood Elevation (BFE) of 13 feet. At Wildemere, the VE zone BFE is 15 feet and extends inland at some locations. Additionally, a portion of Wildemere beach has a zone of limit of moderate wave action (LimWa) between the VE and AE zone with a BFE of 14 feet and an inland AE zone behind that with a BFE of 12 feet. Laurel Beach's AE zone BFE is 11 or 12 feet and lies directly inland of the VE zone. Overall, the FEMA-mapped risks are higher and extend farther inland at Wildemere than at Laurel, which shows the effectiveness of the beach nourishment program at Laurel Beach.

The differences between these two beaches can also be seen through the experiences of lifelong residents. One resident of Wildemere Beach was able to provide a detailed account of the history of erosion in that area since the early 1900's. According to his documentation, in 1910-1912 a series of protective revetments were placed in front of homes, in concert with a field of low "stays" placed perpendicular to the shoreline near the water to capture sediment. This dual-measure sustained a beach and protected homes until 1949, when floodwaters destroyed two homes and badly damaged a third. In 1965, the city Flood and Erosion Control Board received approval from the Connecticut Water Resources Commission and the U.S. Army Corps of Engineers to implement a beach nourishment project to include importation of sand and construction of groins. Letters were sent to landowners assuring them that the project would continue through 1972. No nourishment was ever undertaken.

Significant beach erosion occurred after Winter Storm Beth in 1992. After that storm, fine sand was removed from the beach, large stones were exposed, and the mean-high-tide property line migrated significantly inland. After Super Storm Sandy in 2012, the last of the beach's fine sand was removed and, along with the larger stones, deposited inland. The mean-high-tide line moved farther inland. Property values in the neighborhood of this resident have diminished drastically while risks have increased.

Options for soft shoreline protection around Milford include:

- Dune Restoration
- Sediment Management
- Beach Nourishment

A small dune restoration project was recently funded by the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) program out of the University of Connecticut. This dune will be located at Walnut Beach. Despite this project, dune restoration or construction is generally not a great fit for Milford due to the city's coastal geography. Dunes must be located a significant distance from the water line (50 to 100 feet), and must be wide (greater than 20 feet), to be able to maintain their forms. Most Milford beaches do not have this kind space. However, Walnut Beach, Gulf Beach, Silver Beach, and Bayview Beach may be good candidates for this work. It may also be possible to construct a dune on a beach that is currently unsuitable if other beach building and nourishment projects are undertaken first. Wildemere may be a candidate for this kind of project.

3.2.3 Created and Restored Tidal Wetlands

Due to the character of Milford's shoreline – developed and fronted by beaches and hard structures – there are not many areas that would support the created or restored tidal wetland form of living shorelines. Milford does contain significant tidal marshlands such as those in the Charles E Wheeler Wildlife Area, Great Creek, and Calf Pen Meadow, but these are protected from wave energy. Thus, Milford is not characterized by eroding marsh fronts, and so living shoreline projects focused on tidal marsh restoration will not be relevant to this geography.

Likewise, recent living shoreline projects like the Stratford reef ball project would only have a parallel feasible setting in Milford along the Housatonic River. The Milford shore between Milford Point and Woodmont is unlikely to contain any sites suitable to such a project where the reef balls would survive a powerful coastal storm.

For these reasons, living shorelines that consist of tidal wetlands or artificial reefs will likely not be a significant part of the city's resilience planning.

3.2.4 Bioengineered Banks

A living shoreline approach that may be applicable to larger portions of the Milford coast is bioengineered banks. The many hard structures protecting Milford's coast deflect wave energy down- and up-shore to adjacent areas, increasing risk at those sites. Additionally, when a structure does fail, it leaves a gaping hole that can open the previously protected area to rapid erosion. Incorporation of bioengineered banks into shoreline protection methods could reduce, rather than deflect, wave energy in some areas, thereby reducing deterioration of adjacent structures. Additionally, DEEP is more likely to authorize hybrid or bioengineered methods than new hard structures.

There is a condominium on Point Beach Road that would be a good site to try a bioengineered bank treatment. Utilizing green infrastructure would also support local ecosystems and improve the aesthetic and recreational value of this beach.

3.2.5 Infrastructure Retrofits and Upgrades

Drainage

Some areas of Milford have adequate protection from inundation and wave action, but still experience damage due to failing, inadequate, or malfunctioning drainage infrastructure. Areas that would benefit from upgrades to these systems include the Bayview Beach / Field Court neighborhood, Calf Pen Meadow, and the Point Beach neighborhood. Bayview Beach and Point Beach already suffer from routine storm drain "surcharging" when high water levels in the sound push water backwards through the drainage infrastructure to discharge into otherwise protected low areas.

Roadways and Transportation

The layout of Milford is such that even if some major roads are impassable, other routes should remain open for most residents. Nevertheless, there are some neighborhoods that might be isolated under high sea level conditions, alternate routes would need to be determined for

those that are technically accessible but have had major throughways cut off, and under current conditions there are already roads that experience chronic flooding.

Some of the most significant roads at risk in Milford include State Route 162, State Route 736, Naugatuck Avenue, Milford Point Road, Seaview Avenue, Broadway Street, East Broadway Street, Viscount Drive, Surf Avenue, Rogers Avenue, Gulf Street, Old Field Lane, Field Court, Bayshore drive, Melba Street, Point Beach Drive, Beach Avenue, Seabreeze Avenue, and Anderson Avenue. Areas of the city vulnerable to isolation include Milford Point, Silver Beach, Knobb Hill, and the Morningside neighborhood.

Transportation adaptation options for these neighborhoods may include:

- Roadway elevation
- Roadway strengthening and reinforcement
- Roadway abandonment
- Mapping of alternative routes
- Construction of alternative routes

Wastewater

The wastewater treatment plant at Beaverbrook is within a mapped floodplain and will be affected by sea level rise and coastal storms. The plant is already protected through measures such as floodwalls, but continued maintenance and improvement of its flood mitigation methods will be necessary moving into the future.

Many of Milford's sewer pumping stations lie within hazard zones and may be vulnerable to sea level rise. One example is the pumping station at Sailor Lane which is not housed in a pump house.

3.2.6 Private Property Protection

All properties within flood zones are required to have flood protection measures implemented, but additional actions should be taken to prepare for rising seas. Furthermore, there are some areas of Milford where neighborhood-scale protective measures, such as construction of floodwalls or nourishment of beaches, are not feasible or would not provide adequate protection to individual structures. In such areas, individual property owners should implement additional flood protection measures.

These areas include sections of Cedar Beach, Silver Beach, and Melba Street.

Elevation of residential properties should be pursued in all floodprone neighborhoods.

3.2.7 Other Options

The other adaptation options listed above – regulatory tools and property acquisition – apply throughout Milford. Relevant regulatory tools will vary based on the needs of specific locations.

4 Conclusions

The City of Milford is well positioned to move forward on a variety of important projects to build resilience to coastal flooding, storms, and sea level rise. The city's shore is well studied; many projects have already been completed, are underway, or are in planning phases; and public support for continued resilience-building efforts is strong. The city's capabilities include strong emergency response capabilities, roads that are generally higher in elevation or set back from the coast, and municipal water and sewer utilities.

Beach replenishment and nourishment through sediment placement and control efforts, as well as dune restoration on beaches that are currently, or will in the future be, appropriate for such projects, will be a large part of Milford's resilience efforts. Assisting homeowners to elevate their residences, or purchasing properties from those who no longer wish to invest in protecting their residences, should also be a continuing focus of the city. Although living shorelines are not appropriate for most of the Milford coast, the city is encouraged to explore the use of hybrid and green techniques to hard-shoreline protection where space is limited. Such techniques include bioengineered banks. Finally, Milford should enact a suite of regulatory changes to support resiliency efforts, including making height restrictions flexible in the case of home elevations, and altering zoning regulations to encourage development away from hazard areas.

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Appendix D
Selection of Hurricane Sandy-Impacted Neighborhoods

Memorandum

Selection of Hurricane Sandy-Impacted Neighborhoods

Goal: *Based on the participation of members of the public, impacts from Storm Sandy, the location of low-to-moderate income (LMI) populations, locations of critical community facilities, and the results of the vulnerability and risk assessment, the consultant will recommend up to two specific neighborhoods that should be targeted for more focused planning efforts in each municipality.*

Repetitive Loss (RL) Properties

The greatest number of RL properties is located as follows, from west to east:

- The area of Milford Point-Laurel Beach-Wildemere Beach
- Silver Beach (the area between Silver Sands State Park and Fort Trumbull Beach)
- Bayview Beach and Melba Street
- Point Beach
- Hillside Avenue
- Burwells Beach

Low-to-Moderate Income (LMI) Census Tracts

Two LMI census tracts are located along the shoreline: Laurel Beach/Wildemere Beach and Point Beach.

Areas of Damage from Tropical Storm Irene and Hurricane Sandy

The most severe damage from Tropical Storm Irene and Hurricane Sandy is generally aligned with the areas of the most RL properties listed above. In particular, some of the greatest flooding was experienced in Milford Point, Wildemere Beach, Walnut Beach, Silver Beach, Melba Street, and Point Beach. Where damage was not severe, it was mitigated mainly because many homes have already been elevated (for example, the homes elevated after Storm Beth in the Point Beach area). Wave damage from Tropical Storm Irene and Hurricane Sandy was severe in the Hillside Avenue area.

Areas of Risk from Daily High-Tide Flooding in the 2020s and 2050s

The neighborhoods most at risk from worsening daily high-tide flooding are those that already experience frequent nuisance flooding during high tides. These are Milford Point, the marsh side of Silver Beach, Bayview Beach, the Calf Pen Meadow area north of Melba Street, and Point Beach.

Locations of Critical Facilities

Milford's critical facilities are largely situated in areas of relatively lower risk. However, the Beaverbrook Wastewater Treatment Plant (WWTP) is located in a Special Flood Hazard Area (SFHA) and will be at increasing risk over the long term. Furthermore, this WWTP serves LMI census tracts.

At-Risk Roads

Roads at risk of flooding during daily high tides are listed in the Vulnerability and Risk memo. These are:

Route 162 / New Haven Avenue	Gulf Street
Route 736 / Buckingham Avenue, Edgefield Avenue, Merwin Avenue	Old Field Lane
Naugatuck Avenue	Field Court
Milford Point Road	Bayshore Drive
Seaview Avenue	Melba Street
Broadway Street	Point Beach Drive
East Broadway Street	Beach Avenue
Viscount Drive	Seabreeze Avenue
Surf Avenue	Anderson Avenue
Rogers Avenue	

These roads are located primarily in the neighborhoods already described above: Milford Point, Laurel Beach, Wildemere Beach, Walnut Beach, Silver Beach, Gulf Beach, Bayview Beach, Melba Avenue, Point Beach, and Burwells Beach. Gulf Beach and small parts of Woodmont are also home to vulnerable roads.

Public Input

Bayview Beach's drainage and nuisance flooding problems were the most common *specific* problems identified during the public meeting on January 28, 2016. Wildemere Beach, Walnut Beach, and Point Beach were also mentioned. Similar results were identified from the survey.

Conclusion

The following table cross-references the above issues with the coastal neighborhoods.

Neighborhood	RL Properties	LMI Census Tract	Irene & Sandy Damage	DHT Risk 2020s-2050s	Critical Facilities	At-Risk Roads	Public Input
Milford Point	Yes		Yes	Yes	*	Yes	
Laurel Beach	Yes	**			*	Yes	
Wildemere Beach	Yes	Yes	Yes		*	Yes	Yes
Walnut Beach		Yes	Yes			Yes	Yes
Silver Beach	Yes		Yes	Yes		Yes	
Gulf Beach						Yes	
Bayview Beach	Yes			Yes		Yes	Yes
Melba Street	Yes		Yes	Yes		Yes	
Point Beach	Yes	**	Yes	Yes		Yes	Yes
Morningside							
Hillside	Yes		Yes				
Burwells Beach	Yes					Yes	
Woodmont						Yes	Yes

**Served by Beaverbrook WWTP*
*** These areas are not Low or Moderate Income, but do fall within tracts that have lower median income levels than much of the rest of Milford, as discussed earlier.*

Point Beach and Wildemere Beach are the neighborhoods that meet the most applicable criteria (five). The neighborhoods with the second-highest number of criteria checked are Milford Point, Walnut Beach, Silver Beach, Bayview Beach, and Melba Street (all at four columns).

Wildemere Beach and Point Beach have the most applicable criteria and are either technically LMI neighborhoods (Wildemere Beach) or characterized by relatively low income levels (Point Beach). They were both selected for more focused planning efforts. The layout of Wildemere Beach and the nature of the problem (limited beach at high tide, contributing to elevated base flood elevations) are such that it was determined that an infrastructure design would be more appropriate than a neighborhood-scale approach. Additionally, because the Beaverbrook Wastewater Treatment Plant (WWTP) is at risk and serves LMI areas, it was selected as an infrastructure design.

Bayview Beach was briefly considered as an additional neighborhood for focused planning, but the consultant assigned to the Bayview Beach CDBG-DR grant had already prepared preliminary plans for drainage improvements and green infrastructure as of February 2016. For that reason, it was deemed redundant.

A primary area of interest previously advanced to the 10-town "*Regional Framework for Coastal Resilience*" is the Walnut Beach area. Several different kinds of projects can be completed there, including a new dune for flood protection, green infrastructure drainage systems such as rain gardens and swales, and elevating a section of Nettleton Avenue to provide flood protection and improved

egress from East Broadway's dead end. Because Milford's coastal resilience plan should dovetail with the *Regional Framework* and because Walnut Beach is an LMI neighborhood with a high number of applicable criteria met (as seen in the table above), Walnut Beach was selected as the second neighborhood for focused planning.

In summary, the four selections for focused planning are:

Neighborhoods
- Point Beach
- Walnut Beach

Infrastructure
- Beaverbrook WWTP
- Wildemere Beach (with a restored/created beach as the "infrastructure")

If and when the city undergoes additional planning for the Walnut Beach and Wildemere Beach areas using its CDBG-DR planning grant, the results of this planning phase can be used as a starting point.

2619-09-8-m416-task7memomilford

Appendix E-1
Walnut Beach Neighborhood Resilience Concept

MILONE & MACBROOM

Walnut Beach Flood Settings

The area of Walnut Beach is currently shown as being inundated by the 1% chance storm event based on the most recent Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) preliminary coastal study for New Haven County. The results of this analysis show Base Flood Elevations ranging from 13 feet (ft) to 12 ft NAVD88. According to the Parcel data for the City of Milford, this event would cause approximately 127 homes/structures to be impacted by flooding (see Figure 1).

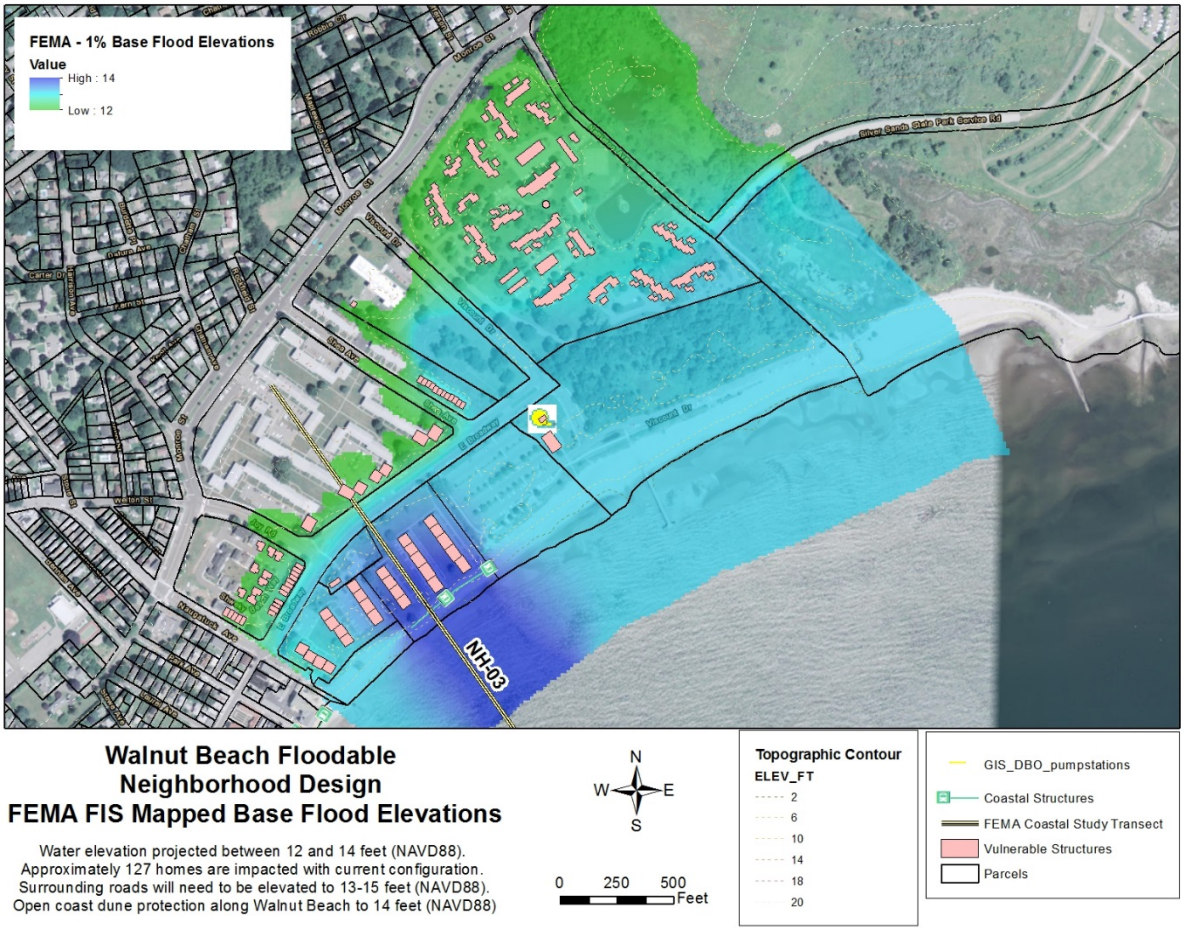


Figure 1: FEMA Preliminary FIS Mapped Base Flood Elevations

In addition to a review of the FEMA preliminary Flood Insurance Rate Map (FIRM) and FIS, a review of The Nature Conservancy's (TNC's) year 2080 Sea Level Rise projections on top of a Category 2 storm was performed. That analysis concluded that the inland flooding extent from the TNC scenario is similar to the extent noted in the FEMA preliminary FIS study data (see Figure 2).

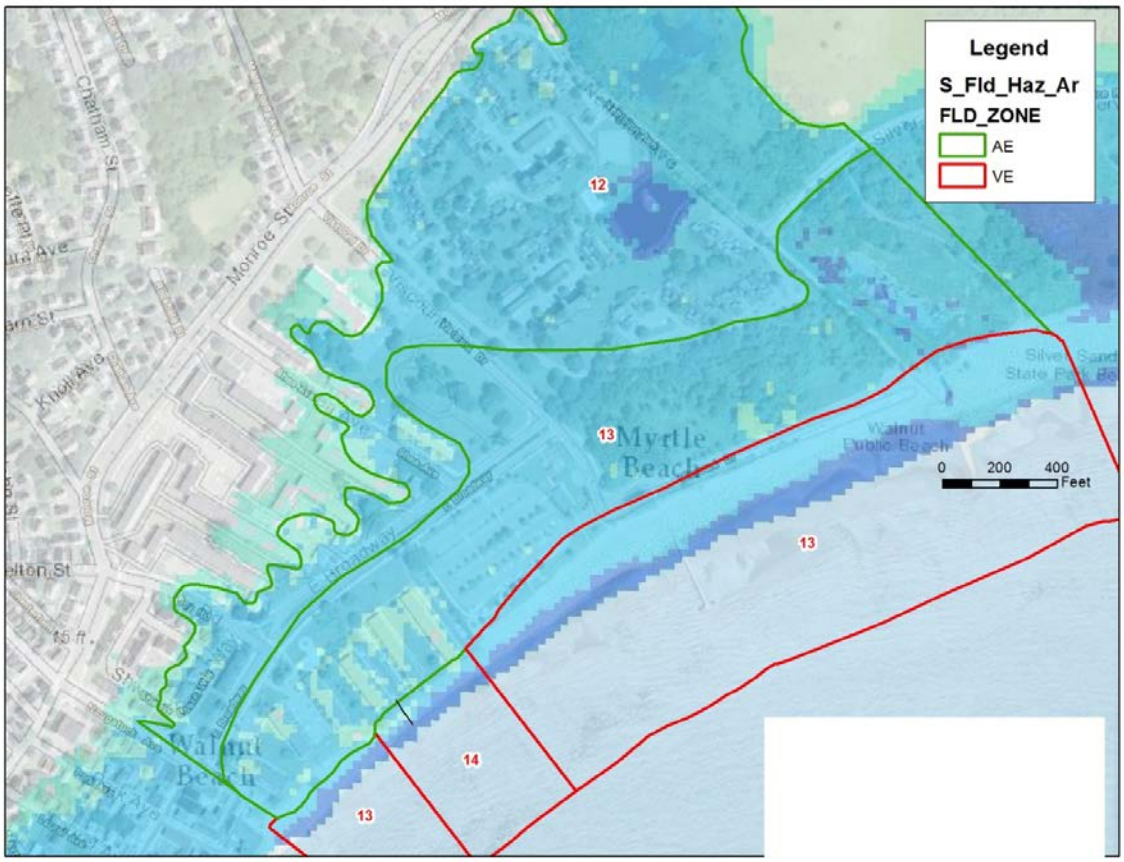


Figure 2: Walnut Beach, Milford, CT - TNC 2080 Cat 2 Sea Level Rise Projection vs. the FEMA 1% flood inundation

Based on this analysis of potential flooding scenarios, the 1%, or 100-year flood, was selected for design. In order to reduce the current number of buildings impacted (127), several alternatives were reviewed.

Walnut Beach Neighborhood Flood Resiliency Alternatives

Several scenarios were considered to address flooding in this area:

<u>Alternative Concept 1: Building Elevations of Floodproofing</u>

Based on the construction type and number (127) of buildings impacted, elevation and floodproofing were determined to be either not technically feasible or cost prohibitive. If other alternatives discussed below are not ultimately constructed, elevation and floodproofing could be used on a limited basis for some of the impacted buildings.

Alternative Concept 2: Elevate Nettleton Avenue

The first scenario that was modeled involved elevating Nettleton Avenue only, to an elevation of 13.5 ft NAVD 88. While this scenario reduced flooding slightly, immediately to the west/southwest of Nettleton, its overall impact on the numbers of buildings impacted by the flood scenarios was limited. Figure 3 shows inundation under this scenario.

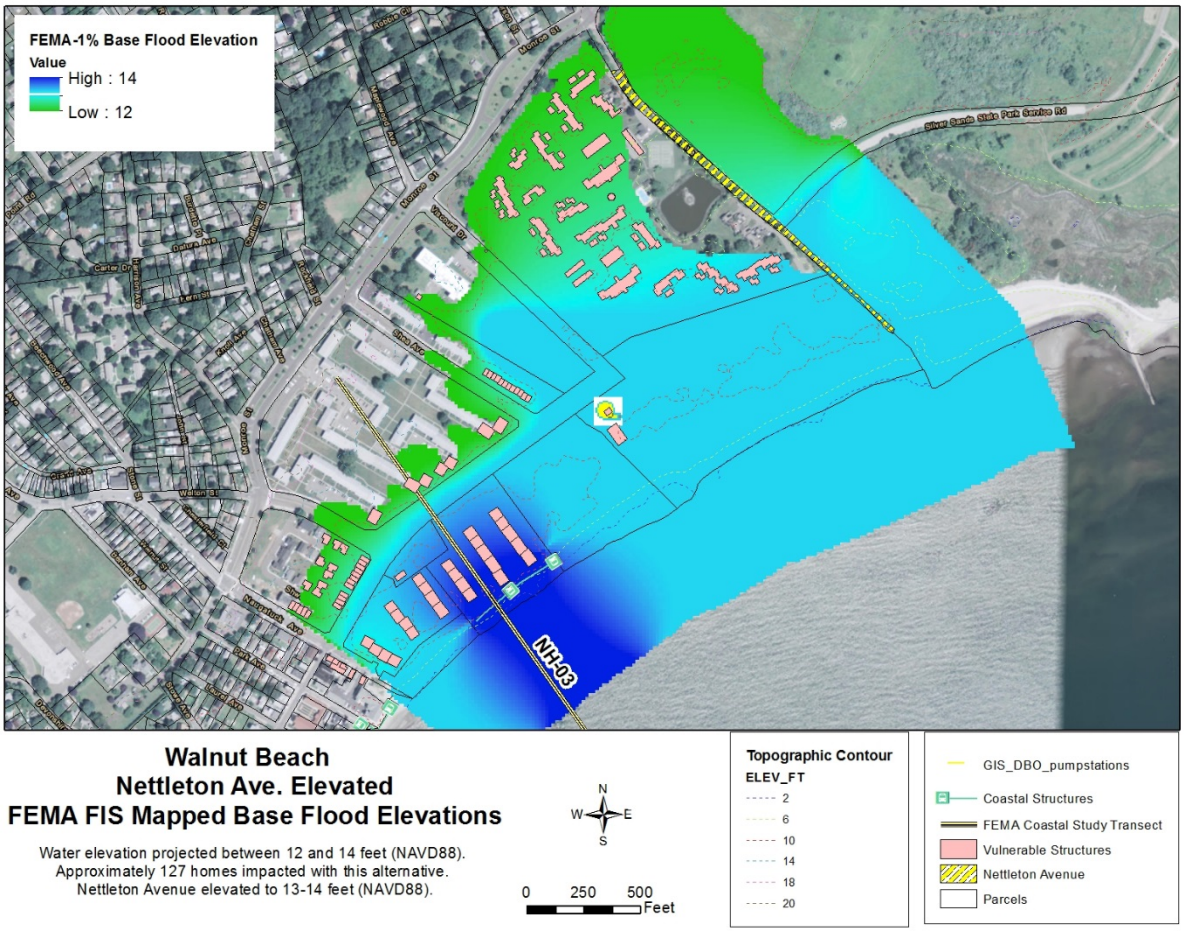


Figure 3: Inundation Under Nettleton Avenue Elevated Scenario

Alternative Concept 3: Elevation of Nettleton Avenue only and Dune Construction

The second scenario modeled included elevation of Nettleton Avenue to 13.5 ft NAVD 88 and the construction of a dune extending the length of the beach from the boardwalk to the west of the parking lot east to Nettleton Road. Figure 4 shows the extent of protection from this scenario. While the inundation area decreases dramatically, approximately 69 buildings would still be inundated.

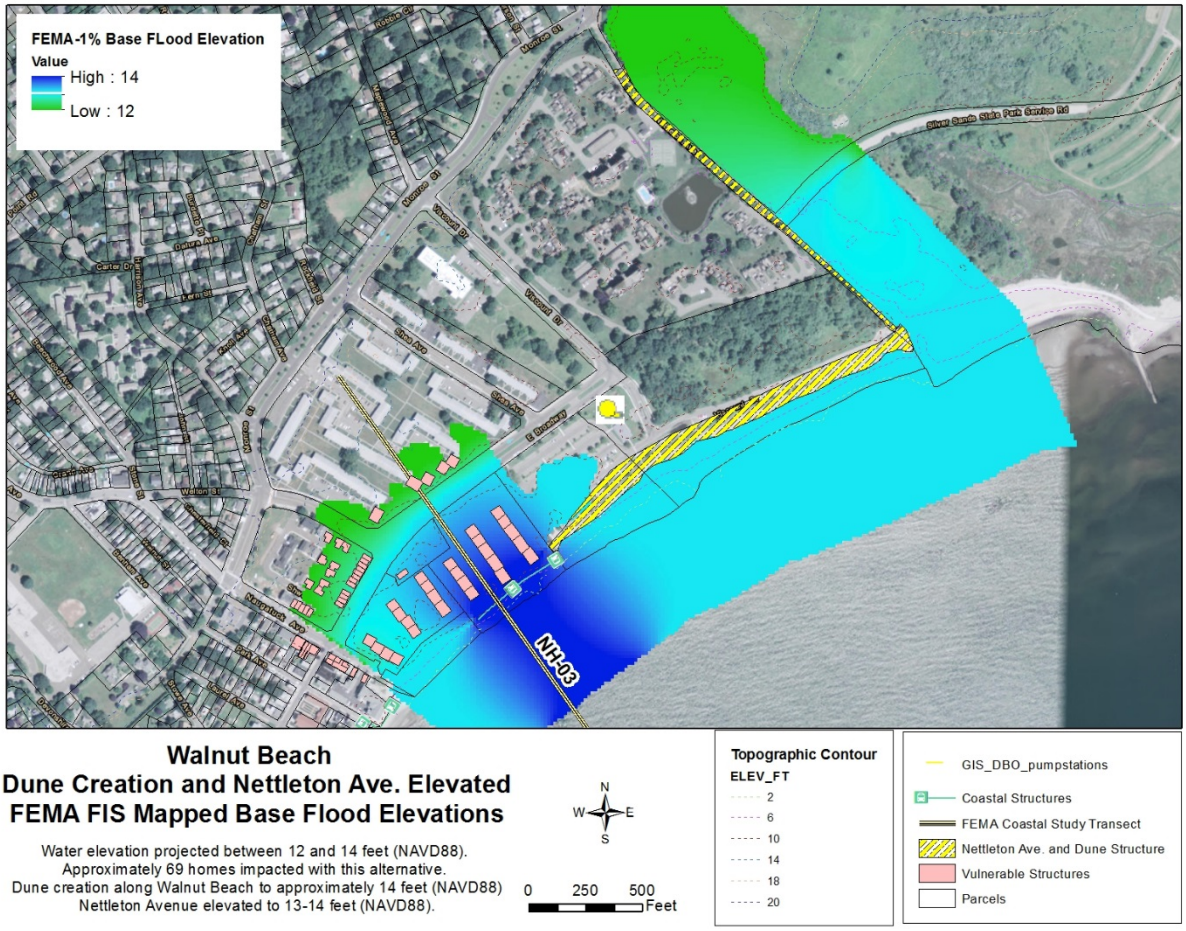


Figure 4: Elevation of Nettleton Avenue only and Dune Construction Alternative

Alternative Concept 4: Elevation of All Roads and Dune Creation

The final and recommended scenario for Walnut Beach includes elevating roads in the area as well as the addition of a dune along Walnut Beach. The greatest reduction in flooding impacts to the inland structures resulted from a combination of road elevations and creation of a larger coastal dune along the beach. We found that with this alternative the number of impacted homes would be reduced to 53. For Walnut Beach the preferred alternative is proposed elevation of the roads along Nettleton Avenue, Joy Road, and the boardwalk surrounding the area of Walnut Beach. In order to provide adequate protection against the 1% storm event in this area the roads will need to be elevated to approximately 14 ft NAVD88 along Nettleton Road, the boardwalk, and East Broadway. Joy Road should be elevated to 13 ft NAVD88 (see Figure 5).

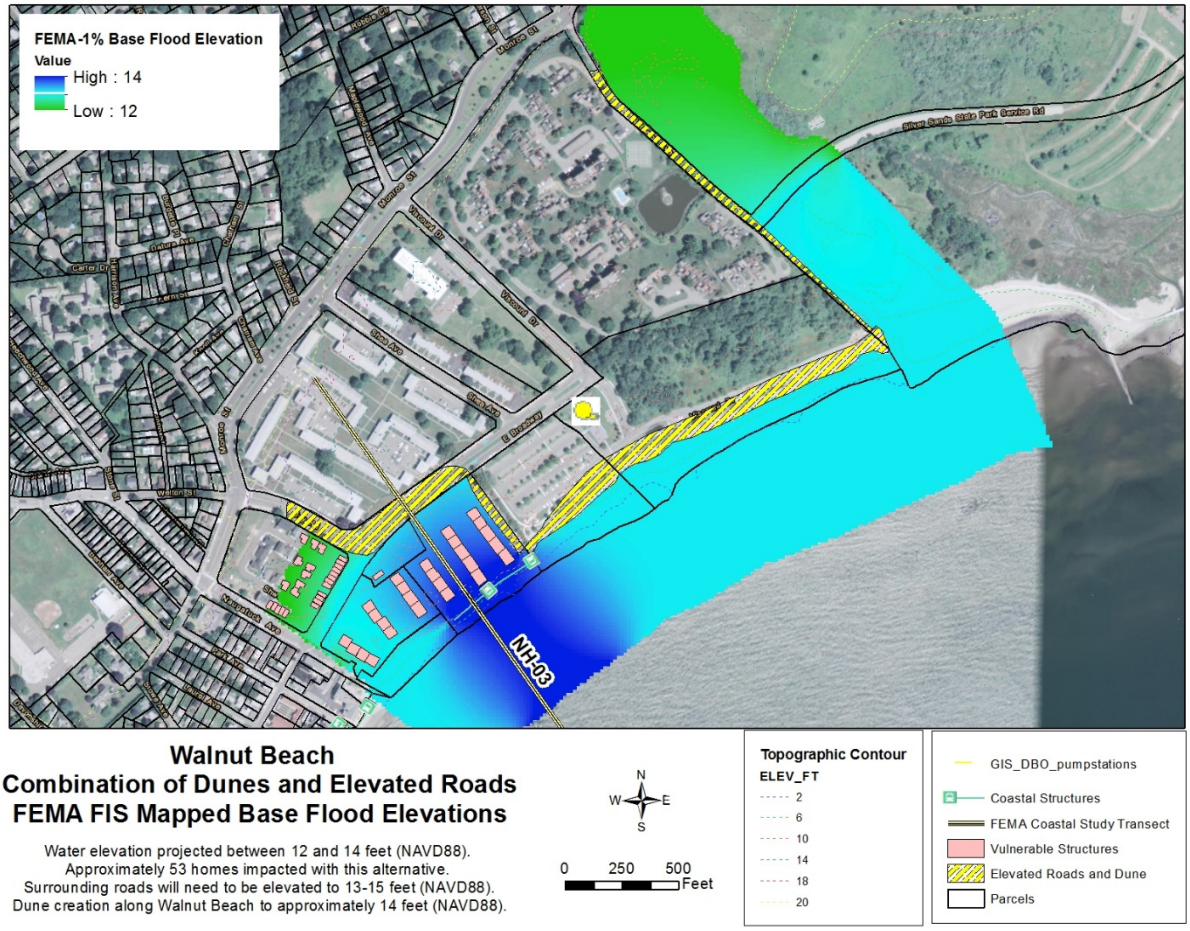


Figure 5: Preferred Alternative Dune and Elevated Roads

In addition, to most effectively reduce the number of structures impacted by the 1% storm event coming off of Long Island Sound construction of a sand dune at this location is advised. The dune would extend the length of the beach from the boardwalk to the west of the parking lot east to Nettleton Road. The proposed dune would need approximately 37,925 cubic yards of sand placed where the existing dune is located (9 ft NAVD88) seaward approximately 90 feet to approximately 6 ft NAVD88. The dune crest should reach 14 ft NAVD88 to provide adequate protection to upland structures based on the FEMA Base Flood Elevation data from the most recent FIS study.

Planning Level Costs for Preferred Alternative

<u>Dune Nourishment</u>

Estimates are based on costs in neighboring West Haven, Connecticut, for a recently completed project. The cost of nourishment sand material varies dramatically depending on quantity, source location, and means of transport to the site. In West Haven, sand was transported to the site from Cape Cod,

Massachusetts, and purchased by the ton. We consider this the most conservative of planning-level cost estimation, based on the distance from Milford to Cape Cod. After converting the per-ton cost to cost per cubic yard, we estimate $50/cubic yard in place and graded to profile for approximately 37,924 cubic yards. Planning-level cost estimate equals **$1,896,200** for the beach nourishment portion of this recommendation.

Elevation of Nettleton Avenue

For the purposes of developing a planning level cost estimate we assumed conservatively that all roads proposed for elevation require a 3-foot increase. Additionally, we assumed:

- 1:1 fill, both sides of the roads
- Existing pavement is 4 inches thick
- New Pavement to be 4 inches thick
- Landside of fill will require new drainage
- Topsoil and turf establishment on landside slopes
- Riprap slope protection on water side of slopes

Total length of all roads combined is roughly 3,200 feet, with estimated aggregate widths of between 20 and 30 feet.

Planning-level cost estimate includes:

1.	Fill – Granular for slopes and 2/3 of road	$252,000
2.	Fill – Processed aggregate base	$145,350
3.	Excavation of pavement	$ 17,100
4.	New Pavement	$212,160
5.	15-inch RCP (2,700 linear feet)	$159,300
6.	Type "C" catch basins (9)	$ 30,600
7.	Trench excavation	$ 5,236
8.	Topsoil/turf	$ 15,050
Subtotal:		$836,796
25% Contingency:		$209,199
Total:		**$1,045,995**

Total planning level cost estimate for the recommended alternative is:

Beach Nourishment	$1,896,200
Road Elevations	$1,045,995
TOTAL:	**$2,942,195**

Based on the number of buildings protected, and the conservative nature of the cost estimates, it is likely that this alternative will be cost effective.

Appendix E-2
Point Beach Neighborhood Resilience Concept

MILONE & MACBROOM

Point Beach, Milford, Neighborhood Adaptation Concepts

The Point Beach neighborhood currently experiences nuisance flooding from "surcharging" storm drainage systems during high tides. High-tide flooding through malfunctioning infrastructure will be an increasing risk with rising sea levels. By the 2080s, high waters are projected to overtop the neighborhood's higher-elevation waterfront land, threatening the neighborhood with flooding even with working drainage systems. Much of the neighborhood lies within a Federal Emergency Management Agency (FEMA) 1% annual-chance floodplain (Zone AE) and was flooded during Hurricane Sandy.

The neighborhood plans developed for this area depict three potential different outcomes:

- A floodable neighborhood
- Protection from the daily high tide with a floodwall of nominal height
- Protection from storm surges with a levee or berm system

Although these three outcomes are different, it is possible to pursue one outcome for the short term and another outcome for the long term.

Alternatives

"Dry Except During Storm Surge Events"

Concept A depicts a combination of options that will protect the neighborhood from flooding during the daily high tides in the 2020s, 2050s, and 2080s. A floodwall would be installed and maintained within the alignment of existing private structures (seawalls) with a design height that is equal to the projected daily high tide in the 2080s plus a reasonable freeboard. A floodwall would be constructed around the perimeter of the tidal wetland to prevent high-tide flooding from this source. This wall would have a similar design height. Floodwalls would not be designed to prevent flooding from storm surges.

Stormwater systems within the protected area would need to be upgraded over time. In addition, backflow prevention would be installed to prevent surcharging from the stormwater system during high tides. A stormwater pumping station would be installed to remove stormwater from areas that can no longer drain directly from streets. This pumping station could also pump stormwater against the higher base level occurring during high tides.

Over time, property owners will still need to elevate homes as they currently do. This will protect homes from storm surges. Approximately 188 houses would be protected. Approximately 70 property owners would need to grant permanent easements for the city to maintain floodwalls. All property owners with flood insurance would continue to hold flood insurance. The implementation of this alternative is shown in the figures below.

Point Beach Neighborhood Resilience Concept

These graphics show the impact of the wall protection system on flooding under different conditions. Note that high-tide flooding is prevented through the 2080s decade. Category 2 Storm flooding is not precluded by the presence of the wall.

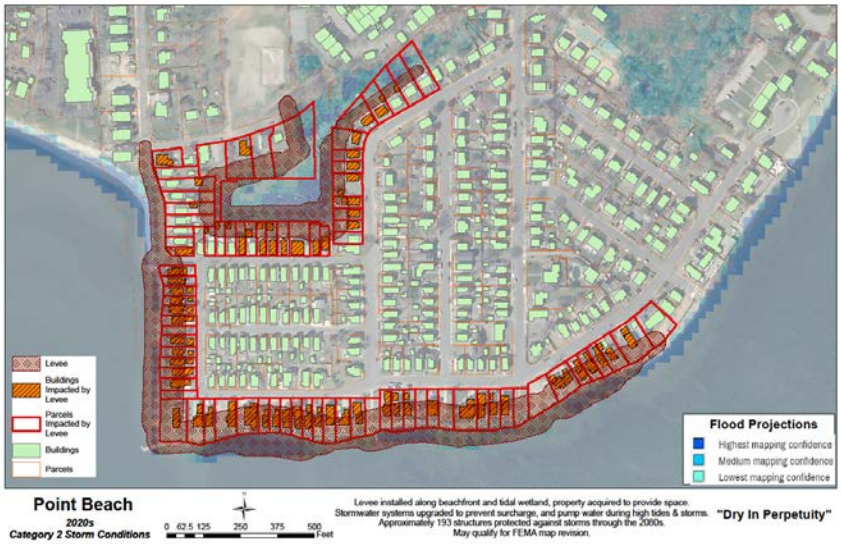
"Dry in Perpetuity"

Concept B depicts a combination of options that will protect the neighborhood from flooding during the daily high tides in the 2020s, 2050s, and 2080s and storm surges in the 2020s, 2050s, and 2080s. A levee, dike, or berm system would be installed and maintained along the beachfront with its front edge located along the alignment of current seawalls. The rear edge would be located an appropriate distance inland to provide a suitable width for the dike. A similar dike would be constructed along the edge of the tidal wetland. The dike would have design height that is equal to the projected storm surge in the 2080s plus a reasonable freeboard. The two dikes would necessitate the displacement of homes on approximately 50 beachside lots and 30 marshside lots. Some of the remaining property owners would need to grant permanent easements for the city to maintain the dike systems. Additional parcels would be affected, but they are either city owned or do not currently have structures. It is important to note that a more thorough exploration of the structural needs of such a dike, as well as incorporation of coastal and wetland construction regulations, may result in a scenario where the impact of this option would be greater than that discussed here.

Stormwater systems within the protected area would need to be upgraded over time. In addition, backflow prevention would be installed to prevent surcharging from the stormwater system during high tides. A stormwater pumping station would be installed to remove stormwater from areas that can no longer drain directly from streets. This pumping station could also pump stormwater against the higher base level occurring during high tides.

Property owners could stop elevating their homes if the dike system was accredited and maintained as a flood protection system and a FEMA map revision was obtained. Approximately 193 structures (including homes, garages, and sheds) would be protected (276 minus the 83 structures lost). Property owners with flood insurance would have the option to discontinue insurance policies after the FEMA map revision.

The implementation of this alternative is shown in the figures below.



These figures depict the impact that construction of a levee-protection system would have on parcels and properties within the Point Beach neighborhood, as well as on flooding under different conditions. Note that even under Category 2 storm surge conditions projected to the 2080s decade, the neighborhood is protected from flooding.

"Floodable Neighborhood"

Concept C depicts a floodable neighborhood. Dikes and floodwalls would not be constructed. Over time, the increasing daily high tides would extend to an increasing number of properties. All homes would be elevated in such a way to allow frequent flooding. Stormwater systems would be minimally upgraded over time, allowing the neighborhood to drain naturally each day at low tide. Roadways would be maintained as floodable, perhaps being reconstructed using materials that are more resilient to frequent inundation. Water and sewer systems would be hardened and made more watertight. All property owners with flood insurance would continue to hold flood insurance.

These graphics show the extent of flooding under different conditions assuming no flood prevention measures are being taken. Structures affected by flooding are highlighted, though the "floodable neighborhood" plan calls for them to be elevated. The two lower figures, depicting Category 2 storm conditions, are nearly identical to the "Dry Except During Storm Surge Events" graphics, since the floodwall discussed earlier would not prevent storm surge flooding.

Planning Level Costs for Alternatives:

Wall Construction

The wall on the seaward side of the neighborhood would need to be approximately 2,410 feet long in order to run along existing seawalls and property boundaries and be sufficiently long to prevent floodwaters from entering the neighborhood from the side. The wall on the tidal wetland side of the neighborhood, if determined to be necessary to prevent flooding from that source, would need to be approximately 1,450 feet long.

FEMA 551 – Selecting Appropriate Mitigation Measures for Floodprone Structures (2007) provides estimates of between $140 and $195 per linear foot for floodwalls between 4 and 6 feet above grade. A floodwall designed to prevent daily high tide flooding in the future would need to vary from a negligible height in some locations (where ground surface is somewhat higher) to a height of 4 to 5 feet in the most low-lying areas around the tidal marsh. To be conservative, an upper linear foot cost of $200 is assumed, which equates to an estimated cost of $772,000 for the floodwall.

Approximately 70 property owners would need to grant permanent easements for the city to maintain the floodwalls. For planning purposes, the cost for securing the easements is assumed to be at least $1,000 per property, or $70,000.

Upgrades to drainage infrastructure and installation of a stormwater pumping system are called for in this plan as explained above. Tideflex gate valves on storm sewer outfalls along with one or more pumping stations and force mains will likely be necessary. This can be expected to add an addition $1 million to the overall project cost.

In total, a reasonable planning-level cost estimate to construct a system to prevent daily high tide flooding in the future is upwards from $2 million when the costs of the wall, easements, stormwater system upgrades, and pumping station are summed.

Construction would not impact flood insurance rates for interior properties, but may potentially affect those for waterside structures that would be given additional protection from wave action. Approximately 188 structures would need to be elevated over time as substantial damage/ substantial improvement thresholds were reached, which is current practice. This cost would be borne by property owners, which is the current situation.

Dike/Berm System Construction:

In order to accommodate The Nature Conservancy's projected Category 2 storm under a "medium" sea level rise scenario through the 2080s, a dike would have to be a minimum of 12 feet elevation, NAVD88. To provide for wave heights, setup, and runup, while recognizing the limits on horizontal space in this location, a peak elevation of 14 feet is suggested for discussion purposes. The dike protecting the neighborhood on the inland side, against flooding from the tidal wetland, can be 12 feet in elevation because of the lack of wave action here.

To be consistent with levee construction guidelines, designed to ensure structural integrity, the side slope of the dike should be approximately 2.5:1 to 5.0:1. Additionally, the crest width should be 5 feet to allow for maintenance. Ground surface elevation along the shoreline varies, and as such so would the relative height of the dike. Based on elevation values from 2-foot contours and the necessary side slopes, an approximation of dike heights and widths required to protect Point Beach was made. These figures are summarized in the following table:

	Section ID	**Approx. Relative Height** (feet)	**Base Width** (feet)	**Length** (feet)
Seaward Side	0	4	37	50
	1	6	53	47
	2	8	69	139
	3	10	85	180
	4	8	69	519
	5	6	53	212
	6	8	69	144
	7	10	85	176
	8	8	69	67
	9	6	53	171
	10	8	69	306
	11	6	53	46
	12	8	69	211
	13	6	53	109
	14	8	69	174
	15	6	53	80
	16	4	37	114
	17	2	21	15
Tidal wetland Side	18	2	17	17
	19	4	29	21
	20	4	29	138
	21	4	29	95
	22	6	41	44
	23	4	29	34
	24	6	41	129
	25	8	53	450
	26	10	65	57
	27	8	53	74
	28	6	41	188
	29	6	41	13
	30	4	29	74
	31	2	17	319

The dike heights and widths will vary because the existing ground surface elevation will vary. This complicates the estimate of construction. However, using the dimensions in the above table, the total volume of material for the dike system will be at least 38,000 cubic yards. At an estimate of $50/cubic yard for compact fill material and neglecting incidental costs, the dike system would cost at least $2 million for fill material. Riprap along the waterward face of the berm or levee would cost an additional $1 million.

The two dikes would necessitate the displacement of approximately 59 homes. This number does not include nonstructural alterations to lots affected by levee construction nor the displacement of secondary structures such as garages or sheds. A review of the assessor data for Point Beach reveals an average assessed value of $800,000 per property for the affected properties. Understanding that market values are typically higher yet variable from year to year, the average assessed value of $800,000 is hereby used for planning. Acquiring 59 lots would cost at least $47.2 million.

Some of the remaining property owners would need to grant permanent easements for the city to maintain the dike systems. A separate cost has not been estimated for the easements, as it would likely be much lower than the real estate acquisitions needed for this alternative.

Upgrades to drainage infrastructure and installation of a stormwater pumping system are called for in this plan as explained above. Tideflex gate valves on storm sewer outfalls along with one or more pumping stations and force mains will likely be necessary. This can be expected to add an addition $1 million to the overall project cost.

One financial benefit associated with the dike option is that property owners would have the choice to discontinue flood insurance policies if the levee system were accredited and maintained as a flood protection system in perpetuity. This outcome also assumes that the city would secure a Letter of Map Revision (LOMR) from FEMA. Around 130 homes would benefit from this cost savings (188 homes minus the lots that were lost for the levee construction).

Another financial benefit associated with the dike option is that structures would not need to be elevated over time as substantial damage/ substantial improvement thresholds were reached, because the LOMR would map the structures out of the FEMA Special Flood Hazard Area (SFHA).

"Floodable Neighborhood"

Costs associated with the floodable neighborhood concept would be borne mainly by property owners. An upper-level cost estimate assumes *all* 188 homes would be elevated at a cost of $100,000 per home (including homes that have already been elevated to FEMA base flood elevations) to a future design elevation that takes sea level rise and frequent flooding into account. The total would be $18.8 million.

Municipal costs associated with upgrading drainage systems and repaving roads would be minimized in accordance with the approach described above (stormwater systems would be minimally upgraded over time, allowing the neighborhood to drain naturally each day at low tide. Roadways would be

maintained as floodable, perhaps being reconstructed using materials that are more resilient to frequent inundation).

Conclusion

While all three options may be technically feasible for the Point Beach neighborhood, they vary considerably in capital costs and social costs. Consider the following:

- The floodable neighborhood shifts the costs from the city to the property owners over the long term as the level of service from roads and drainage systems is minimized and the property owners elevate their homes. The property owners would continue to pay for flood insurance as they currently do.
- The design for protection from the daily high tide be may challenging but has associated costs that are somewhat equitable. The city would be responsible for capital costs for the flood protection, and the property owners would continue to elevate their homes and pay for flood insurance as they currently do.
- The design for protection from storm surges requires a dike system that would displace private properties. Therefore, this option is the most costly and would cause the greatest disruption to the neighborhood. However, this is the only option that could result in a FEMA map revision and eventual discontinuance of flood insurance for approximately 140 property owners.

Because the city is planning ahead with this coastal resilience plan, the three options for Point Beach could be viewed as steps rather than three different outcomes. It would be feasible, for example, to provide protection from the daily high tide through the next 30 to 50 years with the floodwall option while taking steps to eventually construct a dike system if there is consensus. On the other hand, it would be feasible to provide protection from the daily high tide through the next 30 to 50 years with the floodwall option and then revert to a floodable neighborhood if there is consensus for that outcome.

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Appendix F-1
Beaverbrook WWTP Coastal Resilience Concept

MILONE & MACBROOM

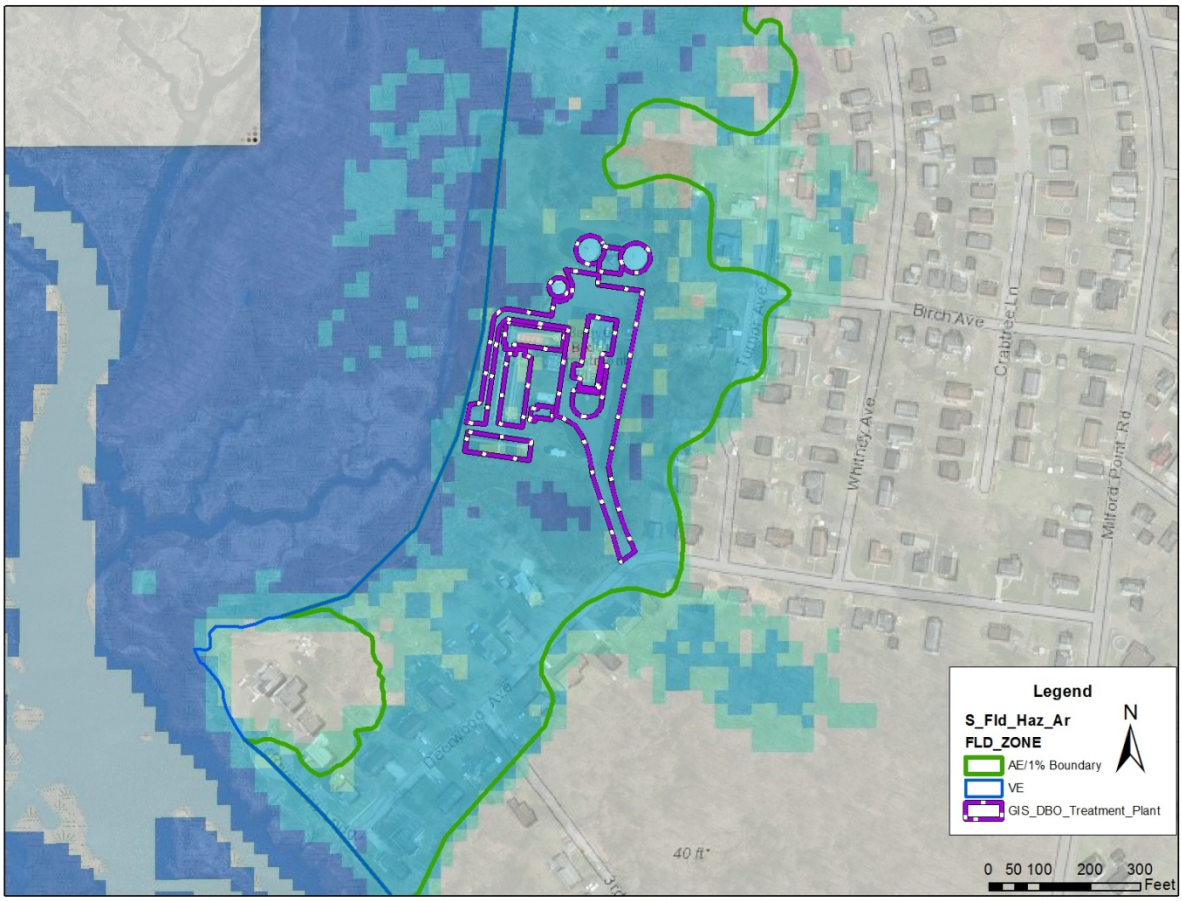
Flood Setting

The Beaverbrook Wastewater Treatment Plant (WWTP) is located along the eastern side of the Housatonic River in Milford, CT. The treatment plant is situated facing northwest on the inland side of a large salt marsh system near the Beaverbrook. After review of the preliminary Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) coastal study for New Haven County, CT, it was determined that the Wastewater Treatment Plant at Beaverbrook is inundated during the 1% chance storm event with a base flood elevation (BFE) of 11-ft NAVD88. The WWTP is mapped with a VE13 immediately adjacent to the built portions of the property according to the most recent preliminary FEMA study (Figure 1). In addition to the plant facilities, there is also a pump station, catch basins, outfalls, and sewer lines that would have an impact, or be impacted, during the 1% event.

Figure 1: Existing Conditions with FEMA preliminary FIS flood zones.

In addition to a review of the FEMA preliminary Flood Insurance Rate Map (FIRM) and FIS, a review of The Nature Conservancy's (TNC's) year 2080 Sea Level Rise projections on top of a Category 2 storm was performed. That analysis concluded that the inland flooding extent from the TNC scenario is similar to the extent noted in the FEMA preliminary FIS study data (Figure 2).

Figure 2: Beaverbrook WWTP, Milford, CT - TNC 2080 Cat 2 Sea Level Rise Projection vs. the FEMA 1% flood inundation



Based on this analysis of potential flooding scenarios, the 1%, or 100-year, flood with an additional foot of freeboard was selected for conceptual planning purposes.

Based on review of the topographic Light Detection and Ranging (LiDAR) data from the preliminary FEMA FIS as well as the wave analysis results (WHAFIS) for this area, it was determined that in order to prevent the storm inundation from impacting the WWTP structure as well as the infrastructure it will be necessary to add a ring wall around the western perimeter of the site to an approximate elevation of 12-ft NAVD88. The proposed placement of the ring wall would tie into the existing grade of 12-ft NAVD88 to the north as well as to the south. The limit of the ring wall and therefore the proposed tie-in areas are shown in Figure 3. The addition of this wall will provide protection to the upland structures under the 1% chance event as shown in the figure below.

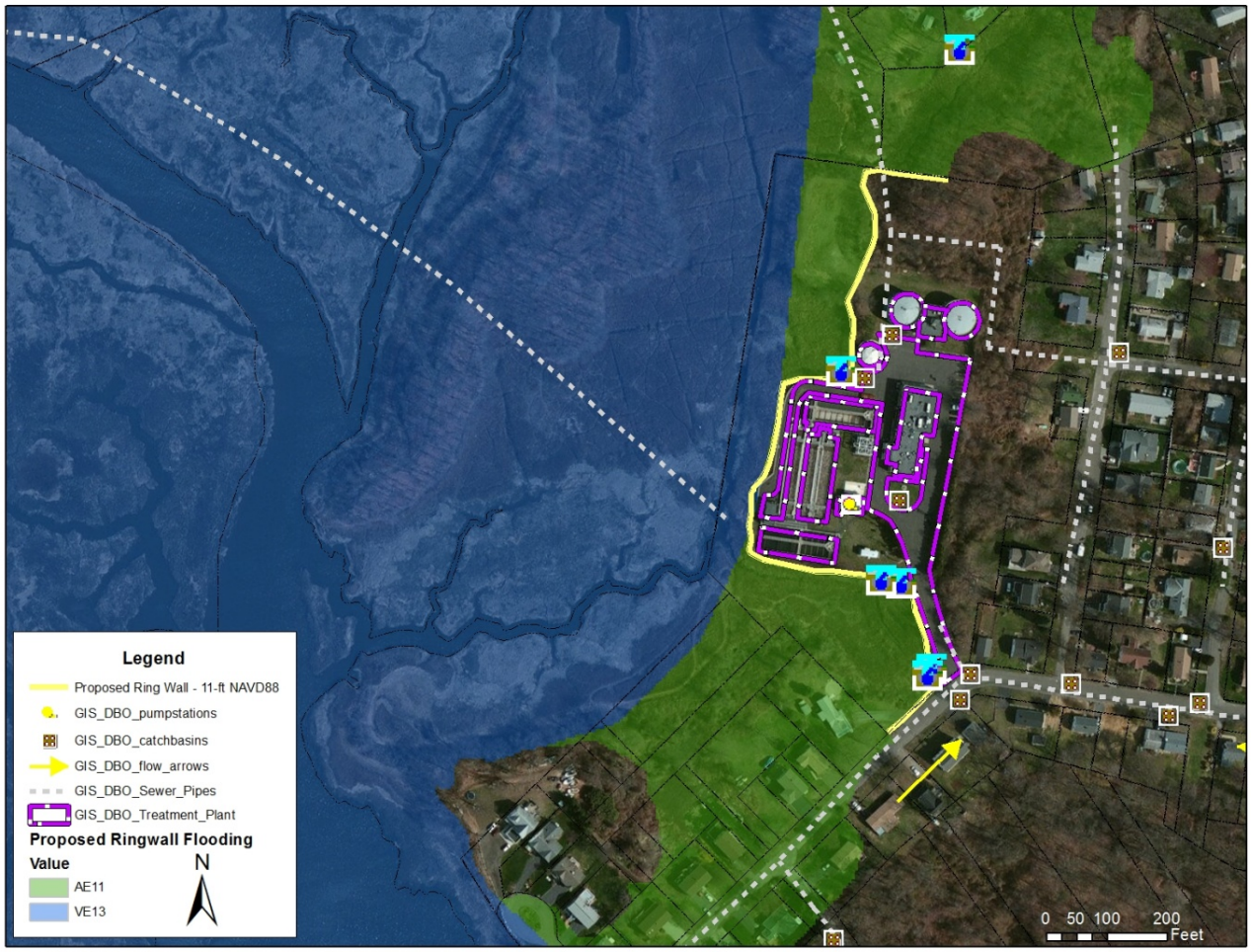


Figure 3: Proposed Conditions with FEMA preliminary FIS flood zones.

In addition to inundation of the site from overland flow of floodwaters, there are three catch basins and four outfalls on the site according to geographic information system (GIS) data provided by the city.

Proposed Infrastructure Resilience Concept

The proposed action to construct a flood barrier wall around roughly two thirds of the plant would also require dewatering measures inside the flood barrier wall to allow the plant to remain in limited operation during a flood disaster, and return to full operation more quickly after floodwaters subside, thereby protecting the health and safety of the public.

The floodwall design would utilize a reinforced concrete inverted T-type floodwall, which is a reinforced concrete wall, consisting of a concrete stem and base slab which form an inverted T, or Cantilever I-Type Wall. I-type flood walls use driven sheet piles capped by a concrete wall. Wall selection will depend on soil properties, geometry, and other factors. All walls should be designed as required to withstand the

hydraulic forces sustained during a flood event. United States Army Corps of Engineers (USACE) EM 1110-2-2502, Retaining and Flood Walls, provides design guidelines.

The wall will roughly follow existing contour 8-ft NAVD 88, and, in most places, will be approximately 4 feet above surface grade and will be approximately 1,500 feet long. *FEMA 551 – Selecting Appropriate Mitigation Measures for Floodprone Structures, 2007*, lists estimates of between $140 and $195 per linear flood for floodwalls between 4 and 6 feet above grade. This is consistent with other published sources. A recent detailed planning level cost estimate conducted for a site in New Haven, for a wall varying in height from 3 to 8 feet, using *RS Means Cost Estimating Guides*, yielded $311 per linear foot. To be conservative, for the purposes of this planning level estimate we've selected a linear foot cost of $250, for an estimated cost of **$375,000** for the proposed wall.

Site underground utilities were not reviewed as part of this concept. However, dewatering measures will be necessary to address accumulating water inland of the wall and the potential of backwater through on-site stormwater infrastructure. Tideflex gate valves on storm sewer lines along with one or more pump stations and force mains will likely be necessary. This can be expected to add an additional **$100,000 - $200,000** to the overall project cost.

Appendix F-2
Wildemere Beach Nourishment Coastal Resilience Concept

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Wildemere Beach Flood Setting

The area of Wildemere Beach presently consists of a narrow stretch of beach that in most areas is inundated to the existing first row of homes under normal high-tide conditions. To the southwest is a stretch of beach (Laurel Beach) that periodically undergoes renourishment, funded by homeowners, presenting a much wider beach and greater level of protection during storm events and daily high tide levels.

In order to determine a best alternative for the section of beach at Wildemere, the preliminary wave data from the most recent Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) was reviewed. Wave analysis was completed for the area approximately 480 feet (ft) to the northeast of FEMA study transect NH-02, near Waterbury Avenue, shown as a red line in Figure 1. Figure 2 shows a photo of the transect area. The wave analysis conducted at the transect is located in an area where the beach is wider than the placement of the FEMA transect and appears more representative of the average width of the existing beach.

Figure 1: Red line represents the location of the wave analysis for the proposed Wildemere Beach nourishment.

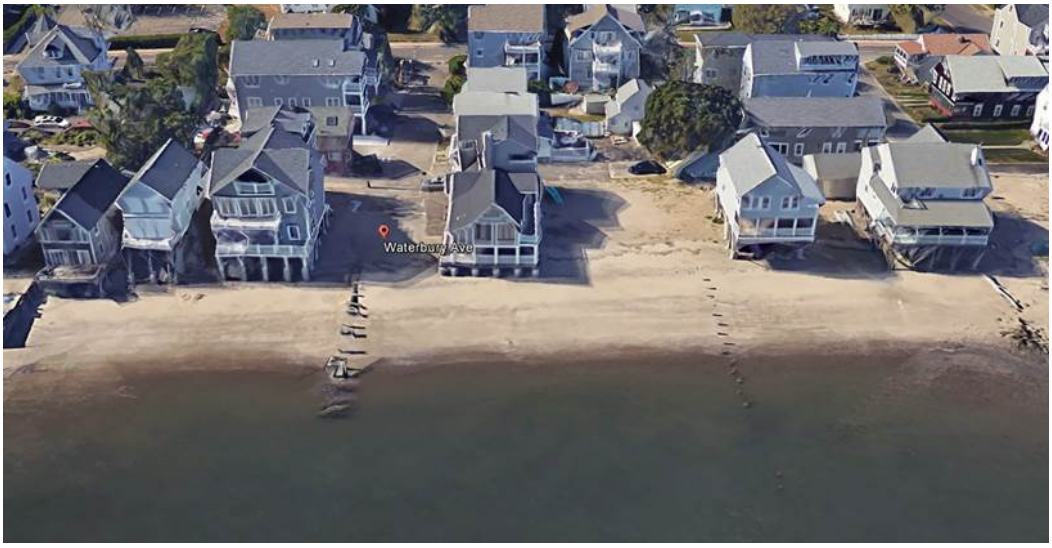


Figure 2: Location of analysis transect in oblique imagery.

In addition to a review of the FEMA preliminary FIRM and FIS, a review of The Nature Conservancy's (TNC's) year 2080 Sea Level Rise projections, on top of a Category 2 storm was performed. That analysis concluded that the inland flooding extent from the TNC scenario is similar to the extent noted in the FEMA preliminary FIS study data as shown in Figure 3.

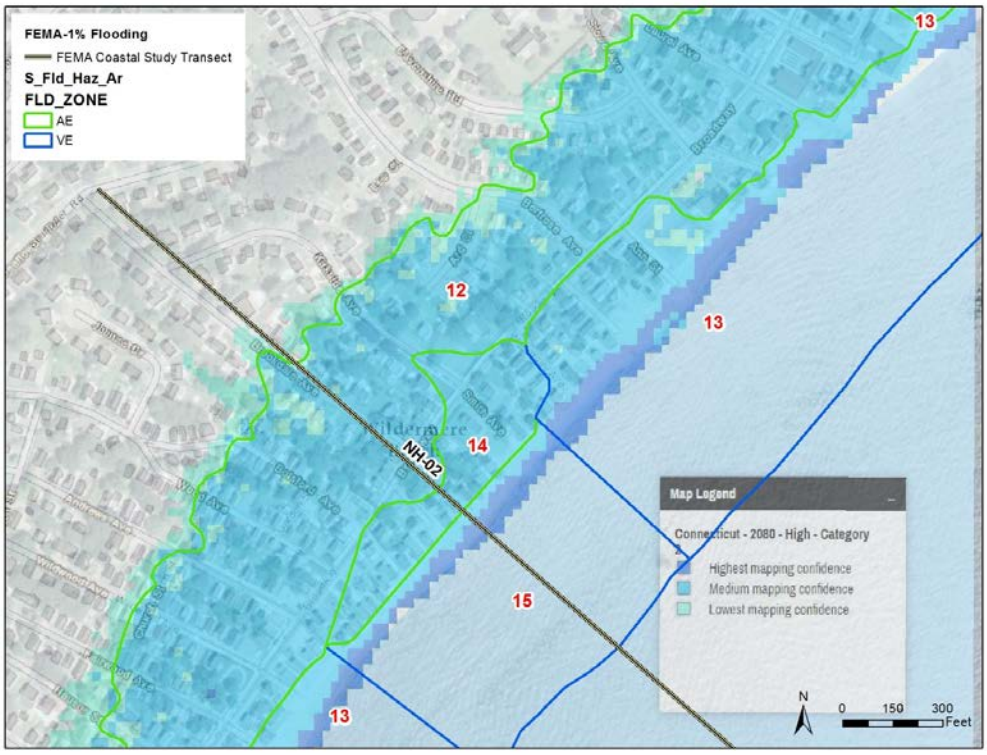


Figure 3: Wildemere Beach, Milford, CT - TNC 2080 Cat 2 Sea Level Rise Projection vs. the FEMA 1% flood inundation

The area landward of Wildemere Beach is densely developed with primarily residential structures with varying low-floor elevations and construction types. A review of the inundation area for the 1% (100-year) flood event determined that approximately 272 homes are potentially impacted by that event (Figure 4) which, as noted above, is very similar to the 2080 SLR scenario combined with a Category 2 hurricane storm surge. In addition, a substantial amount of infrastructure (e.g. roadways, water, sewer, and gas) is also impacted along this section of shoreline.

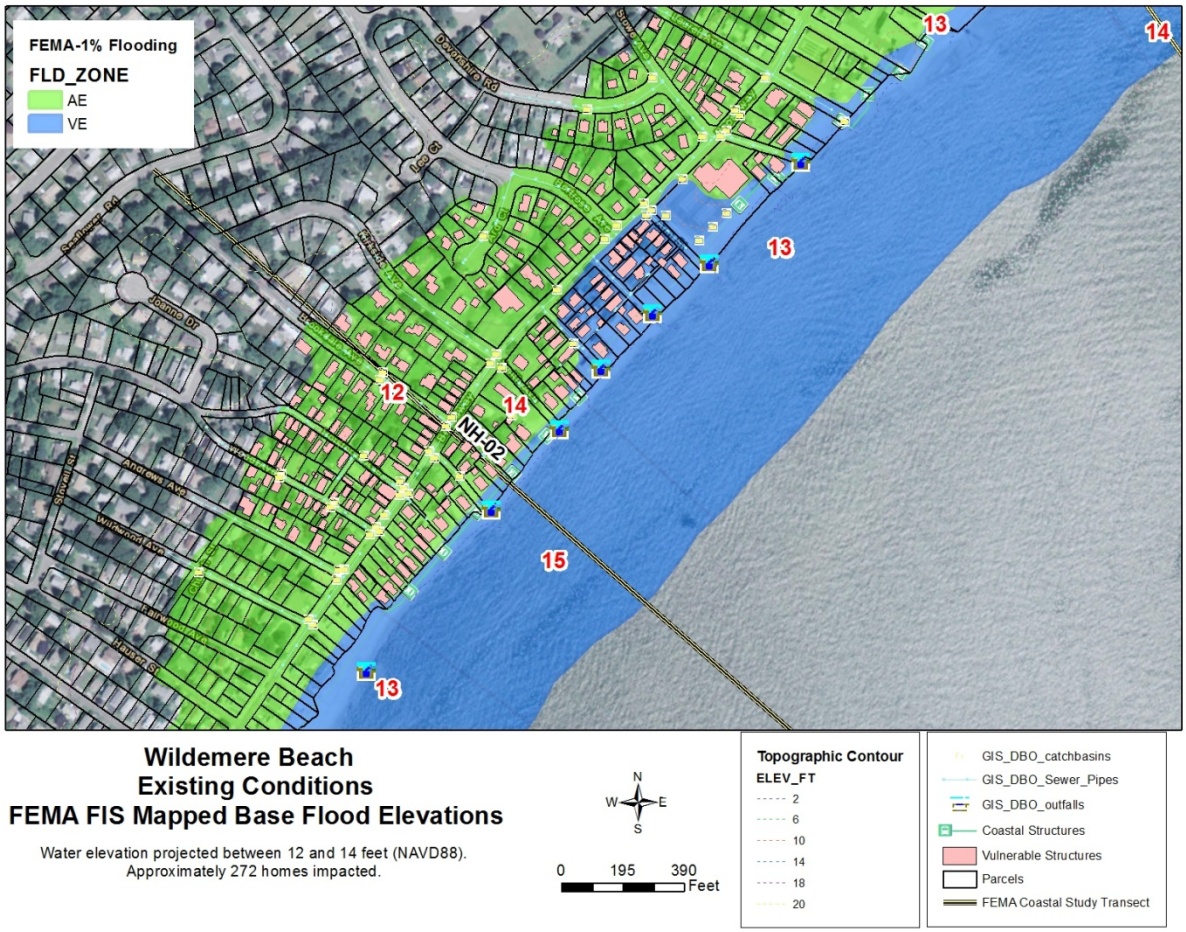


Figure 4: Existing site conditions with FEMA Preliminary FIS Mapped Base Flood Elevations.

Proposed Infrastructure Resilience Concept

In order to provide adequate protection to these upland structures, an alternatives analysis was conducted for this area. The addition of a beach nourishment and berm profile were reviewed for effectiveness.

The proposed construction of a beach and berm at this location, to protect from this event, will require extending the beach for more than 70 ft due to the narrowness of the existing beach. Modeling determined that the following dune dimensions are needed for Wildemere Beach:

- Dune crest elevation = 12.5 ft
- Dune crest width = 10 ft
- Slope = 1:2.5
- Berm width = 20 ft
- Berm slope = 1:10
- Berm elevation = 6 ft (above mean higher high water)

Figure 5 shows a profile graph for the proposed dune. The blue line represents the existing ground profile and the orange line the proposed dune profile. Station 0 is at the existing shoreline. The dune is proposed to extend to approximately 48 ft inland from shoreline (Station 48) which is where the existing houses are located.

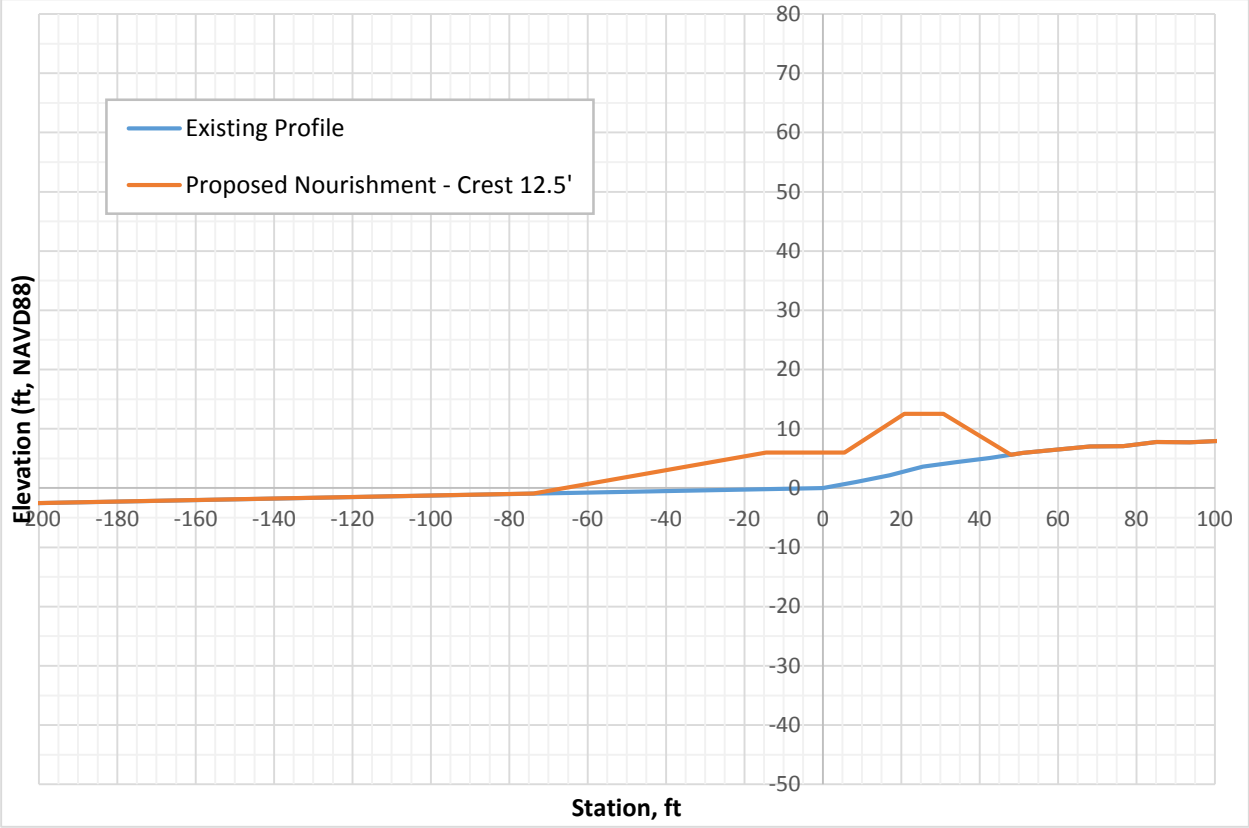


Figure 5: Proposed dune profile

When intact, the dune elevation is higher than water elevation at the 1%, or 100-year (yr), flood event. Figure 6 shows the model results of the extent of protection from the dune before erosion. The drawing at the end of this summary provides a plan view of the project with potential grading.

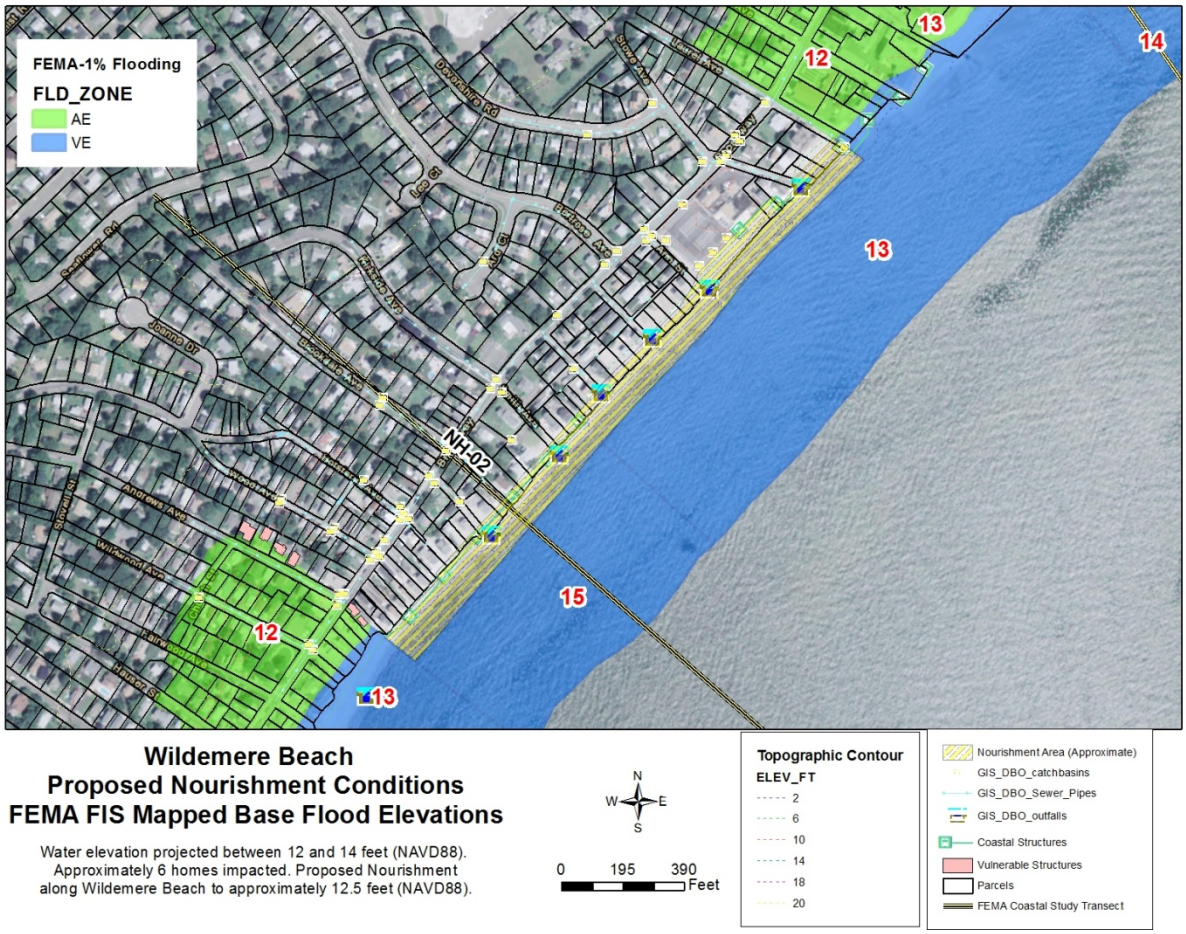


Figure 6: Wildemere proposed conditions

Analysis of Dune Erosion From a 10-year Storm Event

Beach features such as "dunes" and/or "berms" will always get eroded to some extent along the stretch of shoreline and will require regular maintenance. For this reason, the United States Army Corps of Engineers (USACE) Cross-Shore numerical model (CSHORE) for waves, currents, and sediment transport and beach profile evolution was run. After applying erosion based on the 10-yr event, the maximum eroded profile of the dune will be as illustrated in Figure 7. Erosion was applied using CSHORE on this profile for 5-day Hurricane Sandy, scaled to the 10-yr return frequency Stillwater Elevation (SWEL) with wave heights ramped to the 10-yr wave data (Hs and Tp provided by USACE from the NACCS study). The analysis assumed a grain size of d50 = 0.3mm.

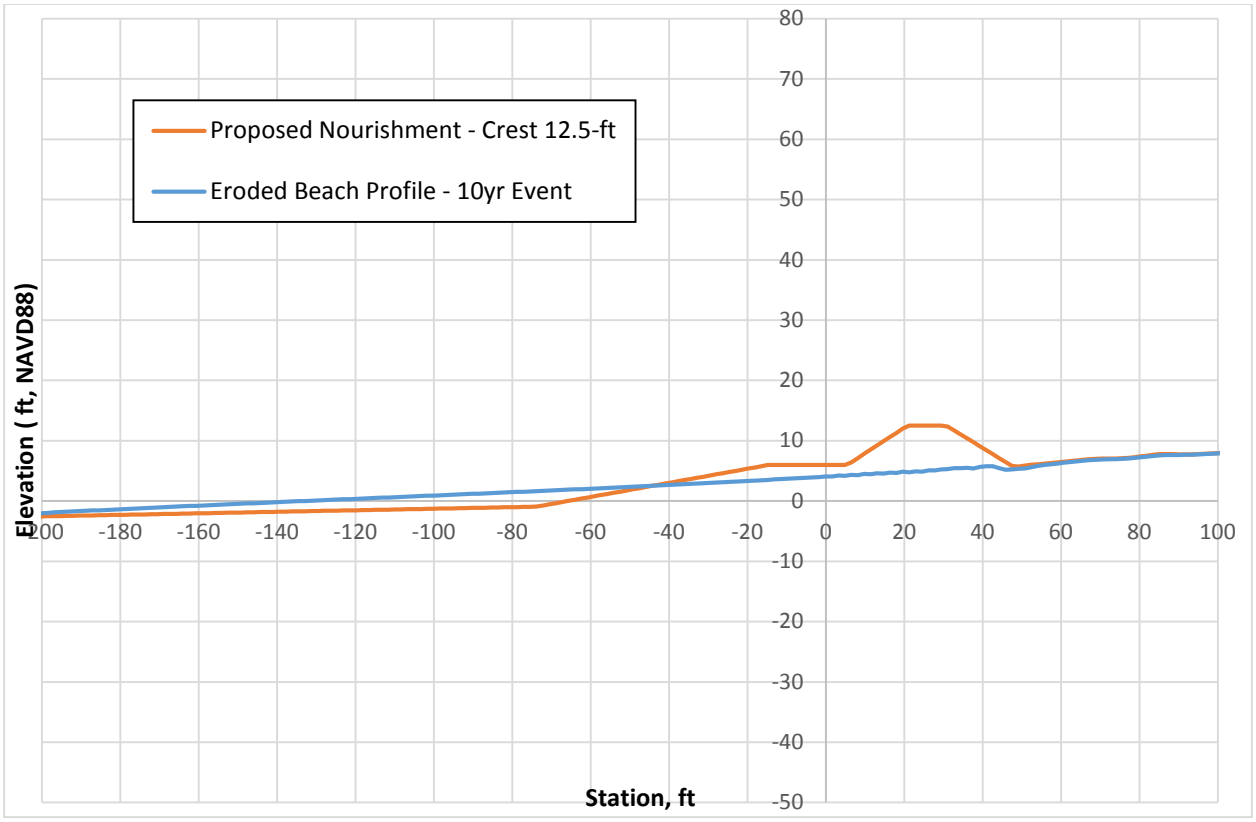


Figure 7: Eroded profile during the 10-yr storm event

Secondary Interventions or Alternatives to Beach Nourishment

Based on the preliminary erosion model run, this dune will get eroded and potentially overtopped by the 10-yr event. To prevent the erosion and the overtopping, a higher dune may be built. However, building a higher beach profile requires building a wider beach. Although a wider beach will afford greater protection, it may not be cost effective and will be increasingly difficult to permit.

To provide more effective long-term protection, construction of offshore breakwaters, along with or without construction of the hardened core sand dune and/or berm, should be considered. Adding a hard core to the "dune" or "berm" feature along this stretch of shoreline up to the elevation of 8.2 ft (10-yr flood elevation) may be a viable option to provide added protection and stabilize the dune core during a 10-yr event.

Another recommended option would be building offshore breakwaters parallel to the shoreline, similar to those shown in Figure 8 and a breakwater perpendicular to the shore line to tie in to the adjacent beach nourishment area located southwest of Wildemere Beach at Laurel Beach.

Figure 8: Example of offshore breakwaters with dune feature.

In order to determine the best secondary protection alternative to mitigate overtopping and erosion of the proposed beach profile during the 10-yr event along Wildemere Beach, it will be necessary to conduct further detailed erosion and wave analysis.

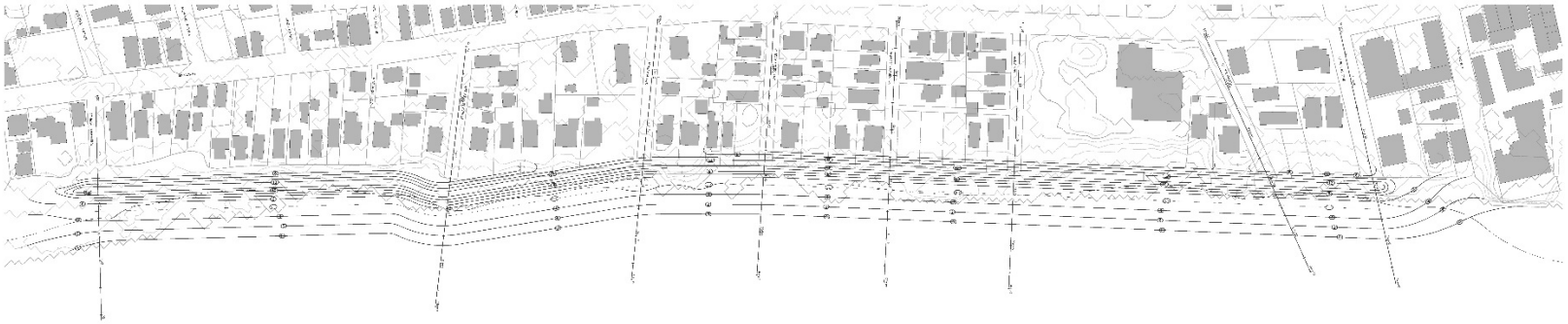
Planning Level Cost Estimates for Beach Nourishment

The length of the nourishment area is roughly 2,150 ft. Construction of the beach profile and the berm will require about 44,130 cubic yards of sand. **Cost =** $308,910 at $ 7.00 per cubic yard.

Estimates are based on costs in neighboring West Haven, Connecticut, for a recently completed project. The cost of nourishment sand material varies dramatically depending on quantity, source location, and means of transport to the site. In West Haven, sand was transported to the site from Cape Cod, Massachusetts, and purchased by the ton. We consider this the most conservative of planning level cost estimation, based on the distance from Milford to Cape Cod. After converting the per-ton cost to cost per cubic yard we estimate $50/cubic yard, in place and graded to profile for approximately 44,130 cubic yards. Planning level cost estimate equals **$2,206,500** for the beach nourishment portion of this recommendation. Material from a local source should significantly decrease this estimate.

As noted above, additional, detailed erosion modeling is needed to determine the most effective secondary protection to prevent dune erosion and overtopping during lesser events. For that reason, it is not possible to provide cost estimates for those features at this time.

Figure 9: Wildemere Beach Project Conceptual Grading Plans



Appendix G
Notes from Public Meetings

City of Milford
Coastal Resilience Plan
Initial Public Meeting: Assessing Vulnerability and Risk

MaryRose Palumbo, City of Milford
Meghan McGaffin, City of Milford
Joseph Griffith, City of Milford

David Murphy, P.E., CFM, Milone & MacBroom, Inc.
Noah Slovin, Milone & MacBroom, Inc.
Scott Choquette, CFM, Dewberry




City of Milford, Connecticut | January 28, 2016

Agenda

- Project: *Funding and Planning Steps*
- Resilience: *What is it?*
- Identifying Risk
- Vulnerability: *Assets and Areas*
- Options *for Adaptation*
- Next Steps
- Discussion

Project: Funding

Community Development Block Grant (CDBG):

Recovery Eligible Activities – Coastal Resilience Plan

- Purpose is to increase social, economic, ecological resilience
- Respond to sea level rise, more frequent & severe storm surges, coastal floods, erosion
- Should benefit underserved, low-to-moderate income populations and their communities.
- These are located in the following areas:
  - *Wildemere Beach*
  - *Point Beach*
  - *Downtown Milford*
  - *Several non-coastal neighborhoods that are linked to the shoreline*

Project › Resilience › Risk › Vulnerability › Options › Next Steps › Discussion

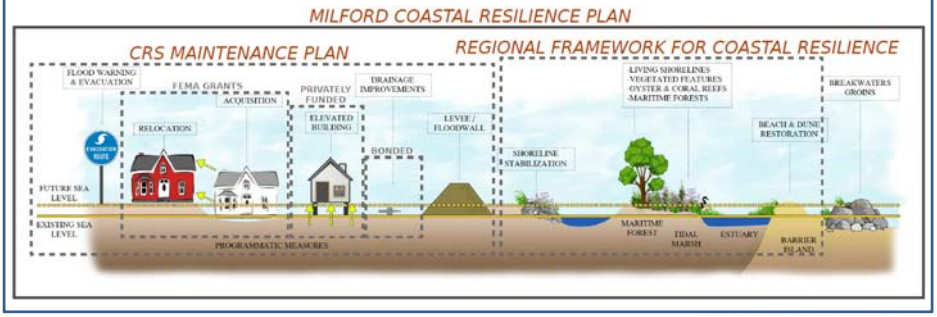
Project: Funding

Community Development Block Grant (CDBG):

Interface with other resilience efforts

- Examples include the *Hazard Mitigation Plan,* the *Regional Framework for Coastal Resilience,* the *Milford Community Rating System (CRS) Plan,* and other resilience projects

MILFORD HAZARD MITIGATION PLAN



Milone & MacBroom

Project: Planning Steps

- Done • Review Existing Capabilities
- Fall • Coordinate with "Regional Framework"
- Fall • Data Collection
- Fall • Vulnerability and Risk Assessment
- Now • Review of Adaptation Options
- Now • Public Information Meetings, Surveys
- Winter • Select Sandy-Impacted Neighborhoods
- Spring • Coastal Resilience Plan
- Spring • Implementation Plan and Process
- Spring • Conceptual Designs

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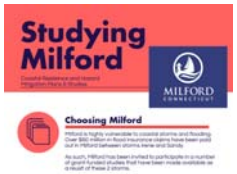
Project: Planning Steps

- Review Existing Capabilities



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Project: Planning Steps

- **Review Existing Capabilities**

The City of Milford Hazard Mitigation Projects 2008 (Flood-Specific)

Vulnerable Location	Mitigation Project	Current Status
City Beach Areas	Identify flood prone properties and develop flood mitigation projects including structural elevation, property acquisition and roadway/storm drain reconstruction	Properties identified, 2013 Project list contains more specific actions. Elevations, acquisitions and reconstruction occurring as needed
Point Beach	Upsize culverts Drainage Work Flapper Valve on Point Beach Drive	Done
Wepawaug River – Eisenhower Park	The pond will be dredged so it will be smaller and deeper. The dam will be repaired. A berm will be removed and a flood plain area of 4-5 acres will be restored.	Project designed, construction awaiting funding.
Local Roads and Highways	Evaluate structural projects	Considered standard business practice, specific actions outlined in 2013 plan list
Wepawaug River at Boston Post Road (Route 1)	Improve hydraulics of bridge to alleviate flooding	In the design phase as a state project
Wepawaug River – North Street	Channel improvement project	Project cancelled*
Silver Sands to Laurel Beach	Improve storm drain outfalls.	Ann St. completed, other areas pending funding

Figure 52: **STAPLEE Evaluation of Municipal Mitigation Projects**

Municipal Mitigation Project	STAPLEE Score	Project Priority Ranking
Naugatuck Avenue	7	High
Bayview Beach	5	High
Flood Gauges	5	High
Tumblebrook	4	Medium
Animal Shelter	4	Medium
Silver Sands	3	Medium
Generators	2	Medium
Beachland/Melba	1	Low
Creeland	-2	Low

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What is Coastal Resilience?

Community Resilience

Prepare

Adapt

Withstand

Recover

Elevating Homes Protects them from Storm Surge. Hillside Ave
Image: activerain.com

Coastal Resilience

Full/New Moon-Tide flooding

Sea level rise

Storm surges

Continued erosion

Walnut Beach
Image: David Murphy

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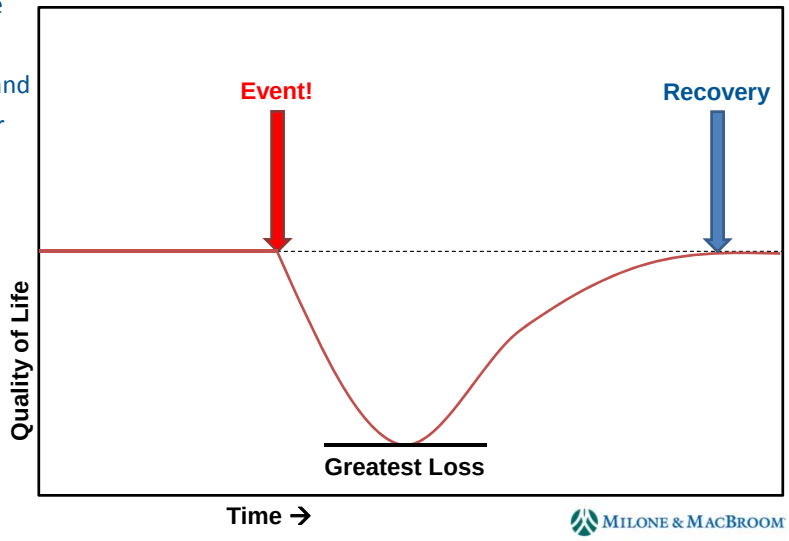
What is Coastal Resilience?

Resilience

- Prepare
- Adapt
- Withstand
- Recover



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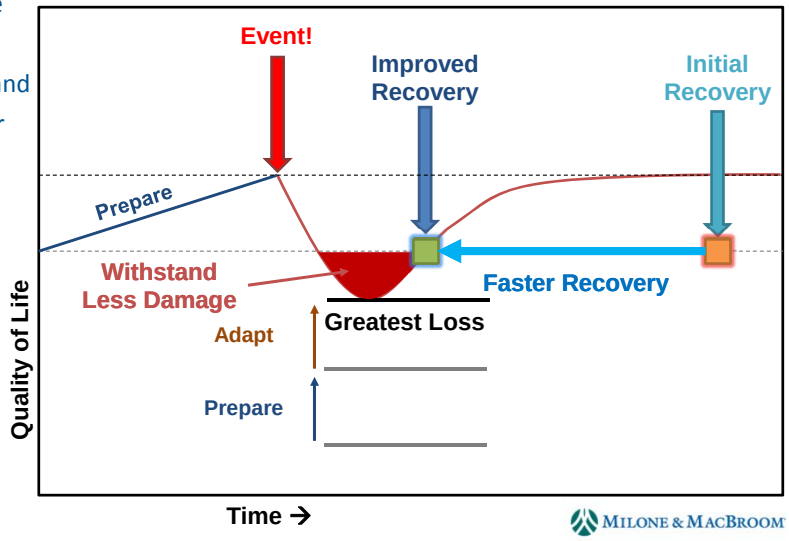
What is Coastal Resilience?

Resilience

- Prepare
- Adapt
- Withstand
- Recover



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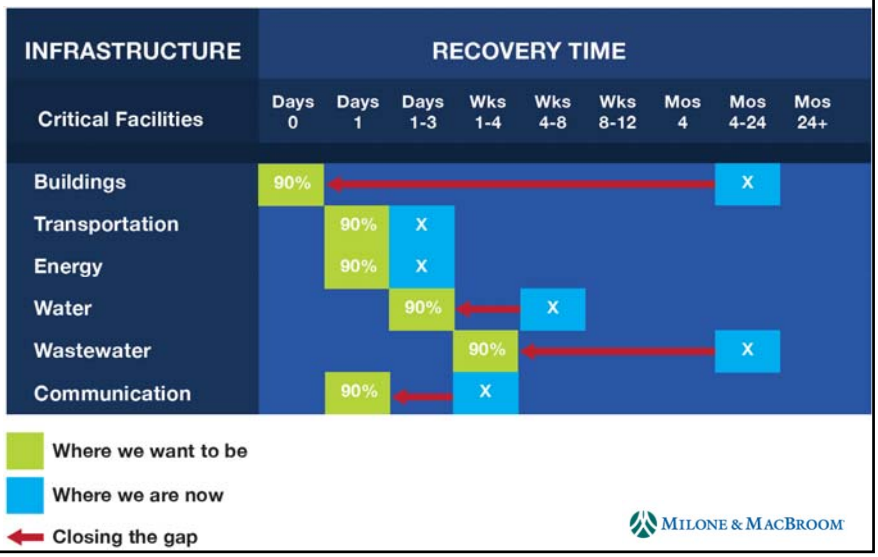
What is Coastal Resilience?

Resilience: Reducing Time to Recovery



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Risk

Risk = Vulnerability x Frequency

Vulnerability: how susceptible to loss or damage?

Frequency: how often does the event happen?

Risk from General Natural Hazards

Minor damage in Plainfield, CT, after a small quake in January

Photo: wtnh.com

Frequency	Vulnerability: Low	Vulnerability: Med	Vulnerability: High
Low	Bear Attack	Earthquake	Tornado
Med	Drought	Wildfire	Hurricane
High	Thunderstorm	Snow Storm	Flood

Flash Flood in Milford, 2012

Image: NBCConnecticut.com

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Risk

Risk = Vulnerability x Frequency

Vulnerability: how susceptible to loss or damage?

Frequency: how often does the event happen?

Risk from Coastal Storm Hazards	Frequency	Vulnerability: Low	Vulnerability: Med	Vulnerability: High
Major Storms	Low	Erosion of Uplands	Wastewater Plant Flooded	Major Roads Eroded
Chronic Storms	Med	Wetlands Flooded	Businesses Flooded	Major Roads Flooded
Daily High Tide	High	Beach Erosion	Septic System Failure	Drainage Infrastructure Flooded

Frequency is changing!

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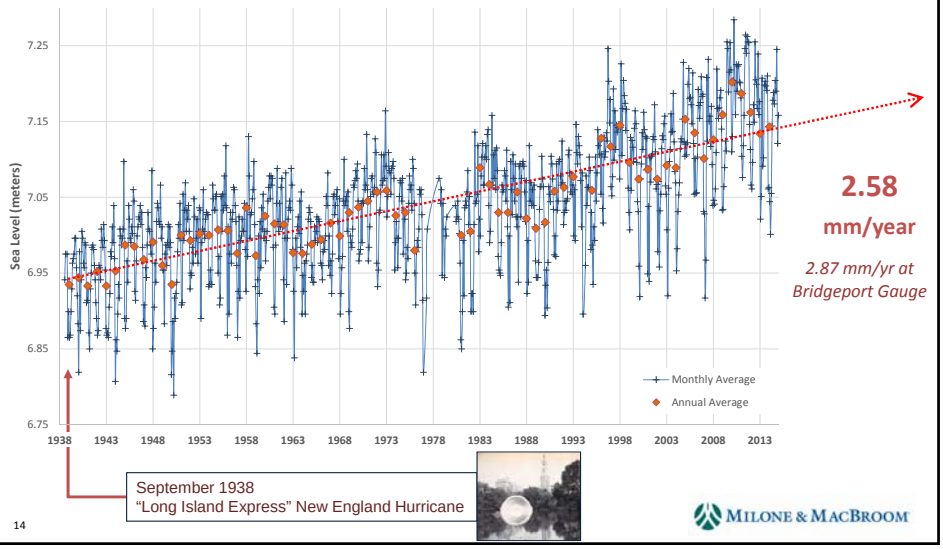
Risk

- **Past Frequency: Sea Level Has Been Rising**
  - NOAA Tide Gauges, 1938 – 2015 (PSMSL data, New London)



2.58 mm/year

2.87 mm/yr at Bridgeport Gauge

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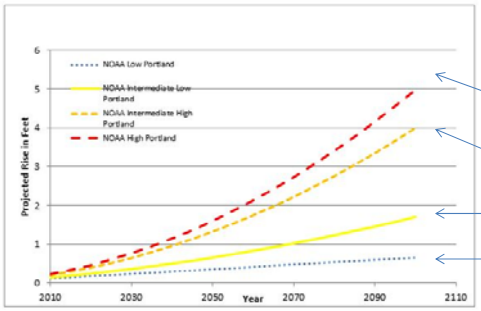
Risk

- **NOAA and the Army Corps of Engineers developed several sets of projections that were published in 2012**



Ocean warming + highest polar ice melt

Ocean warming + some polar ice melt

Ocean warming

Continuation of historical trend

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Risk

- **Future Frequency: Sea Level Rise Projections**
  - The Nature Conservancy
  - Columbia University Earth Institute
  - NASA Goddard Institute for Space Studies
  - *Analysis performed 2010-2011*

Projected Relative Sea Level Rise Averaged Across Long Island Sound (inches)

Scenario	2020's	2050's	2080's
Low	3.5	10	18.5
Medium	3.5	10	20
High	9	26	52

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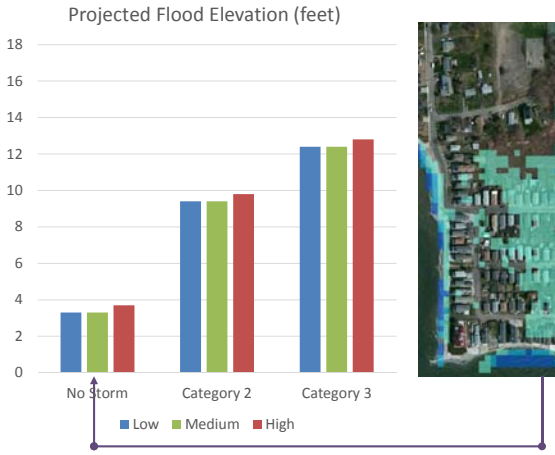
Inundation Risk

- **2020s: medium scenario mapped by TNC's coastal resilience viewer**



No Storm – 2020's
Medium Sea Level Rise Projections
Point Beach

Source: TNC (www.coastalresilience.org)

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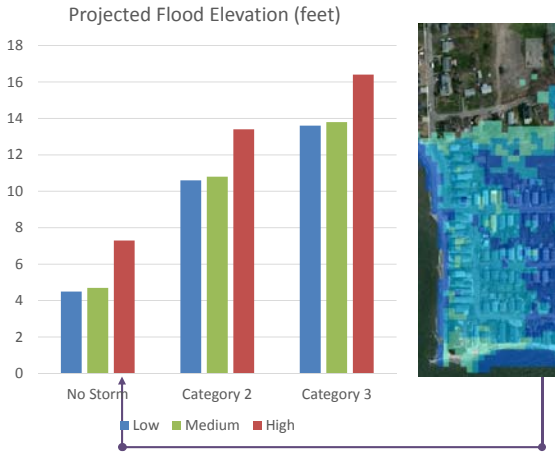
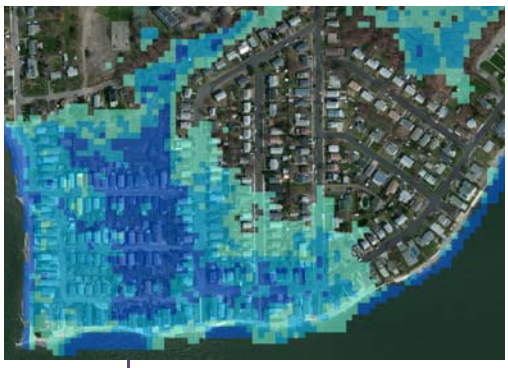
Inundation Risk

- **2080s: high scenario mapped by TNC's coastal resilience viewer**





No Storm – 2080's
High Sea Level Rise Projections
Point Beach

Source: TNC (www.coastalresilience.org)

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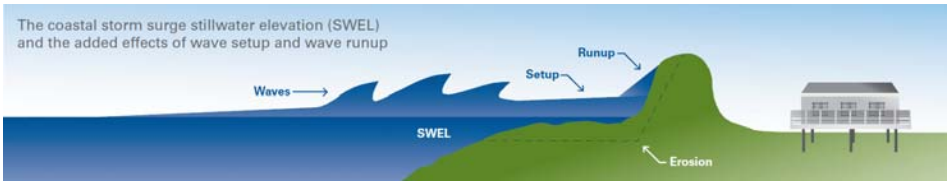
Wave Risk

Other Flood Risk Sources

FEMA Studies Provide Information not Captured by Coastal Resilience Tool



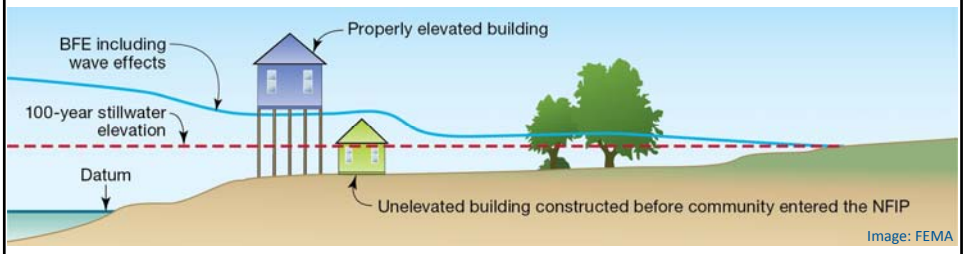


Image: FEMA

It's more complicated than a higher sea level

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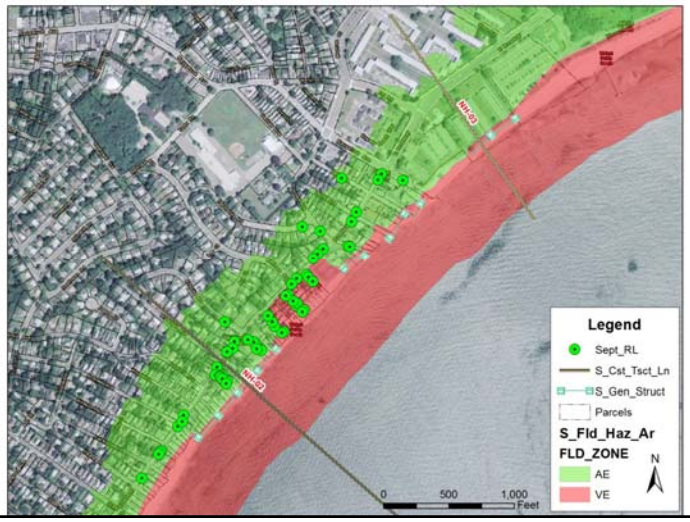
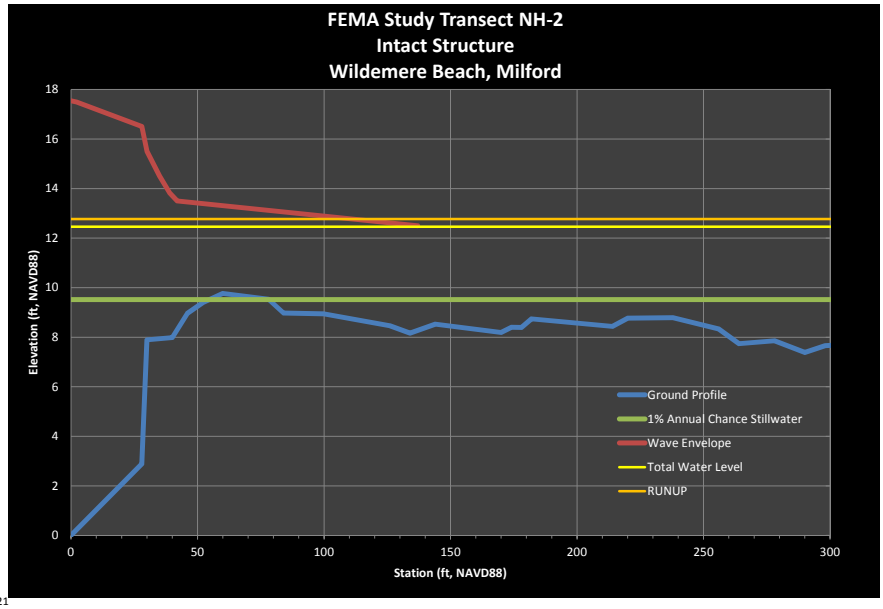
Wave Risk

FEMA (PRELIMINARY) FLOOD INSURANCE STUDY
August 10, 2015
WALNUT AND WILDEMERE BEACH, MILFORD, CT



Wave Risk



Wave Risk

Milford – FEMA Coastal Study - NH-2			
10% **ft., navd88**	2% ft., navd88	1% (incl. wave setup) ft., navd88	0.2% ft., navd88
7.4	8.9	9.5/11.72	10.8
Milford – USACE NACCS Water Levels (all return periods include wave setup)			
10% **ft., navd88**	2% ft., navd88	1% ft., navd88	0.2% ft., navd88
8.4	10.1	11.1	14.1

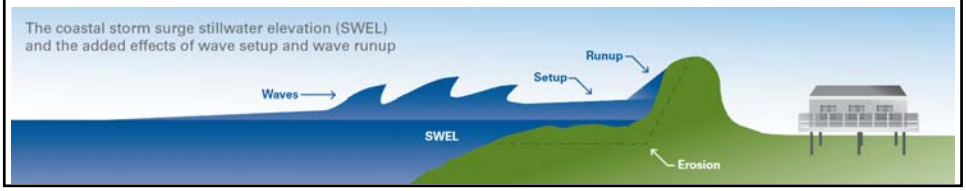
Wave Risk

SUMMARY OF PRIMARY HAZARDS:
Wildemere and Walnut Beaches
Milford

FEMA Coastal Study Transect NH-02 and NH-03:

Vertical concrete wall, 6 feet high (NH-02) and Gabion Revetment (NH-03)

- Wave runup elevations dominate over wave heights (steeply sloped beaches, bluffs, and/or shore-parallel flood protection structures)
- Wave Overtopping – Inland extent of Zone VE mapped to Wave Overtopping Splash Zone
- Overland Wave Inundation – Zone VE offshore and Zone AE mapped inland
- Velocity Zone at Shoreline
- 1-Percent-Annual-Chance Stillwater – 9.5 feet (Total Water Level = 12 feet includes wave setup), NAVD88

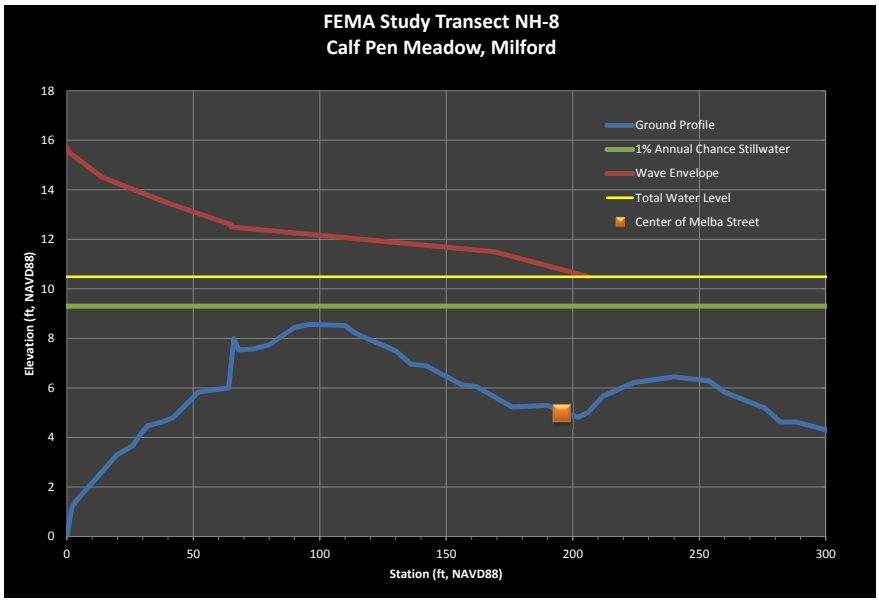


Project › Resilience › Risk › Vulnerability › Options › Next Steps › Discussion

Wave Risk

FEMA (PRELIMINARY) FLOOD INSURANCE STUDY
August 10, 2015
Calf Pen Meadow and Point Beach

Wave Risk



Wave Risk

Milford – FEMA Coastal Study - NH-8			
10% ft., navd88	2% ft., navd88	1% **(incl. wave setup) ft., navd88**	0.2% ft., navd88
7.2	8.6	9.3/**10.5**	10.6
Milford – USACE NACCS Water Levels *(all return periods include wave setup)*			
10% ft., navd88	2% ft., navd88	1% **ft., navd88**	0.2% ft., navd88
8.4	10.1	11.1	14.1

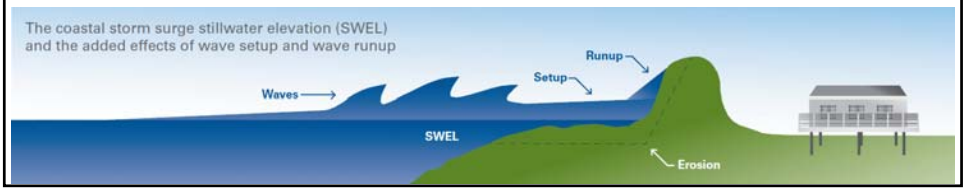
Wave Risk

SUMMARY OF PRIMARY HAZARDS:
Calf Pen Meadow
Milford

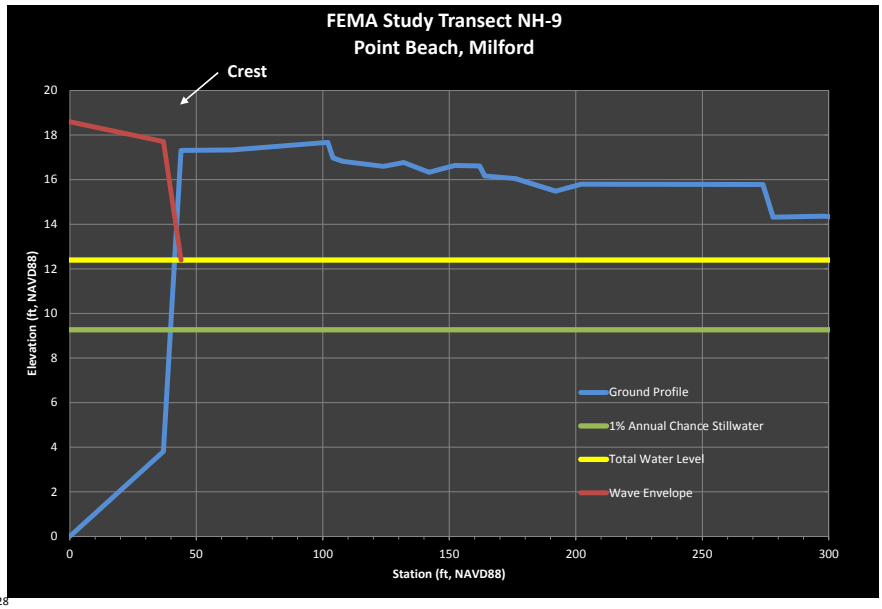
FEMA Coastal Study Transect NH-08:

Vertical concrete wall (NH-08)

- Overtopped– Structure crest is overtopped by the 1-Percent-Annual-Chance Stillwater
- Overland Wave Inundation – Zone VE offshore/extended inland of first row of homes and Zone AE mapped inland (Max. Wave Crest = 13 ft)
- Velocity Zone at Shoreline
- 1-Percent-Annual-Chance Stillwater – 9.3 feet (Total Water Level = 10.5 feet includes wave setup), NAVD88



Wave Risk



Wave Risk

Milford – FEMA Coastal Study - NH-9			
10% ft., navd88	2% ft., navd88	1% **(incl. wave setup) ft., navd88**	0.2% ft., navd88
7.3	8.7	9.3/**12.4**	10.5
Milford – USACE NACCS Water Levels *(all return periods include wave setup)*			
10% ft., navd88	2% ft., navd88	1% **ft., navd88**	0.2% ft., navd88
8.4	10.1	11.1	14.1

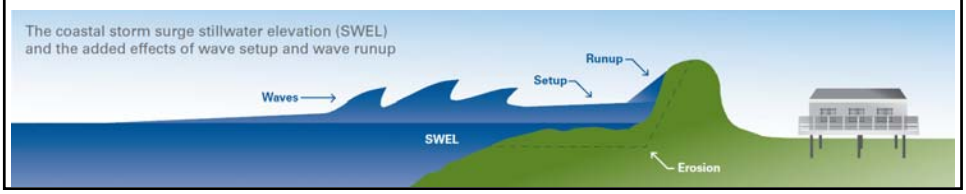
Wave Risk

SUMMARY OF PRIMARY HAZARDS:
Point Beach
Milford

FEMA Coastal Study Transect NH-09:

Vertical concrete wall

- Overland Wave Inundation – Zone VE offshore/extended inland of profile crest (Max. Wave Crest = 20 ft)/AE Zone mapped inland to the southwest of NH-09
- Runup was not mapped along this transect during the most recent FEMA coastal study however based on review of FEMA profile data should be considered a hazard at particular locations along this section of shoreline.
- Velocity Zone at Shoreline
- 1-Percent-Annual-Chance Stillwater – 9.3 feet (Total Water Level = 12.4 feet includes wave setup), NAVD88



Risk

Risk & Vulnerability Assessment: first step to Coastal Resilience Plan

Frequency	Urgency: 2080's	2050's	2020's
Category 3 Storm	?	?	?
Category 2 Storm	?	?	?
Daily	?	?	?

- Infrastructure
- Economy
- Health & Safety
- Natural Resources
- Social Resources

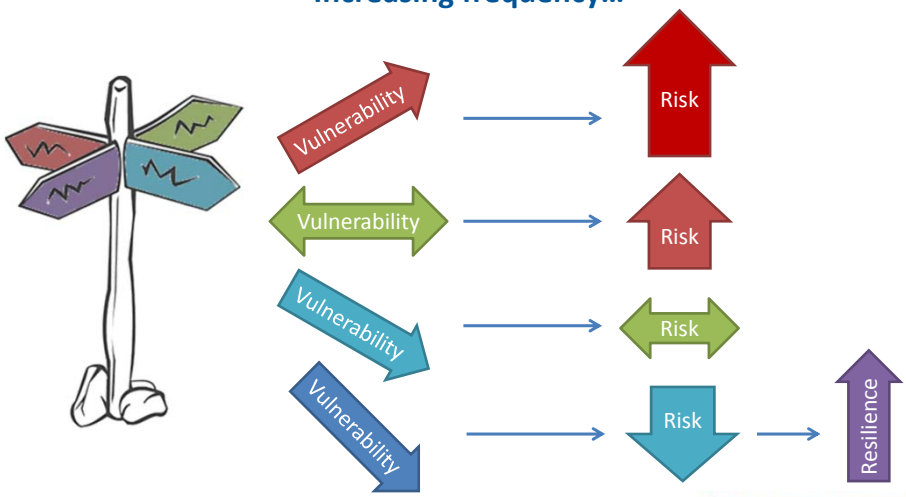
Risk

- **Recall that Risk = frequency x vulnerability**
  - **Sea level rise is increasing frequency of events like daily inundation, damaging storm surges, and erosion**
  - **Vulnerabilities can remain static and risks will increase in the face of rising seas and increased coastal storm frequency or magnitude**
  - **Vulnerabilities can be reduced to hold risk at bay, or…**
  - **If vulnerabilities can be reduced even further, then risks can be lowered, leading to increased resilience**

Risk and Resilience

Milford is at a Crossroads

Increasing frequency…



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Vulnerability

Social/Economic

- Commerce, Industry, Tourism, Development, Health & Safety

Infrastructure

- Roads, Bridges, Flood Control Systems, Public Works, Sewer & Septic Systems

Utilities

- Water Distribution, Private Water Supplies, Electrical Grid, Communications

Critical Facilities

- Fire, Police, Shelters, Evacuation Routes, Healthcare, Senior Living Facilities

Natural Systems

- Tidal Wetlands, Coastal Landforms

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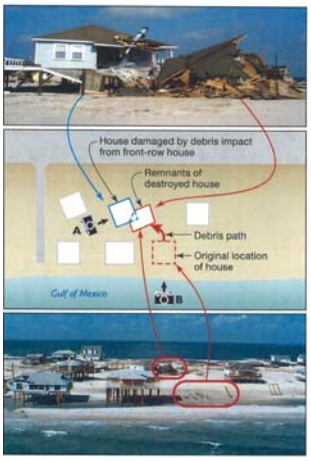
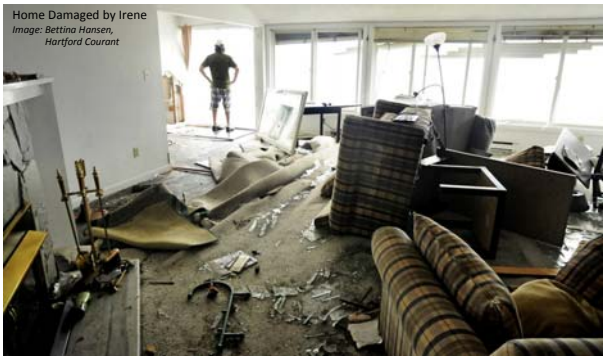
Vulnerability

Social/Economic



Home Damaged by Irene
Image: Bettina Hansen, Hartford Courant



Flooding in Milford after Irene affects business operations
Image: Michelle Gervais

Project Resilience Risk Vulnerability Options Next Steps Discussion

Vulnerability

Infrastructure

Flooding at High Tide
Image: MMI

Sandy Flooding in Milford
Image: REUTERS

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Vulnerability

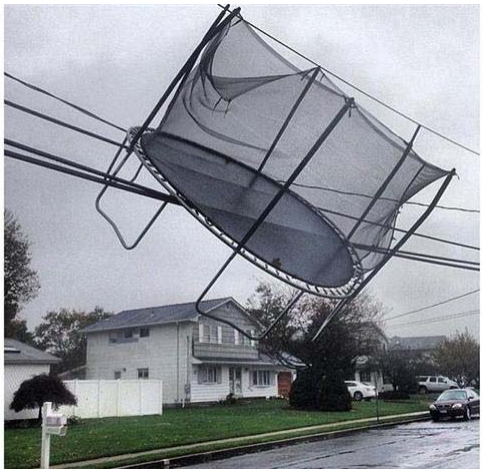
Sanitary Sewer Systems (and their components)

- ✓ Collection Systems
- ✓ Pumping Stations
- ✓ Treatment Facilities & Components
  - (Headworks, Pumps, Tanks, Lagoons)
- ✓ Treatment Facility Offices
- ✓ Chemical Storage Tanks & Areas
- ✓ Controls
- ✓ Outfalls
- ✓ Electricity for the Above
- ✓ Standby Power & Fuel
- ✓ Access Roads
- ✓ Personnel

Beaver Brook WWTP
Image: carlincontracting.com

Vulnerability

Utilities



Trampoline in Powerlines after strong winds
Image: @JackieeOConnor

Electric Crews Prepare to Work after Tropical Storm Irene
Image: FEMA

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Vulnerability

Critical Facilities

Flooded Milford Street During Sandy
Image: Rich Scinto

Flood in Milford, 2014
Image: NBCConnecticut.com

Rescue workers helping a Milford Couple during Irene
Image: NBC Connecticut

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Project > Resilience > Risk > Vulnerability > Options > Next Steps > Discussion

Vulnerability

Critical Facilities

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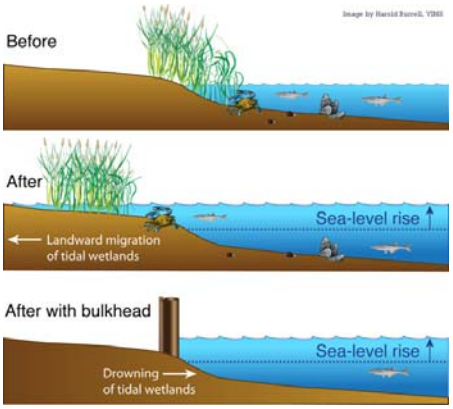
Vulnerability

Natural Systems

Milford Public Boat Landing, Housatonic River
Image: SSymons



Tidal wetlands migrate inland as sea level rises.

If sea level rise outpaces migration, wetlands drown.

If structures block migration, wetlands drown.

- Titus, J.G. 1991. Greenhouse Effect and Coastal Wetland Policy, *Environmental Management.* 15(1):39-58

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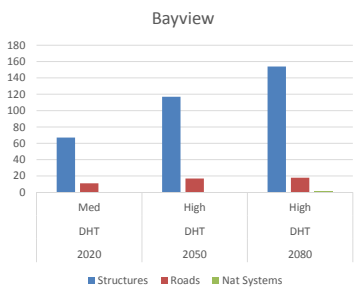
Project > Resilience > Risk > Vulnerability > Options > Next Steps > Discussion

Vulnerability

- **Vulnerable Areas**



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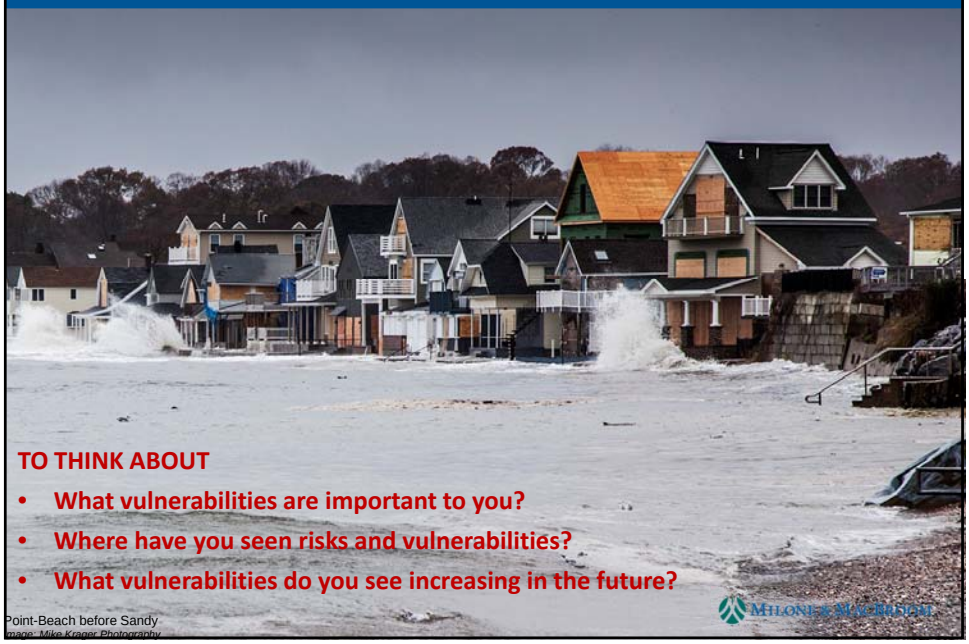
Vulnerability and Risk Discussion



TO THINK ABOUT

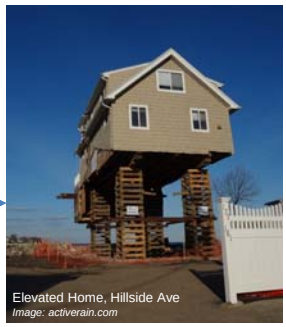
- **What vulnerabilities are important to you?**
- **Where have you seen risks and vulnerabilities?**
- **What vulnerabilities do you see increasing in the future?**

Point-Beach before Sandy
Image: Mike Krager Photography

Resilience Options

3 General Types of Adaptation (IPCC, 1990)

- **Retreat**
  - No shoreline protection
  - Abandon vulnerable area
- **Accommodation**
  - No shoreline protection
  - Remain in vulnerable area
  - Adjust structures, infrastructure, land-use, preparation & response
- **Protection**
  - Shoreline protection
  - Remain in vulnerable area
  - No adjustment of structures, infrastructure, land-use, etc.



Elevated Home, Hillside Ave
Image: activerain.com

Hillside Ave
Image: Dave Murphy

Resilience Options

7 Updated Categories of Adaptation (NOAA, 2010)

1. **Impact Identification and Assessment**
   Know the facts
2. **Awareness and Assistance**
   Share the facts
3. **Growth and Development Management**
   Prevent creation of new vulnerabilities
4. **Loss Reduction**
   Decrease existing vulnerabilities
5. **Shoreline Management**
   Protect natural, aesthetic, & economic benefits of beach & shore
6. **Coastal Ecosystem Management**
   Protect natural, aesthetic, & economic benefits of coastal ecosystems
7. **Water Resource Management**
   Decrease unique risks to drainage & water supply infrastructure

FEMA specialists discuss mitigation options at a Milford Lowe's
Image: activerain.com

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Resilience Options

Specific Options for Connecticut

- **Transportation Options**
  Elevate or Retire Roads
- **Shoreline Management**
  Living Shorelines, Beach Nourishment, Sediment Management, Dune-Management, Bioengineered Banks
- **Shore Protection Structures**
  Seawalls, Bulkheads, Revetments
- **Home Elevation**
- **Water Resource Management**
  Stormwater, Wastewater, Water Supply
- **Retreat**

Melba Street after Irene
Image: Cloe Poisson / Hartford Courant

Shoreview Condos
Image: David Murphy

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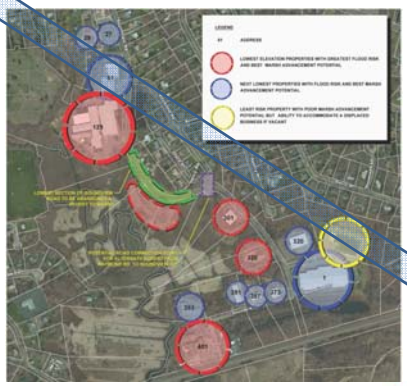
Resilience Options

Regional Scale

Open position

Closed position



Site-Specific Scale

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Resilience Discussion

TO THINK ABOUT

- **What options interest you?**
- **Where would specific options work?**
- **What challenges do you see to different options?**

Madison Coast
Image: Dave Murphy

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Next Steps

- Incorporate YOUR Comments
- Develop Resilience Options
  - Citywide
  - Most Impacted Areas
- Develop Coastal Resilience Plan
- Prepare Conceptual Designs
  - Address specific vulnerabilities (eg homes, infrastructure)

House Raising after Irene in Madison
Image: Testori Bros Excavation Company

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Questions and Discussion

- What vulnerabilities are important to you?
- Where have you seen risks and vulnerabilities?
- What vulnerabilities do you see increasing in the future?
- What options interest you?
- Where would specific options work?
- What challenges do you see to different options?

Participate in the Process!

- *Talk to us now*
- *Look at the printed maps and mark locations of concern*
- *https://www.surveymonkey.com/r/MilfordCRP*
- *Talk to your neighbors*

Hurricane Irene Milford CT
Image: Jerry Angelica, www.flickr.com/photos/jerryangelicaphotography

MILONE & MACBROOM

Notes From Public Meeting

DATE: January 28, 2016
MMI #: 2619-09
PROJECT: Milford Coastal Resilience Plan

SUBJECT: Notes from Public Meeting (Risk/Vulnerability Assessment)
LOCATION: Milford City Hall

ATTENDEES:

Benjamin Blake, Mayor
Joe Griffith, Flood Plain Administrator
Milford Hazard Mitigation Committee Members:
- **MaryRose Palumbo,** Inland Wetlands Officer
- **Meghan McGaffin,** GIS Analyst
- **Steve Johnson,** Conservation Commission
- **Bill Richards,** Deputy Director of Emergency Management

David Murphy, P.E., CFM, MMI
Scott Choquette, CFM, Dewberry
Noah Slovin, MMI

A public meeting was held on January 28, 2016 to introduce the City of Milford coastal resilience planning effort to residents and the public. The specific goal of this meeting was to clarify the term "Coastal Resilience," describe the specific types of coastal hazards and the specific City assets vulnerable to those hazards that will be addressed in the plan, explain how hazards and vulnerabilities can be expected to change in the future, and solicit information and participation from the public.

Mayor Blake opened the meeting, speaking to the value of Milford's coastline to the character of the city, the balance between attempts to recover from recent storms and restore normalcy while also trying to plan for longer-term changes to mitigate future hazards, and importance of recognizing threats posed by Climate Change.

Mayor Blake introduced Mr. Griffith, who in turn introduced the members of the City's Hazard Mitigation Committee. He encouraged meeting attendees to contact him with questions. He then introduced the consultants Mr. Murphy, Mr. Slovin, and Mr. Choquette.

Mr. Murphy then began the PowerPoint presentation, covering the following topics: Project Funding and Planning Steps (including coordination with other projects); Resilience (including general concepts and issues specific to Coastal Resilience); and Risk (including the effects of changing climate and sea level on future risk). Mr. Choquette followed Mr. Murphy by presenting a number of slides illustrating additional complexities with regards to modeling coastal inundation and erosion risk, and noted that such complexities will be incorporated into the planning of site-specific resilience projects. During this section of the presentation, residents asked for more details about the locations of FEMA transects and about coastal-protection structures referenced by Mr. Choquette. These questions were addressed. A resident requested specific focus on the Bayview neighborhood.

Mr. Murphy then presented on: the concept of vulnerability (including how climate change and sea level rise will impact future vulnerabilities, and specific categories and regions that are

vulnerable to coastal hazards); adaptation and resiliency options that will be considered moving forward; and the next steps of the project.

Residents were encouraged to fill out the online survey.

After the presentation, the floor was opened for a question-and-answer session, moderated by Mr. Murphy. Questions or comments (denoted by "Q") and Answers ("denoted by "A") were as follows:

Q The Bayview Neighborhood is often overlooked. What will happen there?
- **A** Mr. Murphy reassured the resident that we are looking at that neighborhood, and have data for the area. There is also a FEMA transect there. Mr. Choquette confirmed.

Q Are there resources for homeowners to mitigate hazards on their own?
- **A** Mr. Murphy explained that there are State-level organizations that provide those kinds of resources. Specific projects include home elevation and flood proofing. The best person to talk to is the city Flood Plain Manager (currently Mr. Griffith). Mr. Murphy encouraged homeowners to seek local resources before looking at State or Federal information or funding, because it will be better geared toward local issues.
- **A** Mr. Choquette suggested searching online for FEMA technical bulletins, which are often easy to understand and helpful.
- **A** Deirdre [Smith-Dey of George J. Smith & Son Insurance] (Deirdre was one of the attendees and an insurance agent who is very familiar with Flood Insurance issues):
  - There are many things that owners of homes located in Special Flood Hazard Zones can do to receive an insurance rate decrease. The FEMA website has more information. The first step is to identify the flood zone designation. The second is to get an elevation certificate.
- **A** Emmeline Harrigan (Emmeline was an attendee and is the former Assistant City Planner and Floodplain Manager. She now works for Shore Up Connecticut.):
  - You must elevate higher than the minimum required elevation in order to get a reduction in insurance premiums.

Q Flood Insurance Rate Maps are online, but the Milford versions are from 2013 and are not the most recent FEMA updated versions from 2015. When will they be updated?
- **A** Mr. Choquette: The maps available online are those that have been legally adopted by the City. The 2013 maps are the versions that are currently adopted. The 2015 maps have not yet been adopted for some reason, but will eventually. For planning purposes, use the 2015 maps so that you are prepared for when they are adopted.

Q Is there a structural limit to the height a home can be elevated before it is no longer safe?
- **A** Mr. Murphy: that is something we'll take into consideration and look into.

Q After a storm there is often more sand that's been built up on the beach (in this specific location). How does that affect a home's safety?
- **A** Mr. Murphy: Generally it lowers the vulnerability of the structure, but that's not always true – in some instances it may prevent drainage from inland. It depends on the specific site.

- **Q** There used to be detailed topographic maps made by the USGS. What do we use now? How do the FEMA transects Mr. Choquette talked about relate to those maps?
  - **A** Mr. Murphy and Mr. Choquette: we now have much better and more detailed maps. The FEMA transects use those improved topographic maps. Some flood insurance rate maps have been altered based on newer, more accurate maps.
- **Q** We should consider projects to remove phragmites, which impact the ability of wetlands to store water and mitigate flooding.
  - **A** We will do that.
- **Q** Are there limits to home elevation heights based on zoning regulations?
  - **A** Mr Griffith: There are zoning limits to home heights (35 feet), and elevating a home can put you above those limits. However, it's possible to get a permit to raise a home above those limits. You can present your case to the Zoning Board of Appeals.
- **Q** Can the community raise funds to get work done – specifically, with matching funding from a government source?
  - **A** Mr. Murphy: yes, there are many State and Federal grants that require local fund matching. If you are able to raise money as a neighborhood or a community, you can look for those types of grant programs.
- **Q** There is a plan to dredge Milford Harbor and put the sand on beaches. How will that affect flooding?
- **Q** Laurel Beach has jetties, and does not experience the same types of problems as Wildermere beach next-door. Why don't we just build jetties at Wildermere beach?
- **Q** You should connect to with all the beach associations in each community.
- **Q** The Department of Environmental Protection [no clarification] in 1981 issued a report in which Wildermere Beach was identified as high priority for action, but no action happened. Studies are well and good, but we need to start doing the action part!
- **Q** Are there restrictions on the kind of work that can be done based on the funding sources?
  - **A** Mr. Murphy: There are many subtleties based on funding sources. We will not go into detail now but it is a consideration throughout the project process.
- **Q** Is qualifying for the Community Rating System part of the plan?
  - **A** There is an existing plan within the City [City of Milford Community Rating System Maintenance and Improvement Plan prepared by Milone & MacBroom, Inc. (MMI #2625-23) through funding from the Northeast Regional Ocean Council and the Connecticut Association of Realters) that is focused on bringing it into the CRS. We will make sure to consult that plan so that we don't interfere with those efforts, but we will not specifically be taking steps to achieve that goal.
- **Q** Hawley Avenue beach in Woodmont was replenished with rocks once. Now, after a storm, the sand is washed away and the entire beach is just rock!
- **Q** I live in Woodmont. We got a $200K grant to study Crescent Beach. I can tell you the problem: the sand travels down the shore and ends up in West Haven. Why don't we just move the sand back?
- **Q** In the late 1950s the USACE replenished beaches all along the Long Island Sound Shore. It lasted for many years. Is there any prospect of this happening again?
  - **A** The "Blue Plan" will be looking at that sort of thing.

- **Q** I've lived in a Condo at Walnut Beach for 50 years. I've seen it all. The shoreline here eroded back over the years until it was right up to the building. We put in riprap (6-foot rocks), which washed out, so we put in more, back and forth over and over. Finally, an engineer came, he dug a 500 foot long, 4 foot deep, 15 foot wide trench. He put in a steel mesh full of rocks. This has been working ever since. You should all come check it out!
- **Q** What happens when this project finishes in March? What is the certainty of success of this project?
  - **A** Mr. Murphy: We won't be doing any final project design – the goal of this project is to put the city in the position to apply for funding for specific projects. We're going to come back in March with sets of options for mitigation projects in specific areas.
  - **A** Mr. Choquette: All funding organizations want studies and conceptual designs finished before they give money.
- **Q** Great Creek by Silver Sands State Park is an area that should be looked at.
- **Q** Is there anything that we can do while all this planning is happening?
  - **A** Mr. Murphy: There are things that individual homeowners can do to protect their homes. This planning process will produce results that will lead to completion of on the ground projects in the near future.
- **Q** Can this study be used for *other* grants that also require studies to be done before funding is given?
- **Q** Replenishing a beach with sand is always temporary. We need hard structures to keep the sand there.
- **Q** Drainage pipes at the Bayview neighborhood are not working correctly. Water is able to come *into* the neighborhood through the pipes, which are supposed to be one-way. Now there is water under the actual homes.
- **Q** Water is also coming into the Point Beach neighborhood through the storm drains
- **Q** Is there a clearinghouse for all the different projects and plans that are going on?
  - **A** Mr. Griffith: The Hazard Mitigation Plan can serve as that
- **Q** Can there be other opportunities for use to gather and talk about active projects and immediate possibilities, as opposed to this kind of long-term, big-picture planning?
- **Q** At Bayview the street itself is sinking, and flooding all the time. Fixing this is not a project that can wait 10-20 years.
- **Q** We have lost jetties that used to be protective, and we're not able to replace them [why?].
- **Q** Field Court, Deerfield Ave, Westland Ave, are actively being flooded and experiencing problems. The city tried repaving the roads, but it ended up just making it worse.
- **Q** The Wildermere Beach Association brought coastal engineers in the 90s, which made some suggestions: (1) put huge mats of artificial seaweed off the coast to capture sediment and build up a berm (2) put in some sort of complex pipe system that will interact with currents and capture sand. Are these types of out-of-the-box engineering plans an option?
- **Q** Water levels are rising, but the real damage comes from waves. The laws of physics say that if we act farther out from the shoreline, we'll be able to dissipate the wave energy and decrease hazards. For example, having reefs offshore.
- **Q** A researcher working on living shorelines invited people to come to Stratford to see what an active, effective living shoreline project can look like. It includes artificial reefs.

- **Q** Bayview used to have flapper valves on drainage pipes, but they switched to "fish mouth" after Hurricane Gloria, and now the mouth gets stuck open and water comes in through the pipes. We need to switch back to flapper valves!
- **Q** Wildermere Beach has 6 drainage outlets. After each storm they get filled with sand, and maintenance crews come in and rip out another section. They've gotten shorter and shorter.
- **Q** Bad engineering can make problems worse. For example, the intersection of Naugatuck Avenue and US 1 used to flood, so huge drainage pipes were put in. Will that just cause increased flooding at the lower part of the street, now that all that water is being sent down there? We're just moving the problem from one spot to another!
- **Q** Westland Avenue and Field Court experiences flooding.
- **Q** We want good engineering to happen, not just band-aid projects.

After the question-and-answer session, attendees were invited to ask questions of any of the consultants, Mr. Griffith, or members of the Hazard Mitigation Committee. Attendees were also asked to sign-in, take the online survey, or fill out one of the hard-copy surveys that had been brought to the meeting.

One comment received after the public discussion segment was as follows:

- **Q** Man from the Wildermere Area: He wants to tear down his house and rebuild to a more resilient standard, but if he rebuilds the city will make him lose width on each side of his house. If he keeps his current house he does not have to lose any width, but it will not be as resilient even if he performs a lot of retrofitting.
  - **A** This is a zoning/regulatory issue that we should address in the plan.

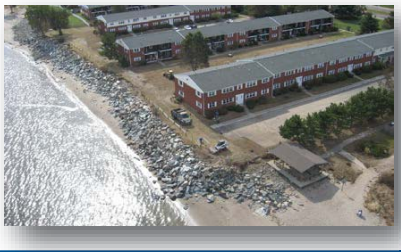
City of Milford

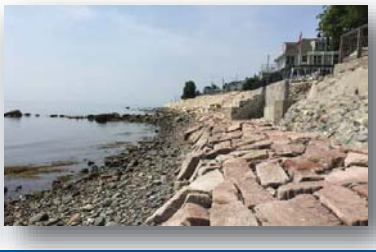
COASTAL RESILIENCE PLAN

Presentation of Adaptation Options

MaryRose Palumbo, City of Milford
Meghan McGaffin, City of Milford
Joseph Griffith, City of Milford

David Murphy, P.E., CFM, Milone & MacBroom, Inc.
Noah Slovin, CFM, Milone & MacBroom, Inc.
Scott Choquette, CFM, Dewberry





City of Milford, Connecticut | March 29, 2016

Presentation Agenda

- **Review**
  - **Progress and Status**
  - **Resilience Concepts**
  - **Adaptation Concepts**
- **Options for Milford**
  - **Feedback**
  - **Recommendations**
  - **Planning Examples**
    - *Neighborhood Concepts*
    - *Infrastructure Designs*
- **Conclusions**
- **Next Steps**
- **Discussion**





Review: Progress and Status

- Done • Review Existing Capabilities
- Done • Coordinate with "Regional Framework"
- Done • Data Collection
- Done • Vulnerability and Risk Assessment
- Done • Review of Adaptation Options
- Now • Public Information Meetings, Surveys
- Done • Select Sandy-Impacted Neighborhoods
- Now • Conceptual Designs
- Now • Coastal Resilience Plan
- Next • Implementation Plan and Process

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Review: Resilience Concepts

Resilience

Prepare

Adapt

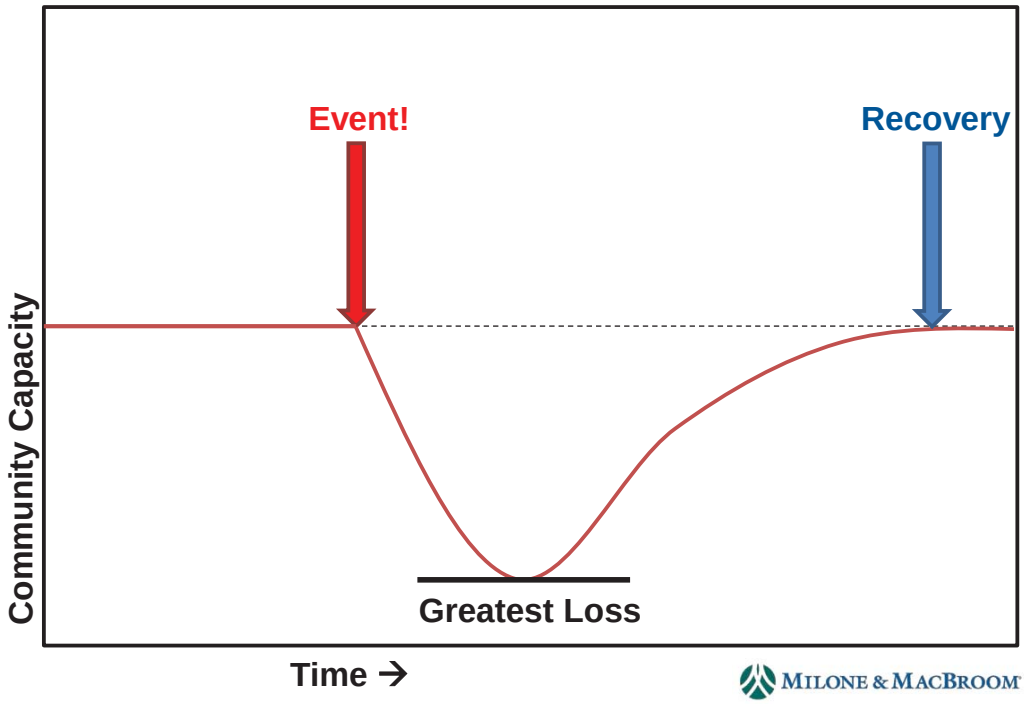
Withstand

Recover

Reduce Recovery Time

Decrease Damage

Increase Capacity



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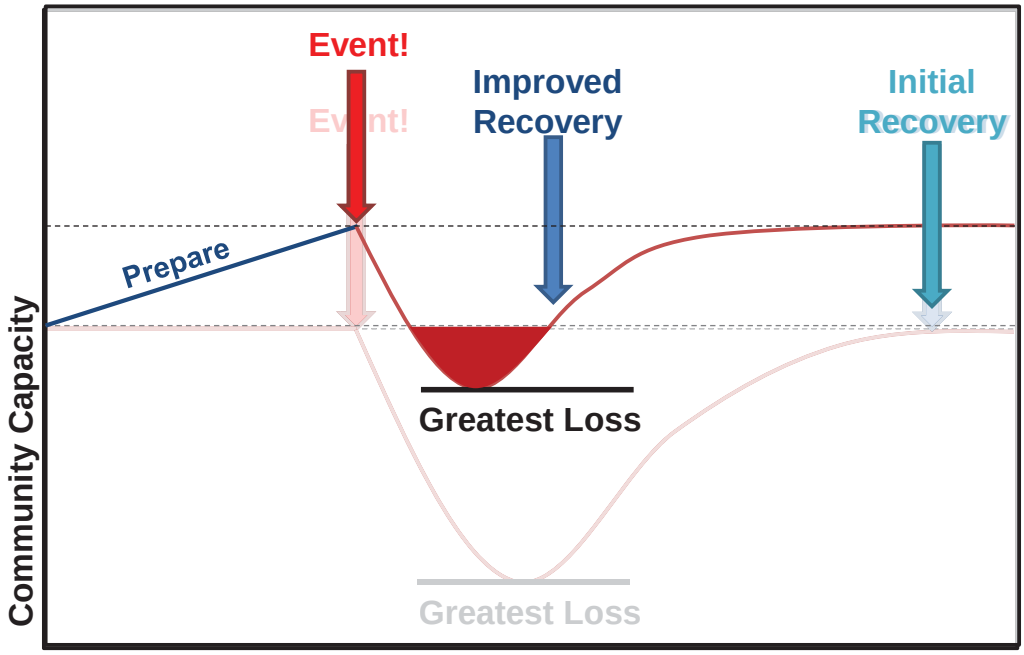

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Review | Progress | Resilience | Adaptation | Options | Feedback | Recommend | Examples | Summary | Next | Discussion

Review: Resilience Concepts

Resilience

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Adapt

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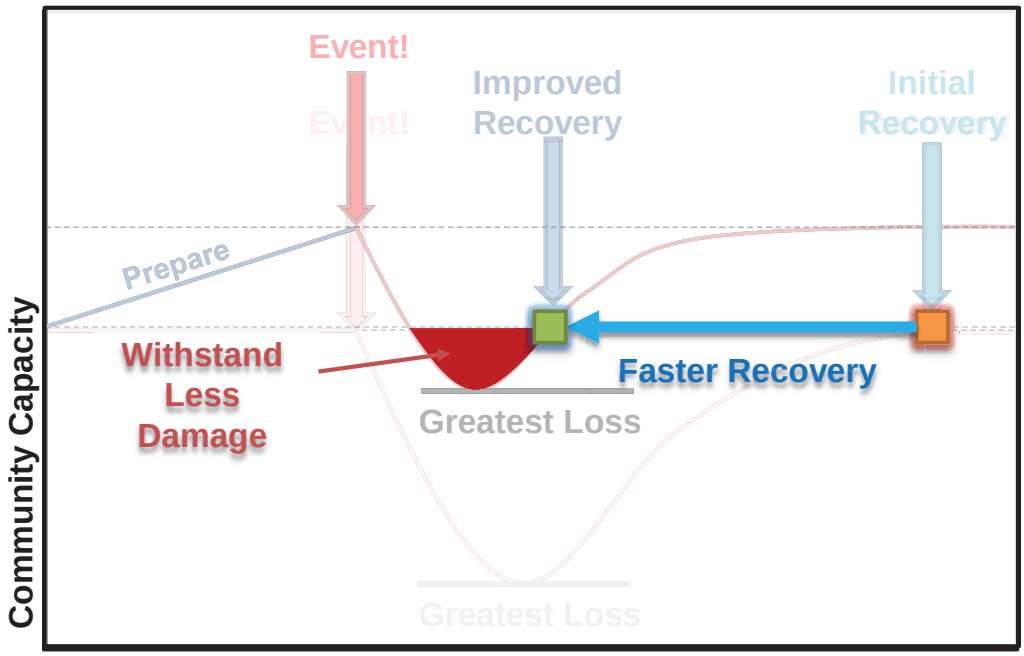

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Review: Resilience Concepts

Resilience

Prepare

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Withstand

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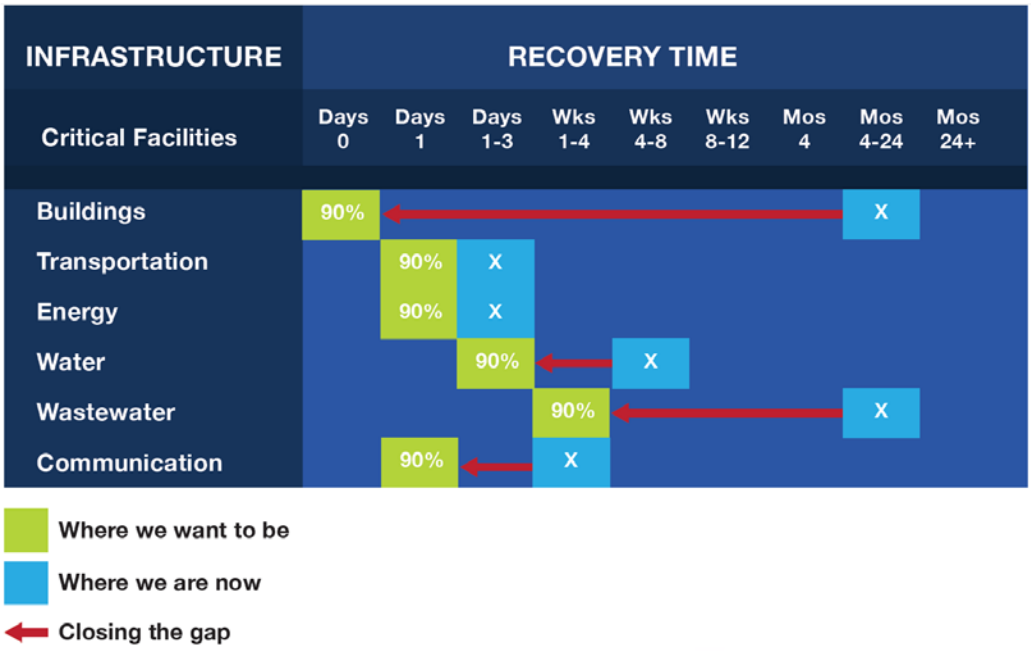

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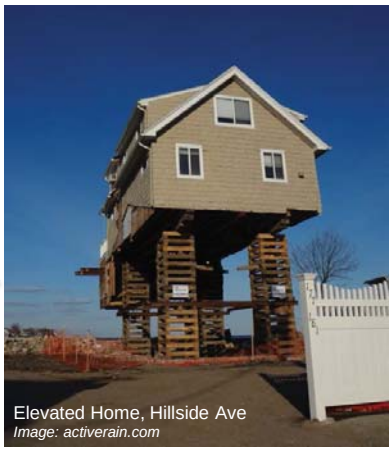
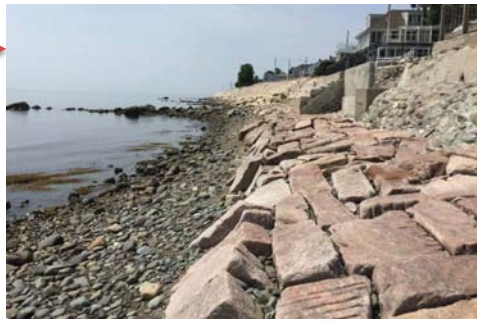
Review: Adaptation Concepts

3 General Types of Adaptation (IPCC, 1990)

- **Retreat**
  - No shoreline protection
  - Abandon vulnerable area
- **Accommodation**
  - No shoreline protection
  - Remain in vulnerable area
  - Adjust structures, infrastructure, etc.
- **Protection**
  - Shoreline protection
  - Remain in vulnerable area
  - No adjustment of structures, infrastructure, etc.



Elevated Home, Hillside Ave
Image: activerain.com



Hillside Ave
Image: Dave Murphy

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Review: Adaptation Concepts

7 Updated Categories of Adaptation (NOAA, 2010)

1. **Impact Identification and Assessment**
   Know the facts
2. **Awareness and Assistance**
   Share the facts
3. **Growth and Development Management**
   Prevent creation of new vulnerabilities
4. **Loss Reduction**
   Decrease existing vulnerabilities
5. **Shoreline Management**
   Protect natural, aesthetic, & economic benefits of beach & shore
6. **Coastal Ecosystem Management**
   Protect natural, aesthetic, & economic benefits of coastal ecosystems
7. **Water Resource Management**
   Decrease unique risks to drainage & water supply infrastructure

FEMA specialists discuss mitigation options at a Milford Lowe's
Image: activerain.com

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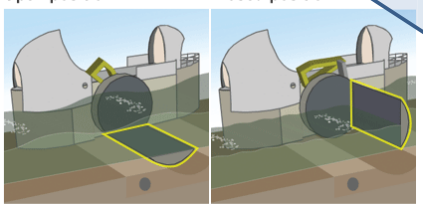
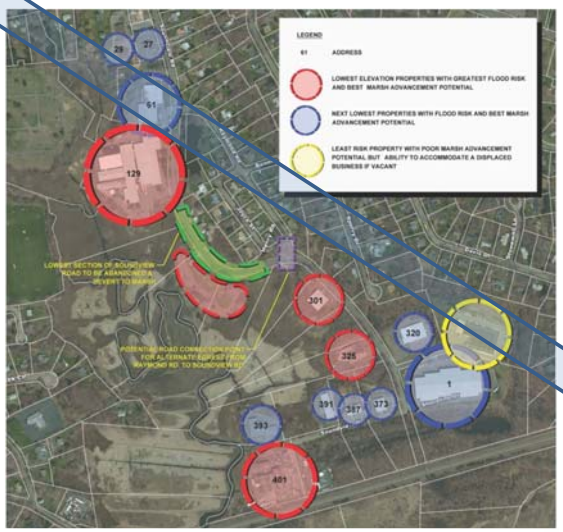
Review | Progress | Resilience | Adaptation | Options | Feedback | Recommend | Examples | Summary | Next | Discussion

Review: Adaptation Concepts

Regional Scale





Site-Specific Scale

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Options for Milford: Feedback

Community Engagement

Online Survey

69 respondents:

You care about:

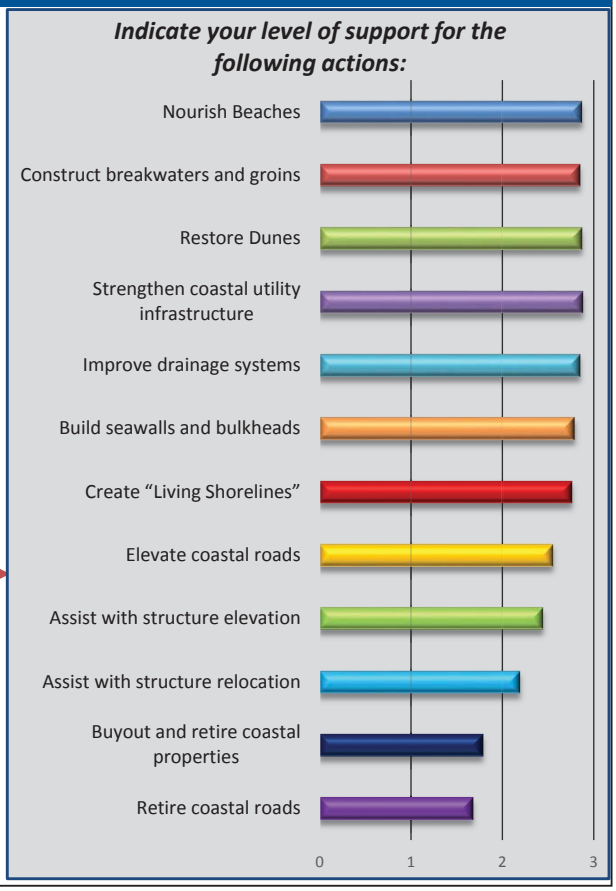
- Homes, Recreation, Water Utilities, Drainage, Natural Systems, Safety

You're worried about:

- Wind, water, waves, erosion, debris

You're asking for:

- Town projects, technical assistance, enable independent action
- Beaches, dunes, strong utilities, drainage



Options for Milford: Recommendations

Category	Specific Options
Hard Protection	Seawalls
	Bulkheads
	Revetments
	Dikes
	Groins
	Breakwaters
Soft Protection	Beach Nourishment
	Dune Restoration
Hybrid Protection	Bioengineered Banks
	Artificial Reefs
Infrastructure	Drainage Improvements
	Road Elevation
	Wastewater Treatment Plants
	Sewer Pumping Stations
Home Protection	Elevation
Regulatory Tools	Flood Damage Prevention : • Freeboard • V zone standards in Coastal A zones
	Zoning Modifications: • Height Limit Flexibility • Reconstruction Flexibility
Coastal Realignment	Road Retirement
	Property Acquisitions

Milford High Tide, October 2012
Image: Michelle Mcloughlin / REUTERS

Sandy Flooding in Milford
Image: REUTERS

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Options for Milford: Recommendations

	Shoreline Protection					Structures & Infrastructure			Realignment		
	Hard Protection	Nourish Beaches	Restore Dunes	Hybrid Protection	Bio-engineered Banks	Improve Drainage	Elevate Roads	Elevate Structures	Retire Roads	Develop Alternate Routes	Acquire Property
Cedar Beach		x	x				x	x			
Laurel Beach		x						x			
Wildemere Beach	x	x	x	x				x			
Walnut Beach		x	x	x			x			x	
Silver Beach		x	x	x			x	x	x		x
Fort Trumbull	x			x	x						
Gulf Beach	x	x	x	x	x		x				
Bayview Beach	x	x	x	x		x	x	x			
Calf Pen Meadow		x				x	x	x	x		x
Point Beach	x				x	x		x			x
Morningside	x			x	x						
Hillside Avenue	x					x	x	x			
Burwells Beach		x					x	x			
Woodmont	x	x		x	x			x			

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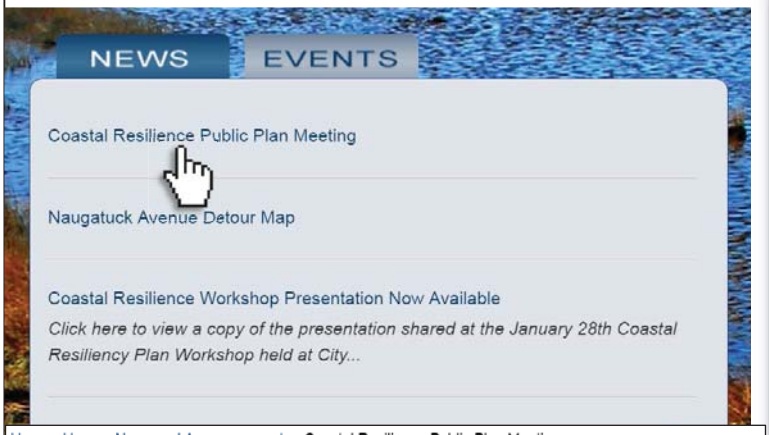
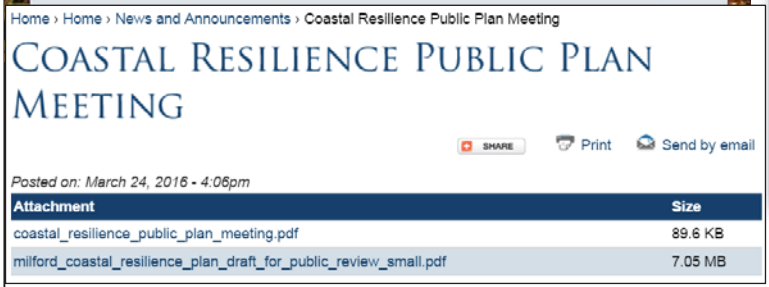
Review | Progress | Resilience | Adaptation | Options | Feedback | Recommend | Examples | Summary | Next | Discussion

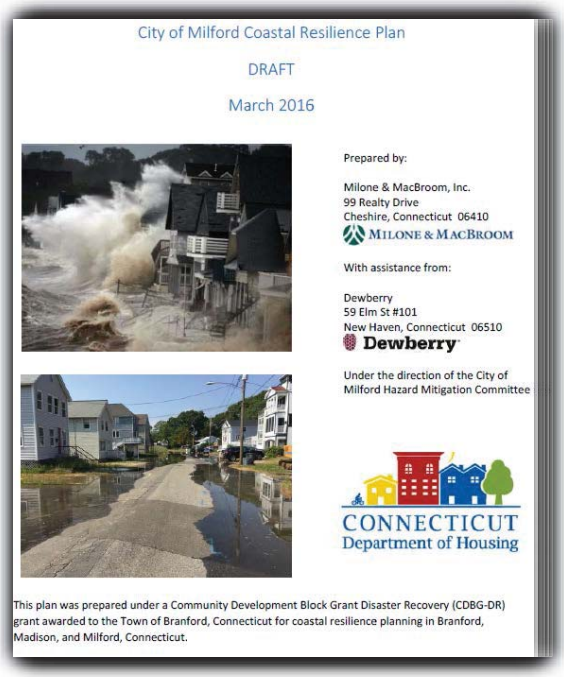
Options for Milford: Recommendations

The Plan

http://www.ci.milford.ct.us







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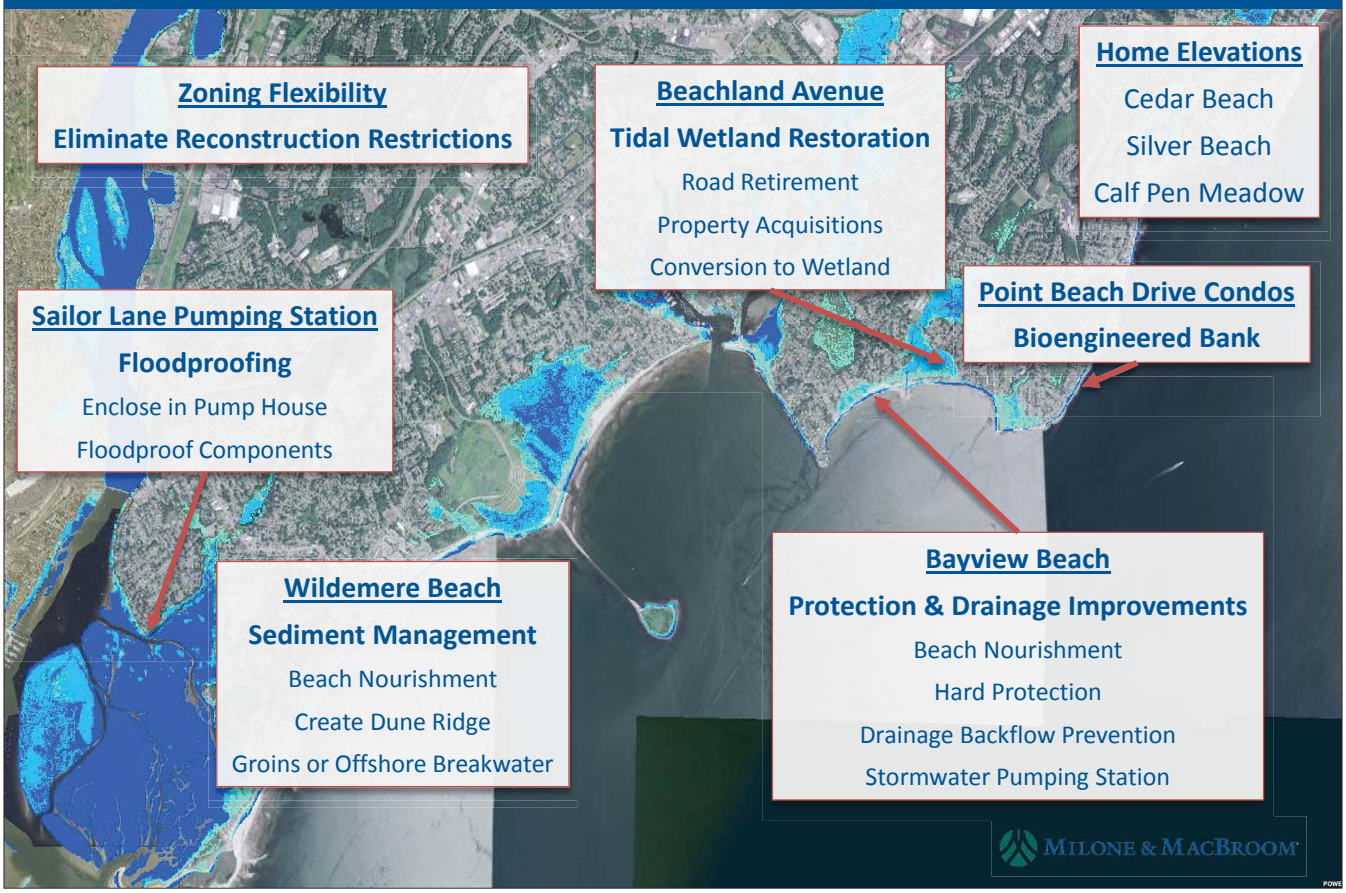
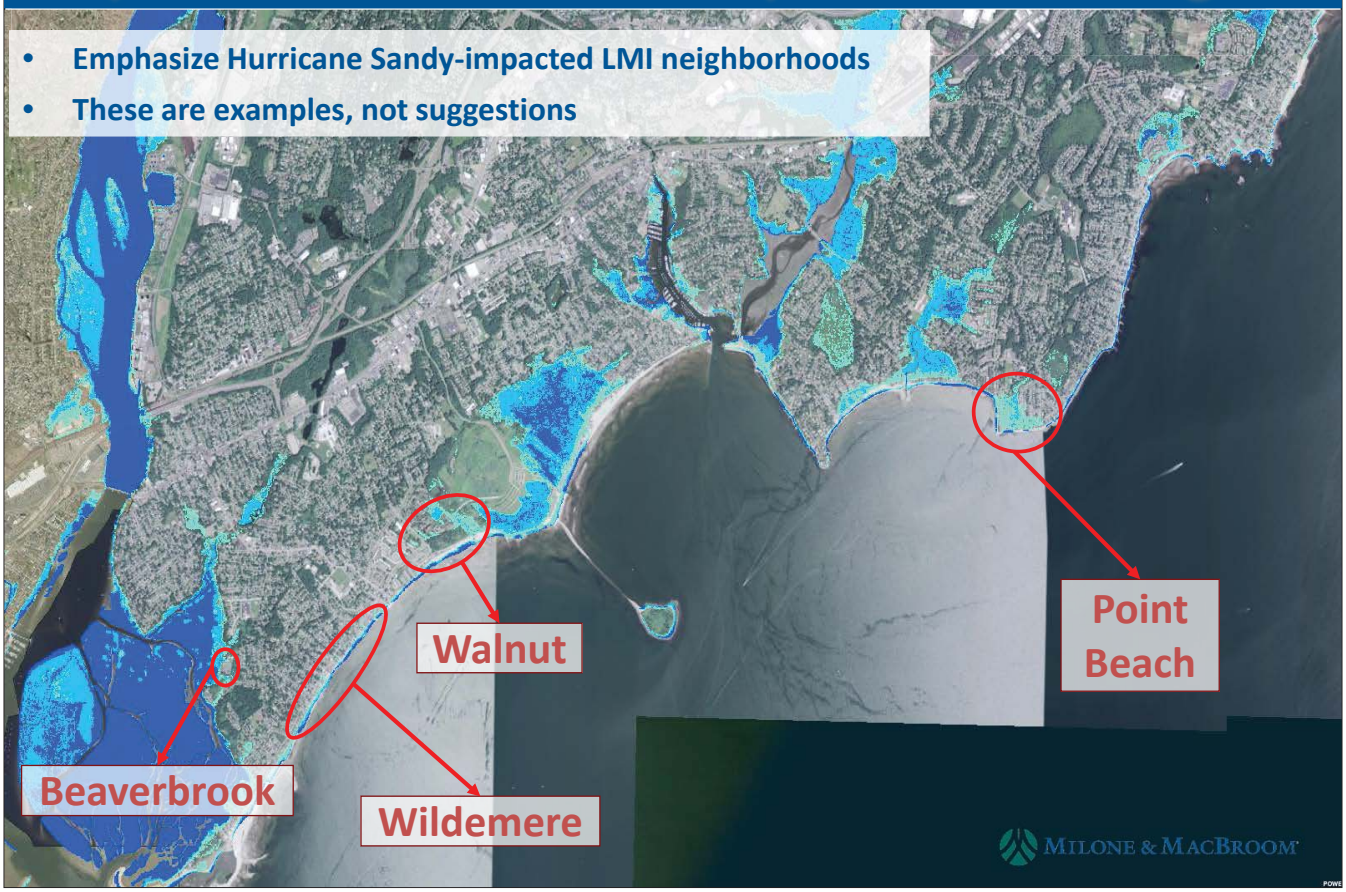
Options for Milford: Recommendations



Options for Milford: Examples for Planning

- **Emphasize Hurricane Sandy-impacted LMI neighborhoods**
- **These are examples, not suggestions**

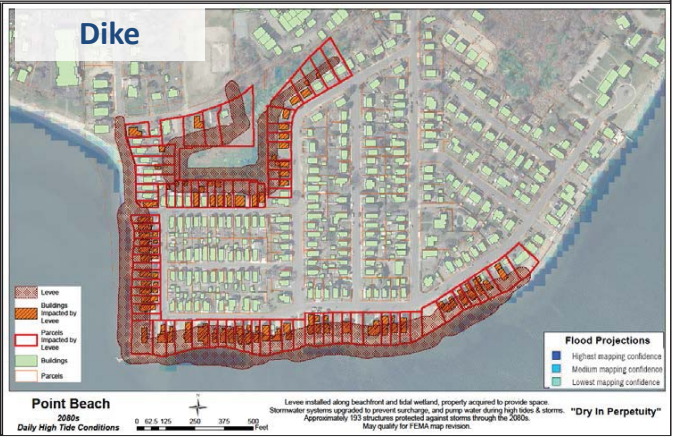


Examples: Point Beach

Review | Progress | Resilience | Adaptation | Options | Feedback | Recommend | Examples | Summary | Next | Discussion

Examples: Point Beach

2080s Daily High Tide

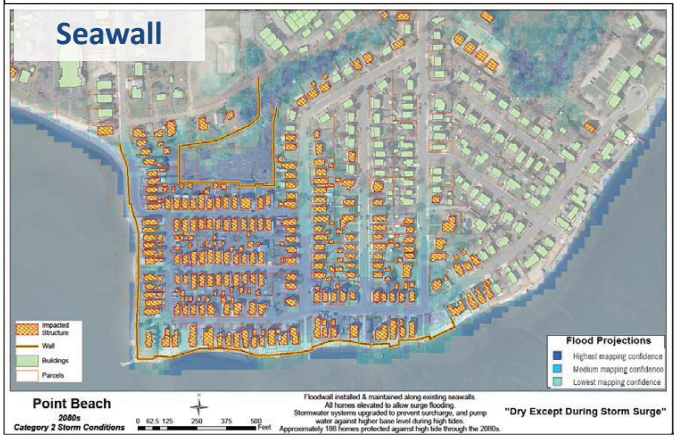


Examples: Point Beach

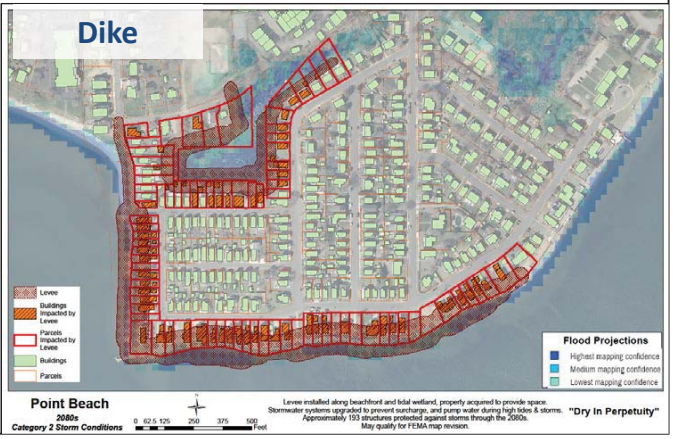
2080s Category 2 Hurricane

Floodable

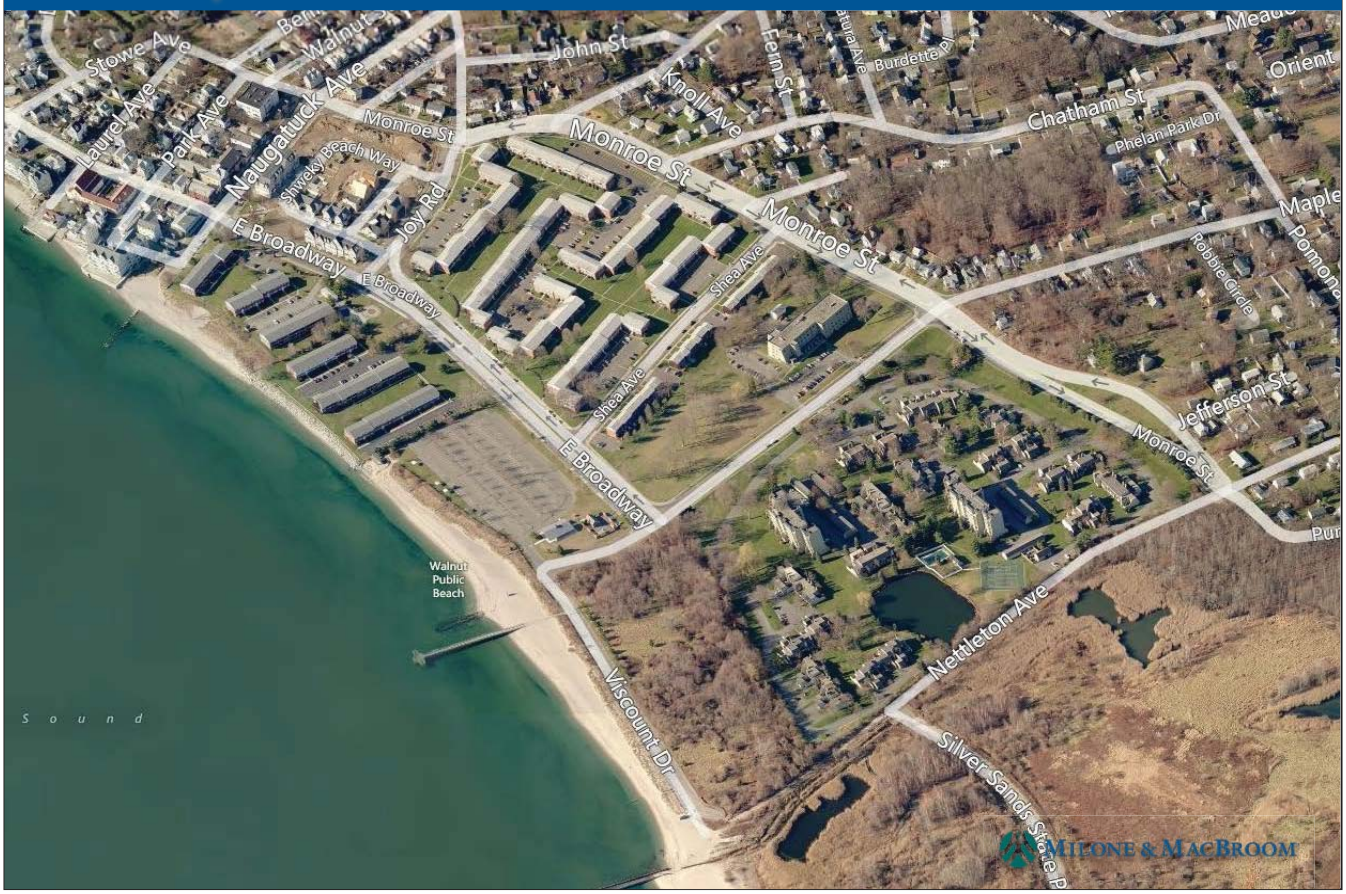
Seawall



Dike

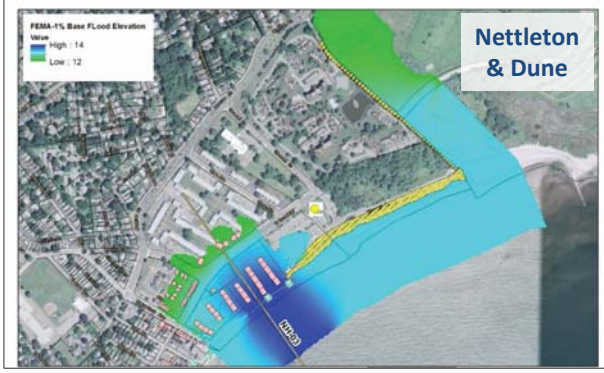


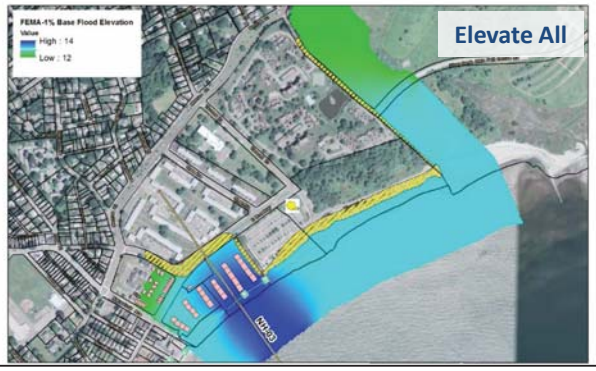
Examples: Walnut Beach



Examples: Walnut Beach

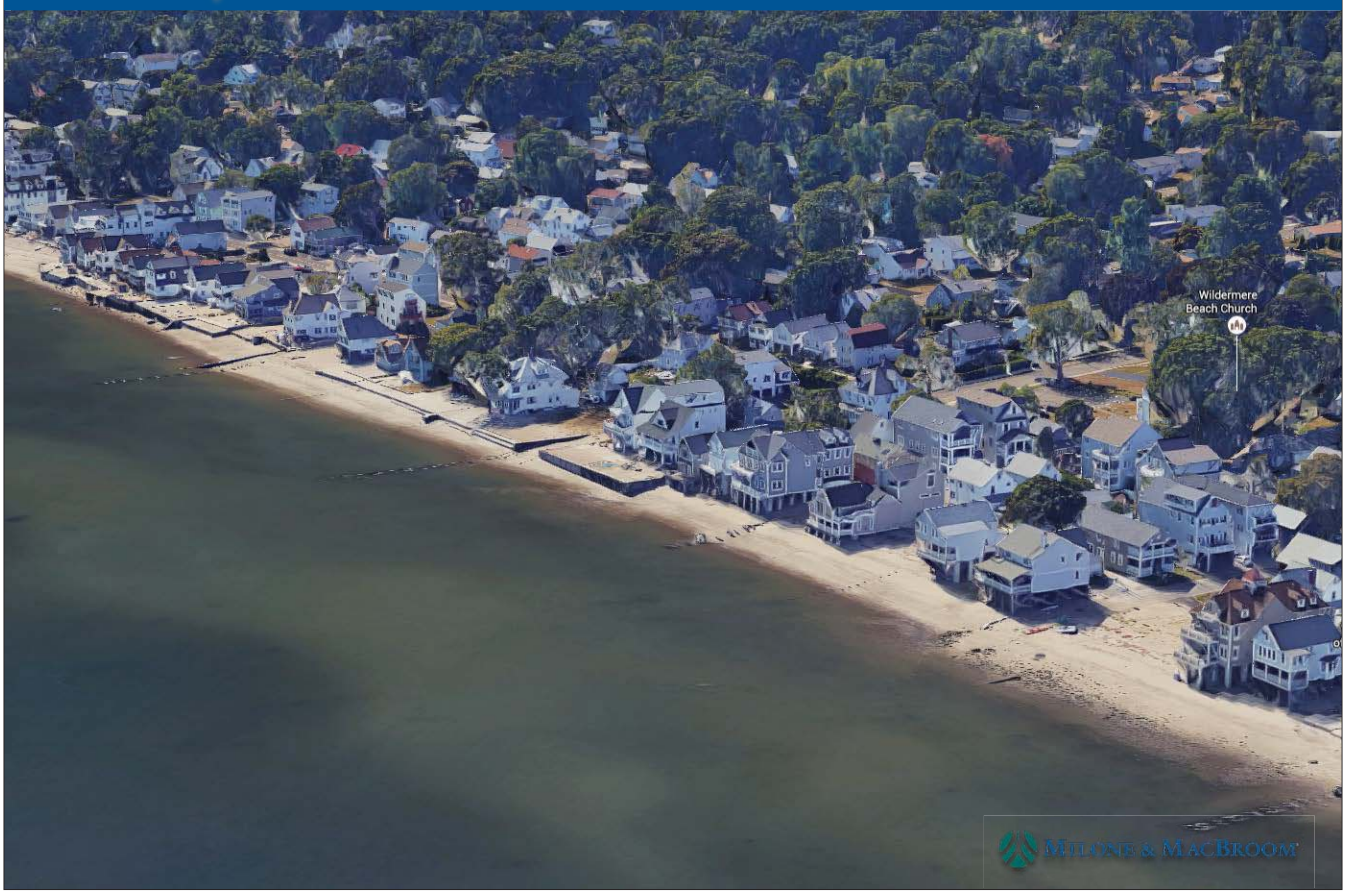
Base Flood



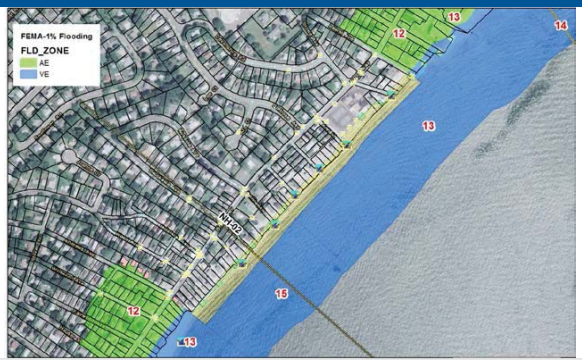


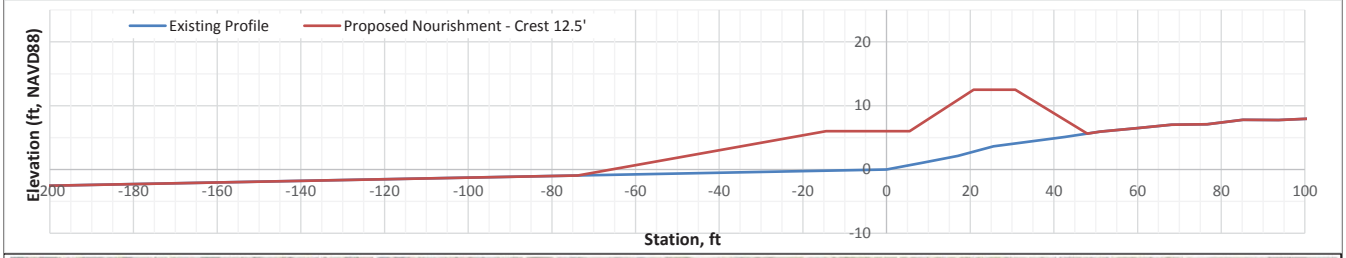
Review Progress Resilience Adaptation Options Feedback Recommend Examples Summary Next Discussion

Examples: Wildemere Beach



Examples: Wildemere Beach

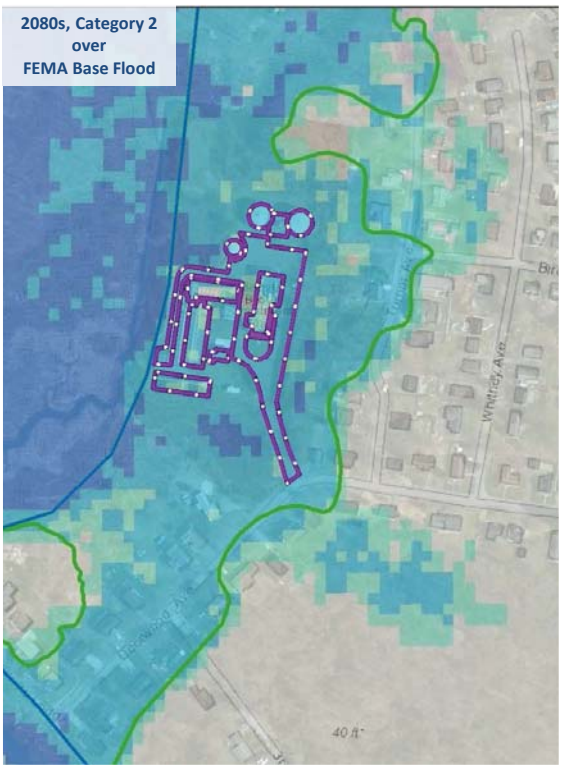




Review | Progress | Resilience | Adaptation | Options | Feedback | Recommend | Examples | Summary | Next | Discussion

Examples: Beaverbrook Wastewater Plant

Examples: Beaverbrook Wastewater Plant



Conclusions

Milford has the capacity to decrease vulnerabilities and therefore decrease risks

- From daily high tide flooding, storm surges, erosion, and sea level rise

Milford can adapt

- At the City, neighborhood, and parcel scale
- Utilities & infrastructure can be strengthened
- Access can be maintained
- Beaches and dunes can be nourished/restored
- Drainage can be upgraded
- Homes will continue to be elevated
- Residents can relocate if desired

Milford has the capacity to increase its Resilience

- *Prepare, Adapt, Withstand, Recover*

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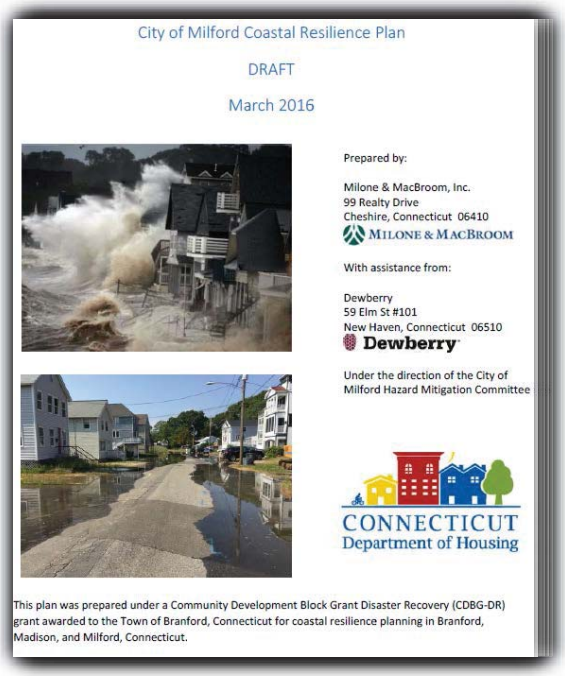
Next Steps

- **Review the Draft Plan**
- **Provide Input**
- **Prepare Final Document**
- **City has options for formalizing the plan:**
  - Adopt as a stand-alone plan
  - Accept as a working/living document to be maintained by the Hazard Mitigation Committee or other board
  - Append to Hazard Mitigation Plan
  - Append to Plan of Conservation and Development
- **Implementation**
  - Execute existing grants from NRCS, CIRCA, CDBG, and others
  - Keep securing grants from those along with FEMA, NOAA, and others
  - Become more resilient!

http://www.ci.milford.ct.us


City of Milford Coastal Resilience Plan

DRAFT

March 2016

Prepared by:

Milone & MacBroom, Inc.
99 Realty Drive
Cheshire, Connecticut 06410

With assistance from:

Dewberry
59 Elm St #101
New Haven, Connecticut 06510

Under the direction of the City of Milford Hazard Mitigation Committee

CONNECTICUT Department of Housing

This plan was prepared under a Community Development Block Grant Disaster Recovery (CDBG-DR) grant awarded to the Town of Branford, Connecticut for coastal resilience planning in Branford, Madison, and Milford, Connecticut.

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Review Progress Resilience Adaptation Options Feedback Recommend Examples Summary Next Discussion

Discussion

ImagePaige Miglio, watercolor
Milfordarts.org

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Notes From Public Meeting

DATE: March 29, 2016
MMI #: 2619-09
PROJECT: Milford Coastal Resilience Plan

SUBJECT: Notes from Public Meeting
Presentation of Adaptation Options
LOCATION: Milford City Hall Auditorium
111 River Street, Milford CT

ATTENDEES:
Benjamin Blake, Mayor
Milford Hazard Mitigation Committee Members:
- **MaryRose Palumbo,** Inland Wetlands Officer
- **Meghan McGaffin,** GIS Analyst
- **Steve Johnson,** Conservation Commission
- **Bill Richards,** Deputy Director of Emergency Management

David Murphy, P.E., CFM, MMI
Scott Choquette, CFM, Dewberry
Noah Slovin, MMI
Milford Residents

A meeting was held on March 29, 2016, to keep Milford residents updated on the progress of the City's Coastal Resilience Plan ("The Plan"), and to invite participation and feedback. This was the second of two public meetings about The Plan. The first, on January 28, 2016, introduced residents to the planning process, explained the term "Coastal Resilience," described coastal hazards and specific vulnerabilities, and explained how those hazards and vulnerabilities are expected to change in the future.

This meeting focused on adaptation options that apply to the City of Milford, some specific recommendations, four conceptual designs for specific neighborhoods and infrastructure projects, and what can be done with The Plan once it is completed.

Mr. Murphy opened the meeting, briefly reminding attendees that there had been an earlier meeting in January, and introducing the other presenters, Mr. Slovin and Mr. Choquette.

Mr. Slovin began the presentation, describing the night's agenda, and running through a review of the planning project's progress, and topics covered at the last meeting. These included the concept of resilience, and methods and approaches to adaptation. He also summarized the results of a public survey that had been posted online for a few months, where residents were able to provide their input into the planning process. Mr. Slovin shared some of the key information extracted from the survey with regard to what residents value along the coast, what hazards concern them, and what types of actions and projects they would like to see implemented.

Mr. Murphy then presented a selection of specific adaptation options that were deemed to be relevant to the City of Milford in general. These included structural methods of protecting the shoreline, infrastructure, and homes, as well as methods of altering regulations to improve resilience. Mr. Murphy also showed a graph summarizing which adaptation methods would be beneficial to which Milford neighborhoods. Following that, he described about seven specific project recommendations for areas across the Milford coastline.

The next section of the presentation focused on conceptual designs for projects at Point Beach, Walnut Beach, Wildemere Beach, and the Beaverbrook Wastewater Treatment Facility (WWTF). At Point and Walnut Beach, multiple different project options were developed and presented, to illustrate how there

may be multiple solutions to coastal vulnerabilities at a particular location, each with its own costs and benefits. Wildemere Beach and the Beaverbrook WWTF each had one adaptation option presented.

Mr. Murphy described the options developed for Point Beach, which were to maintain a floodable neighborhood, construct a floodwall to protect the area from high tide flooding through conditions in the 2080s, or construct a levee to protect the neighborhood from Category 2 storm surge conditions through the 2080s.

Mr. Choquette described the options developed for Walnut Beach, which were to just elevate Nettleton Road, elevate that road and construct a dune, or elevate the road, construct a dune, and elevate Joy Road as well. Each of these options produces a different level of protection, and is associated with a different cost and benefit. Mr. Choquette also explained the options developed for Wildemere Beach and the WWTF. At Wildemere, a beach nourishment and dune creation project was described. At the WWTF, construction of a wall to protect against future base flood events was described.

Mr. Murphy finished the presentation, summarizing the findings regarding Milford's vulnerability and adaptation capacity, and explaining the steps following plan completion that the City can take to ensure it goes to good use.

The floor was then open to questions. Questions or comments (denoted by "Q") and Answers (denoted by "A") were as follows:

- Q Ryan Anderson – One unique challenge we have is not only with our coastline but also with our tidal marshes. Does The Plan go into detail on those? For example, the finger streets off of East Broadway? We really saw the impact of Irene and Sandy in communities next to Tidal Marshes. Tidal Marshes buttress communities from direct storm damage.
  - **A** Mr. Murphy – Milford's tidal wetlands are located in back bays, rather than directly adjacent to Long Island Sound. Therefore they are somewhat protected, and are doing better than the collapsed or actively eroding marshes in other towns. For that reason, living shorelines (constructed wetlands) as a coastal protection method aren't as relevant here. This is covered in the Plan.
  - **A** Additionally, we're aware of some of the issues around invasive species impacting wetlands in Connecticut. This aspect is not covered in the Plan.
- Q Two part question. First, we can find this document online?
  - **A** Mr. Murphy – correct. It is on the City website.

  – Second question is regarding the Point Beach Plan. From what was presented, it appears the sea wall option would be to avoid nuisance flooding, correct? Currently, we don't get nuisance flooding from water coming over the top of the seawalls or the shoreline. It comes from the storm drains. If we can reduce the water coming through the storm drains we'd reduce the risk. I don't think a seawall would be necessary.
  - **A** Mr. Murphy – yes, this is a good point. This is a similar problem to that faced by the Bayview neighborhood. One of the options for addressing that issue could include installation of a stormwater pumping station. In this case, though, the seawall option is intended to address future high tide conditions, when water is projected to overtop current seawalls and the shoreline.
- Q What is the timeline for implementation of this plan and its recommended projects? You're here to solve the problem, right? What's the timeline for dealing with these problems?

A Mr. Murphy – Let's take Wildemere beach as an example. The City currently has a plan to do design work there. This is also true for Walnut Beach. The City is planning on having a design complete within a year. After that, the design would go out to the different regulatory agencies to be reviewed for permitting. While that permitting process is taking place, the City would be working to secure funding for implementing the projects.

– So this is nothing short term. This is long term?

A – Correct

– Where did the Wildemere Beach plan come from, for example?

A Mayor Blake took the podium to describe some of the exising projects and grants secured by the City, and included information on the sizes of those grants and projects. Some of the information noted here may be incomplete – We do have projects from Smiths Point to Woodmont. We have a $345 million grant to get Wildemere and Walnut projects off the ground. I'm willing to talk to anybody off the line about any particular beach. The project to develop this plan was funded by a grant of $150K for 3 towns. As part of that grant they looked at a few planning concepts. We also have a 10-town grant for $750K which will provide us with more of this level of planning. We have many other grants with 6 figures of funding for each. [More grants and projects were listed. The point being made by the Mayor was that this project is one piece of the work being done by the City to build coastal resilience. While the recommendations and plans developed here are not action-ready, they are adding to the bigger picture in the City, which does include active and soon-to-be active projects.].

Q Can you give us some examples of the costs of these projects? What would be the cost of the floodwall surrounding Beaverbrook, for example? How would that be built? What about the Wildemere Beach dune project? Etc.

A Mr. Choquette – keep in mind that these are planning level design estimates, so they are conservative (expected to be higher than the project would actually cost), and they don't take into account information that would require a more in-depth analysis:

- Beaverbrook WWTF: Building an 8 – 12 foot wall would cost about $375K. An additional $100K – 200K would be needed to install the dewatering/stormwater drainage infrastructure. So about a half-million dollars total.
- Wildemere Beach – We were not able to price construction of groins or breakwaters. To complete the beach nourishment itself would cost approximately $2.2 million.
- Walnut Beach – Elevating all of the roads and constructing the dune would cost about $2.9 million.

A Mayor Blake – we received a grant to work on Beaverbrook some years ago. We turned it down at the time because there were many home elevation and acquisition projects that had not been funded yet. We made a policy decision that we would ask the State to focus on residential property owners first. At this point we've been notified that there is additional funding at the State level, and that $4 million grant we applied for years ago (for Beaverbrook) may be funded again.

- These projects are so costly because you have to engage engineers, and pass the hurdle of permitting.
- Again, the City has many ongoing projects. Some are cited in this study online.

Q Jennifer Mattei – I am a research scientist at Sacred Heart University, working on the reef ball project in Stratford. Did you look at what happens in Point Beach, for example, with the

installation of seawalls and the effect they have on erosion? Seawalls increase erosion, and will remove any beach there is seaward of them.

A Mr. Murphy – At this conceptual level, we did not analyze the impacts of the seawall on erosion. One interesting thing about the Point Beach neighborhood is that the City would be committed to creating these seawalls for the entire neighborhood, so there wouldn't be gaps in the wall where erosion would be focused, or neighbors that would be negatively impacted by a seawall next door.

A One thing to make clear as well is that the wall would be above high tide line, constructed on top of existing walls. This would reduce any impact of the walls on the sediment dynamics at the base of the walls.

– We're looking at installing breakwaters offshore, breaking waves farther out, reducing wave energy, and helping deposit sediment. This would prevent some of the dune erosion problems, such as what was mentioned regarding the Wildemere Beach plan.

A Mr. Choquette – Yes, that's right. That's one of the options we included in the Wildemere Beach nourishment and dune creation plan, to diminish erosion risks and maintain the beach

Q Where do you anticipate the sand for the Wildemere Beach nourishment would be coming from?

A Mr. Murphy – West Haven just brought in a huge amount of sand from Cape Cod to nourish a beach. That is one option.

A Mr. Choquette – the cost estimate we developed for that option came from buying sand and then transporting it from Cape Cod. The transport is much more costly than purchasing the actual sand. Shipping all the way from Cape Cod is very far and expensive, but we estimated on the high side to match West Haven's activity, and to provide a conservative estimate of costs. Sometimes sand can come from dredging projects that are more local. West Haven's nourishment project cost roughly a million dollars.

– Sand drifts down the beach. What if we just took it and shifted it back. Seems not to make sense to ship all the way from Cape Cod!

A Mr. Murphy – yes, that is a possibility. We just maximized the cost estimate for conservative planning.

This ended the formal question and answer session. Afterwards, individual meeting attendees approached the consultants or city officials to discuss the project further. Notes from Some of these discussions are provided below. Discussions are denoted in the same method as above:

Q I live at Laurel Beach. We have more sand than we know what to do with. If you put sand at Wildemere, it'll drift down to us. We know it'll get there. We have 3 groins on our beach. I saw the groins being built. Before that, there was no beach to speak of. Just rocks and pebbles. In the 50s we put in wooden groins, then stone groins.

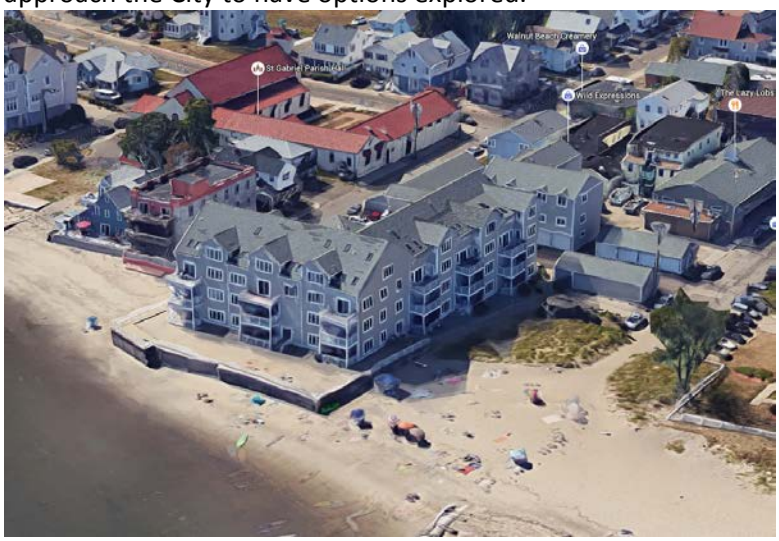
Q Gulf Street is being undercut across from Eveningside Drive. Right now there's about 10 feet of soil between the road and the water. But it's actively eroding. Trees are falling in. Theres a pole that they keep having to move so it doesn't fall into the Sound.

Q There are a series of drainage pipes at Point Beach that don't seem to work anymore. Specifically, at the corner of Platt Street and Morehouse avenue. What happened to the drainage?

Q There is a condominium complex at the end of Naugatuck Avenue (between Naugatuck and Park, right on the water). It gets flooded during storms. Water overtops the front of the

bulkhead/seawall. Was this area included in the conceptual plans presented? Is there anything that can be done?

A This area is located just east of the Wildemere design and just west of the Walnut design. Because the structure extends southeast into the Sound, it is unlikely the plans presented (beach and dune nourishment) would be able to protect the complex, although they also would not increase hazards at the side. The main problem is likely caused by wave runup and overtopping, despite the structure being elevated above the base flood elevation (assuming that is the case). The condominium association should approach the City to have options explored.



Appendix H
Results from Online Survey

Milford Coastal Resilience

Please enter the street of your residence or place of business, or both

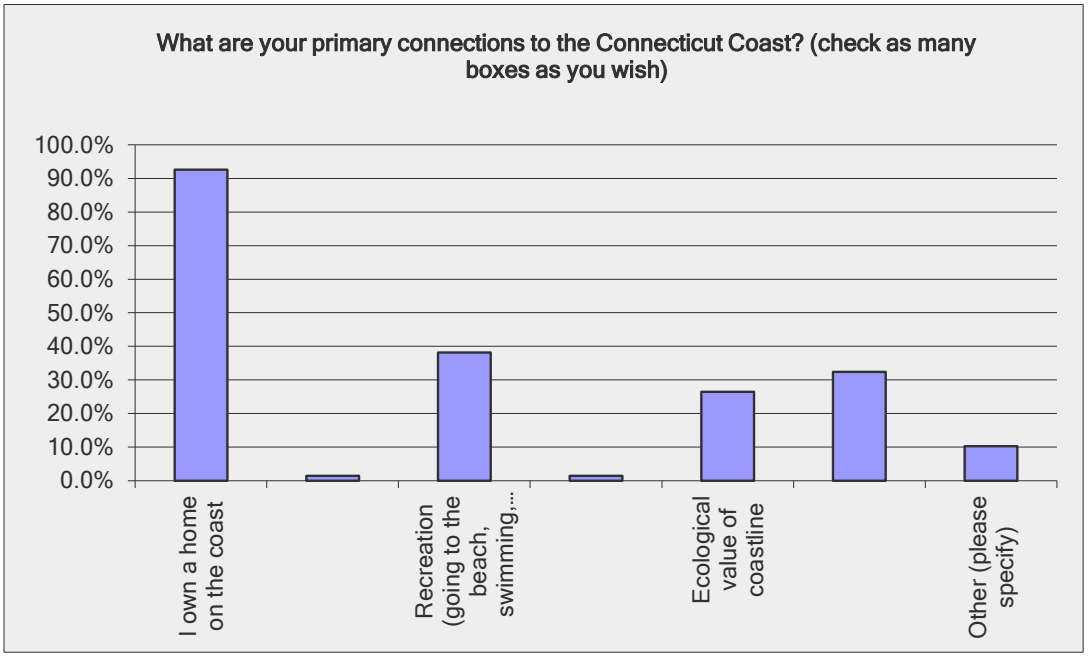
Answer Options	Response Percent	Response Count
Residence	100.0%	67
Place of Business	9.0%	6
answered question		67
skipped question		2

Number	Response Date	Residence	Categories	Place of Business	Categories
1	Mar 4, 2016 8:34 PM	30 Parkland Place, Milford, Ct			
2	Feb 26, 2016 8:02 PM	19 ann street milford ct			
3	Feb 23, 2016 6:31 AM	72 broadway		costa azzurra restaurant	
4	Feb 17, 2016 6:47 PM	16 Bridgewater Ave			
5	Feb 16, 2016 6:59 PM	40 Richard St.			
6	Feb 16, 2016 4:41 PM	38 Kirkside Avenue		same	
7	Feb 16, 2016 1:12 AM	18 Oakdale St, Milford, CT			
8	Feb 14, 2016 12:16 PM	Beach ave			
9	Feb 12, 2016 3:04 PM	summer place			
10	Feb 11, 2016 9:56 PM	6 Stowe Ave			
11	Feb 9, 2016 3:24 AM	161 Broadway		Residence	
12	Feb 8, 2016 11:03 PM	24 Morehouse Ave, Milford, CT 06460			
13	Feb 8, 2016 8:14 PM	21 Hauser St			
14	Feb 8, 2016 5:01 PM	160 Broadway Milford CT			
15	Feb 8, 2016 1:32 PM	28 Clinton street			
16	Feb 6, 2016 9:17 PM	Broadway			
17	Feb 6, 2016 6:36 PM	202 broadway			
18	Feb 6, 2016 1:00 PM	25 Botsford Avenue Milford CT			
19	Feb 6, 2016 4:22 AM	110 waterbury ave.			
20	Feb 5, 2016 8:15 PM	27 Clinton St, Milford, CT 06460			
21	Feb 5, 2016 8:08 PM	16 Usher Street			
22	Feb 5, 2016 7:01 PM	30 clinton			
23	Feb 4, 2016 4:23 PM	685 East Broadway Milford, CT			
24	Feb 3, 2016 12:48 AM	160 Broadway			
25	Feb 2, 2016 10:49 PM	214 Broadway, Milford, CT 06460			
26	Feb 2, 2016 5:37 PM	59 Hillside Ave		19 Shea Ave	
27	Feb 2, 2016 12:29 PM	258 BROADWAY			
28	Feb 1, 2016 9:55 PM	1 Platt Street			
29	Feb 1, 2016 6:01 PM	Virginia st			
30	Feb 1, 2016 5:52 PM	11 Platt Street Milford			
31	Feb 1, 2016 2:45 PM	east ave			
32	Feb 1, 2016 12:24 PM	Mark St			
33	Feb 1, 2016 11:51 AM	160 Broadway Milford CT			
34	Feb 1, 2016 4:27 AM	5 Platt Street Milford, Ct			
35	Feb 1, 2016 2:27 AM	23 Platt St			
36	Feb 1, 2016 12:49 AM	21 Hauser St			
37	Feb 1, 2016 12:24 AM	7 Wall Street			
38	Jan 31, 2016 10:40 PM	21 hauser st milford			
39	Jan 31, 2016 10:31 PM	13 Platt Street			
40	Jan 31, 2016 9:27 PM	Hawley Ave			
41	Jan 31, 2016 8:24 PM	16 Clinton Street			
42	Jan 31, 2016 7:20 PM	19 Clinton Street			
43	Jan 31, 2016 6:33 PM	16 devol st			
44	Jan 31, 2016 4:10 PM	63 Hawley Avenue			
45	Jan 31, 2016 2:51 AM	Clinton Street			
46	Jan 31, 2016 1:30 AM	Dunbar Rd			
47	Jan 30, 2016 9:46 PM	East Broaway			
48	Jan 30, 2016 9:42 PM	70 Hawley Avenue Milford CT			
49	Jan 30, 2016 9:17 PM	8 Belmont St			
50	Jan 30, 2016 7:01 PM	10 Dixon St. Milford			
51	Jan 30, 2016 6:17 PM	Dunbar Road Milford CT			
52	Jan 30, 2016 5:46 PM	16 Hawley Avenue, Milford, CT			
53	Jan 30, 2016 5:45 PM	Westland Avenue			
54	Jan 30, 2016 4:58 PM	18 Hawley Avenue			
55	Jan 30, 2016 4:43 PM	14 Usher St Milford, CT 06460		Same	
56	Jan 30, 2016 4:25 PM	22 Shorefront Milford			
57	Jan 30, 2016 4:24 PM	21 Summer Pl			
58	Jan 30, 2016 4:10 PM	Devol Street			
59	Jan 30, 2016 1:43 PM	Waterbury Avenue			
60	Jan 29, 2016 6:13 PM	38 Field Court			
61	Jan 29, 2016 6:04 PM	19 Platt Street Milford CT 06460			
62	Jan 29, 2016 6:04 PM	Cooper Ave			
63	Jan 29, 2016 5:58 PM	68 Point Beach Drive			
64	Jan 29, 2016 5:49 PM	79 Beachland Ave			
65	Jan 29, 2016 4:50 PM	77C East Broadway			
66	Jan 29, 2016 4:02 PM	159 Rogers Ave		247 Broad St	
67	Jan 29, 2016 2:20 PM	28 Seaview Avenue			

Milford Coastal Resilience

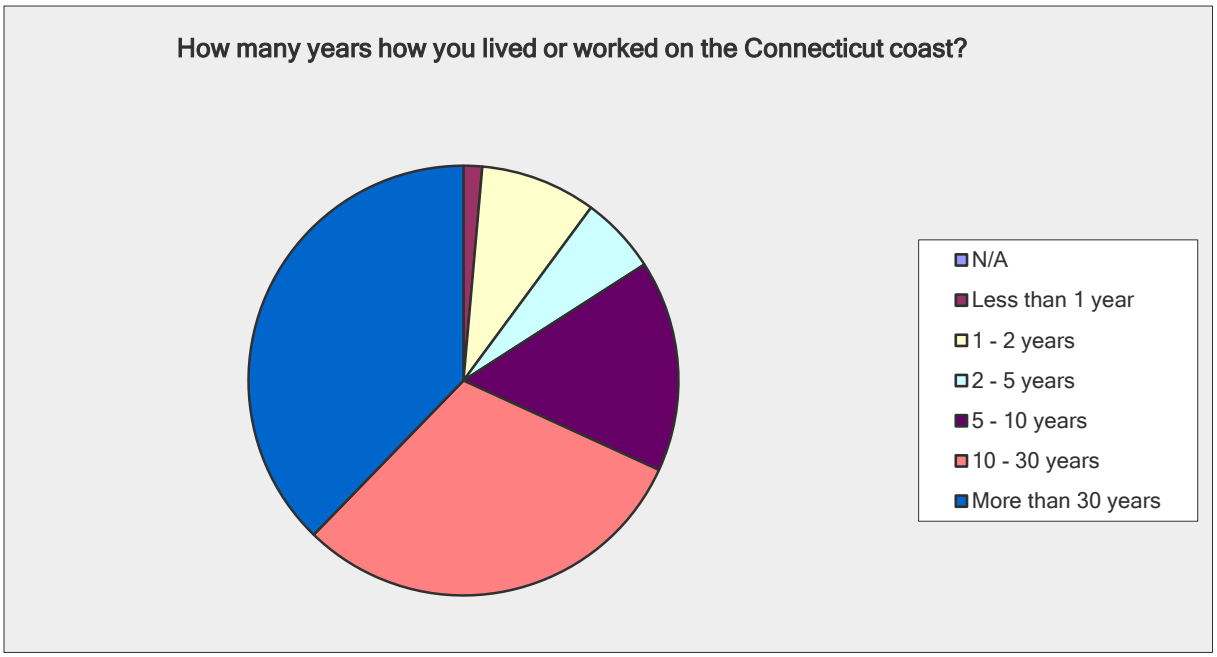
What are your primary connections to the Connecticut Coast? (check as many boxes as you wish)		
Answer Options	**Response Percent**	**Response Count**
I own a home on the coast	92.6%	63
I own a commercial property on the coast	1.5%	1
Recreation (going to the beach, swimming, boating,	38.2%	26
Income (fishing, tourism, etc)	1.5%	1
Ecological value of coastline	26.5%	18
Aesthetic (I like how it looks)	32.4%	22
Other (please specify)	10.3%	7
	answered question	**68**
	skipped question	**1**

Number	Response Date	Other (please specify)	Categories
1	Feb 26, 2016 8:06 PM	enjoyed every summer since I was born in 1944	
2	Feb 16, 2016 1:13 AM	I own a home near the coast	
3	Feb 2, 2016 5:39 PM	Trying to rebuild a Resilient home at 59 Hillside Ave	
4	Jan 31, 2016 10:41 PM	I walk along the shoreline (Walnut beach park) daily viewing birds	
5	Jan 31, 2016 8:25 PM	We rent for many years 500 feet from the beach	
6	Jan 29, 2016 4:51 PM	I own 2 condos on the coast	
7	Jan 29, 2016 4:04 PM	My yacht club has been severely damaged by Irene and Sandy	



Milford Coastal Resilience

How many years how you lived or worked on the Connecticut coast?		
Answer Options	**Response Percent**	**Response Count**
N/A	0.0%	0
Less than 1 year	1.4%	1
1 - 2 years	8.7%	6
2 - 5 years	5.8%	4
5 - 10 years	15.9%	11
10 - 30 years	30.4%	21
More than 30 years	37.7%	26
	answered question	**69**
	skipped question	**0**



Milford Coastal Resilience

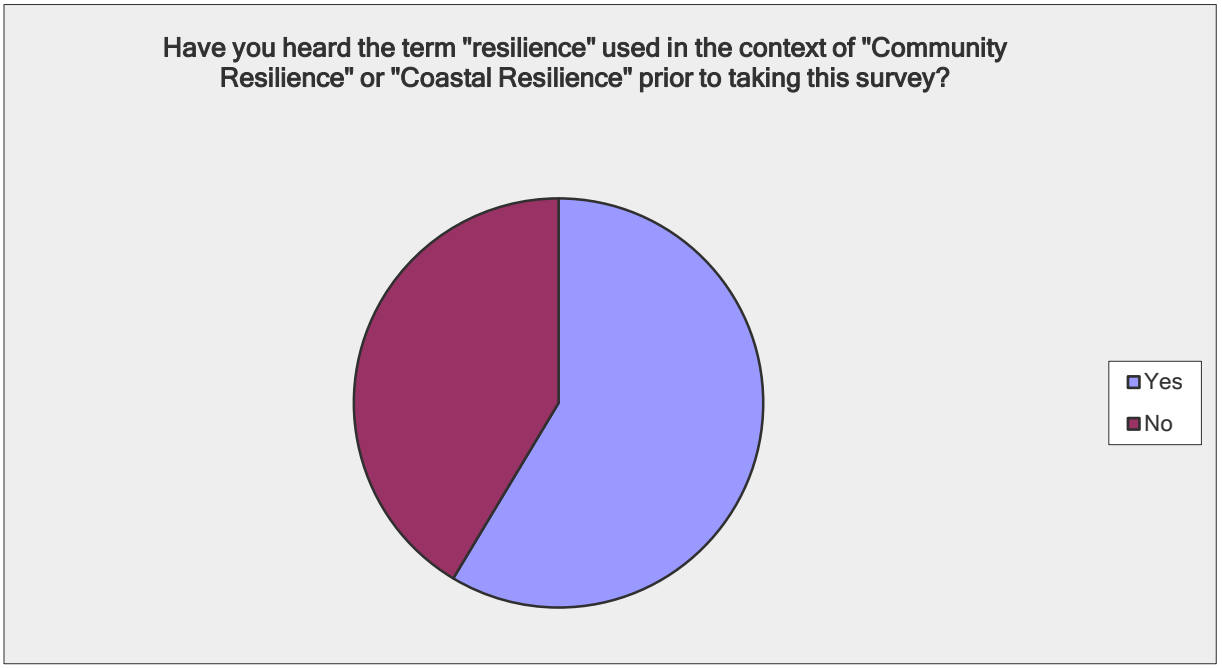
What does the term "resilience" mean to you?

Answer Options	Response Count
	56
answered question	56
skipped question	13

Number	Response Date	Response Text	Categories
1	Mar 4, 2016 8:36 PM	resistance, integrity	
2	Feb 26, 2016 8:12 PM	coastline able to handle the wrath of storm waters w/o loss	
3	Feb 23, 2016 6:33 AM	protect the coast and properties	
4	Feb 18, 2016 12:00 AM	resistance, able to with stand or refurbish	
5	Feb 16, 2016 7:09 PM	ability to bounce back after a traumatic occurance	
6	Feb 16, 2016 4:45 PM	The ability to sustain a positive condition despite challenging conditions.	
7	Feb 16, 2016 1:14 AM	the ability to prevent damage and rebuild with ease	
8	Feb 12, 2016 3:35 PM	Ability to recover	
9	Feb 9, 2016 3:26 AM	worry	
10	Feb 8, 2016 11:06 PM	Able to recover from natural disasters with the least amount of damage	
11	Feb 8, 2016 8:16 PM	ability to bounce back	
12	Feb 8, 2016 5:05 PM	Ability to Recover In a timely or quick fashion	
13	Feb 8, 2016 1:35 PM	Lasting	
14	Feb 6, 2016 9:19 PM	Ability to withstand conflict	
15	Feb 6, 2016 6:39 PM	ability to survive an adverse event	
16	Feb 6, 2016 1:03 PM	Plan of action to mitigate flood risk	
17	Feb 5, 2016 8:18 PM	Able to recover.	
18	Feb 5, 2016 8:13 PM	Recover quickly	
19	Feb 5, 2016 7:03 PM	Regenerative	
20	Feb 4, 2016 4:53 PM	The ability to recover in suitable fashion from hardship or adversity.	
21	Feb 2, 2016 10:53 PM	the ability of our coast line to endure and recover from a storm	
22	Feb 2, 2016 5:44 PM	Will not be damaged in the same way by a natural disaster- Ever	
23	Feb 2, 2016 12:35 PM	Ability to cope with adversity and return to a positive position	
24	Feb 1, 2016 6:17 PM	Coastal Resilience would be putting measures in place to help defer the potential for flood damage and if damage is done to be able to recover at a quicker pace than we have now.	
25	Feb 1, 2016 6:03 PM	Personal Residence	
26	Feb 1, 2016 5:55 PM	stregnth	
27	Feb 1, 2016 2:48 PM	protection	
28	Feb 1, 2016 4:30 AM	The able to bounce back	
29	Feb 1, 2016 2:30 AM	Ability to withstand adverse conditions and return to original state	
30	Feb 1, 2016 12:51 AM	being able to recover from damage	
31	Jan 31, 2016 10:43 PM	It is stable	
32	Jan 31, 2016 10:33 PM	it means having the strength to stand up against any storm	
33	Jan 31, 2016 6:36 PM	Ability to survive	
34	Jan 31, 2016 4:14 PM	Able to bounce back after a tragedy or in this case a natural disaster or storm	
35	Jan 31, 2016 11:15 AM	strength	
36	Jan 31, 2016 2:55 AM	Being able to quickly and effectively bounce back	
37	Jan 30, 2016 9:48 PM	ability to survive a disaster	
38	Jan 30, 2016 9:45 PM	being able to recover quickly from a bad event	
39	Jan 30, 2016 9:21 PM	Stand up to forces. Steadfast.	
40	Jan 30, 2016 6:20 PM	strength	
41	Jan 30, 2016 5:51 PM	toughness, ability to recover quickly	
42	Jan 30, 2016 5:49 PM	Survival, returnability	
43	Jan 30, 2016 5:01 PM	Able to return to a former state	
44	Jan 30, 2016 4:46 PM	Recover quickly to set backs	
45	Jan 30, 2016 4:28 PM	able to withstand difficulties	
46	Jan 30, 2016 4:28 PM	ability to stand up to	
47	Jan 30, 2016 4:13 PM	to stay the same, ward off negative change	
48	Jan 30, 2016 1:46 PM	coming back from a problem and being able to move forward successfully	
49	Jan 29, 2016 6:14 PM	?	
50	Jan 29, 2016 6:08 PM	strong	
51	Jan 29, 2016 6:05 PM	Able to withstand anything.	
52	Jan 29, 2016 6:01 PM	how well my property can stand up to a storm	
53	Jan 29, 2016 5:53 PM	able to resist or recover quickly from an event	
54	Jan 29, 2016 4:54 PM	The ability to withstand dangerous situations	
55	Jan 29, 2016 4:27 PM	Ability to recover from a storm in a minimum amt of time	
56	Jan 29, 2016 2:22 PM	ability to withstand and overcome	

Milford Coastal Resilience

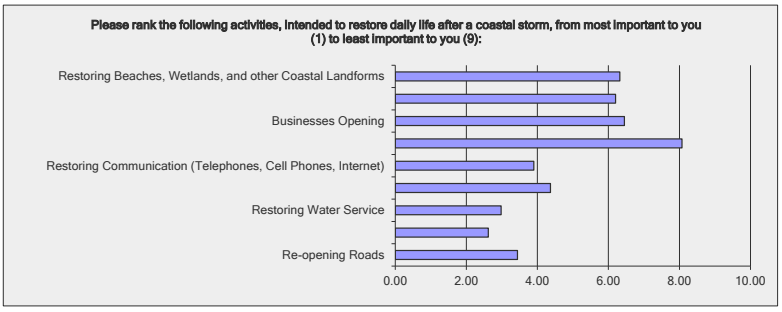
Have you heard the term "resilience" used in the context of "Community Resilience" or "Coastal Resilience" prior to taking this survey?		
Answer Options	**Response Percent**	**Response Count**
Yes	58.6%	34
No	41.4%	24
	answered question	**58**
	skipped question	**11**



Milford Coastal Resilience

Please rank the following activities, intended to restore daily life after a coastal storm, from most important to you (1) to least important to you (9):

Answer Options	1	2	3	4	5	6	7	8	9	Rating Average	Response Count
Re-opening Roads	12	7	6	10	9	1	3	2	0	3.44	50
Making my Home Livable	24	12	5	3	2	0	1	1	4	2.62	52
Restoring Water Service	6	16	14	9	3	1	1	1	0	2.98	51
Restoring Wastewater Collection and Disposal (Sewer or	1	6	7	13	14	4	5	1	0	4.37	51
Restoring Communication (Telephones, Cell Phones,	3	7	12	9	13	6	0	0	1	3.90	51
Tourists Returning	3	1	0	2	1	0	1	3	43	8.07	54
Businesses Opening	0	1	3	1	4	15	19	11	1	6.45	55
Repairing Damaged Buildings	1	1	4	4	2	14	16	13	0	6.20	55
Restoring Beaches, Wetlands, and other Coastal	5	1	1	3	5	9	7	21	4	6.32	56
										answered question	59
										skipped question	10

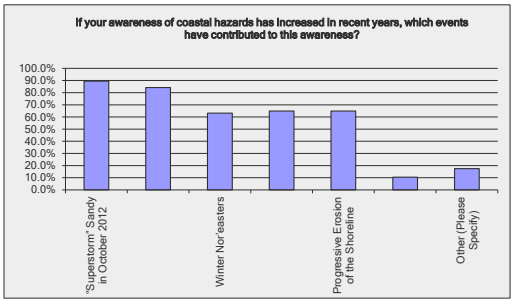


Milford Coastal Resilience

If your awareness of coastal hazards has increased in recent years, which events have contributed to this awareness?

Answer Options	Response Percent	Response Count
"Superstorm" Sandy in October 2012	89.5%	51
Hurricane/Tropical Storm Irene in August 2011	84.2%	48
Winter Nor'easters	63.2%	36
High-Tide Flooding without a Storm Event	64.9%	37
Progressive Erosion of the Shoreline	64.9%	37
Significant Coastal Events outside of Connecticut	10.5%	6
Other (Please Specify)	17.5%	10
answered question		57
skipped question		12

Number	Response Date	Other (Please Specify)	Categories
1	Mar 4, 2016 8:38 PM	I work in the marine construction business	
2	Feb 23, 2016 6:40 AM	do not forget the nor easter of december 1992, storm beth some of the worst flooding , the beaches were never the same since!! Locale government never did anything!! just studies with nothing ever being done!	
3	Feb 18, 2016 12:18 AM	Constant elevation shoreline changes	
4	Feb 16, 2016 5:04 PM	Katrina	
5	Feb 16, 2016 1:31 AM	visiting beach and observing sand and structure erosion	
6	Feb 5, 2016 7:08 PM	Pollution from sewage releases	
7	Feb 2, 2016 5:56 PM	Winter Storm Beth 1991	
8	Jan 31, 2016 6:39 PM	New Orleans	
9	Jan 29, 2016 6:10 PM	Storm Beth 1993	
10	Jan 29, 2016 6:06 PM	Damage that Sandy called to New York and New Jersey beaches	

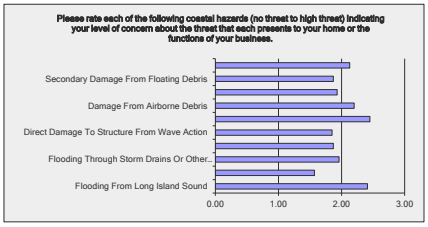


Milford Coastal Resilience

Please rate each of the following coastal hazards (no threat to high threat) indicating your level of concern about the threat that each presents to your home or the functions of your business.

Answer Options	No Threat	Some Threat	High Threat	Rating Average	Response Count
Flooding From Long Island Sound	7	19	30	2.41	56
Flooding From Tidal Rivers And Estuaries	30	16	7	1.57	53
Flooding Through Storm Drains Or Other Drainage	16	25	14	1.96	55
Erosion Of Land Under Structure	23	15	16	1.87	54
Direct Damage To Structure From Wave Action	27	9	19	1.85	55
Direct Damage From High Winds	3	24	28	2.45	55
Damage From Airborne Debris	6	32	17	2.20	55
Contamination From Overflowing Septic Systems Or	16	27	12	1.93	55
Secondary Damage From Floating Debris	19	23	12	1.87	54
Secondary Damage From Natural Gas Or Propane	6	35	13	2.13	54
Comments					4
				answered question	56
				skipped question	13

Number	Response Date	Comments	Categories
1	Feb 4, 2016 4:54 PM	I have repaired from Sandy. The homes on either side of me have not. The replenishment of the beach, as recommended by the 2012 Woods Hole Study has yet to occur. I feat that in a subsequent storm, the instability of the neighboring homes, will eventually re-damage	
2	Feb 2, 2016 5:56 PM	SInce there is no longer a house at 59 Hillside Ave I want to reduce these threats	
3	Jan 31, 2016 4:20 PM	My home is far enough from the water (about 4 houses) that we don't usually have flooding problems related to Long Island Sound	
4	Jan 29, 2016 6:10 PM	not business but residence	



Milford Coastal Resilience

Which of those same hazards have directly impacted you or your business?

Answer Options	Response Percent	Response Count
Flooding From Long Island Sound	70.5%	31
Flooding From Tidal Rivers And Estuaries	15.9%	7
Flooding Through Storm Drains Or Other Drainage	31.8%	14
Erosion Of Land Under Structure	25.0%	11
Direct Damage To Structure From Wave Action	31.8%	14
Direct Damage From High Winds	63.6%	28
Damage From Airborne Debris	25.0%	11
Contamination From Overflowing Septic Systems Or	11.4%	5
Secondary Damage From Floating Debris	29.5%	13
Secondary Damage From Natural Gas Or Propane	6.8%	3
Other (Please Specify)		9
	answered question	**44**
	skipped question	**25**

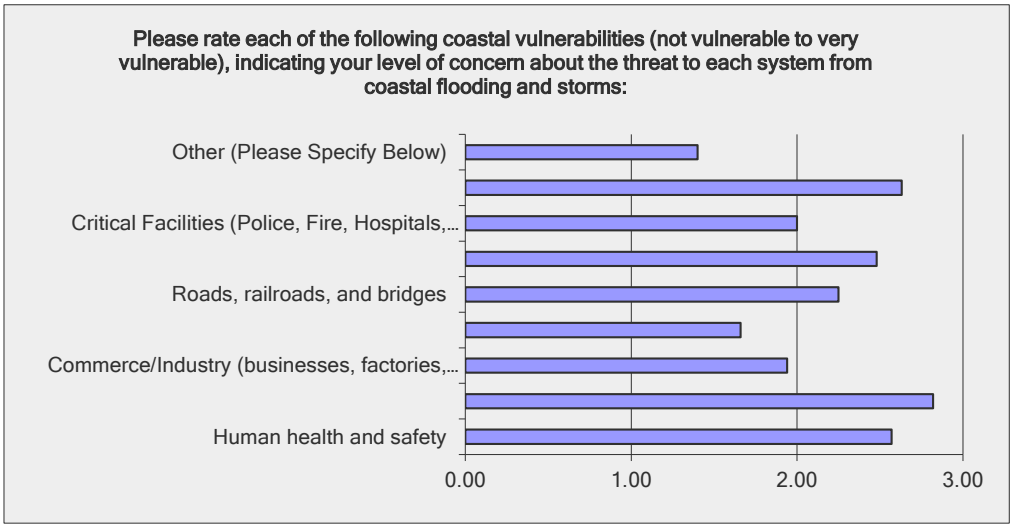
Number	Response Date	Other (Please Specify)	Categories
1	Feb 16, 2016 5:04 PM	Power outages	
2	Feb 8, 2016 8:20 PM	None	
3	Feb 6, 2016 1:10 PM	We have been personally fortunate not incurring any loss from recent storms. But we are keenly aware of the fact that you can't count on luck. We are concerned about our neighbors and friend who have not been so lucky based on where their homes are locatec	
4	Feb 2, 2016 5:56 PM	These led to demolition of present structure	
5	Jan 31, 2016 10:39 PM	we haven't lived here long enough to have seen any flooding to our home	
6	Jan 30, 2016 9:50 PM	none as I haven't been here that long	
7	Jan 29, 2016 6:17 PM	Rental business	
8	Jan 29, 2016 6:10 PM	not business but residence	
9	Jan 29, 2016 6:09 PM	N/A	

Milford Coastal Resilience

Please rate each of the following coastal vulnerabilities (not vulnerable to very vulnerable), indicating your level of concern about the threat to each system from coastal flooding and storms:

Answer Options	Not Vulnerable	Somewhat Vulnerable	Very Vulnerable	Rating Average	Response Count
Human health and safety	2	19	32	2.57	53
Homes	1	8	46	2.82	55
Commerce/Industry (businesses, factories, offices)	10	36	7	1.94	53
Tourism	23	25	5	1.66	53
Roads, railroads, and bridges	5	28	18	2.25	51
Utilities (water, wastewater, electricity, gas,	1	26	27	2.48	54
Critical Facilities (Police, Fire, Hospitals, Shelters)	12	29	12	2.00	53
Natural Systems (Tidal Wetlands, Coastal Landforms)	2	16	36	2.63	54
Other (Please Specify Below)	4	0	1	1.40	5
Comments					1
				answered question	55
				skipped question	14

Number	Response Date	Comments	Categories
1	Feb 16, 2016 1:31 AM	seawalls and structures assisting with impact of wave action	

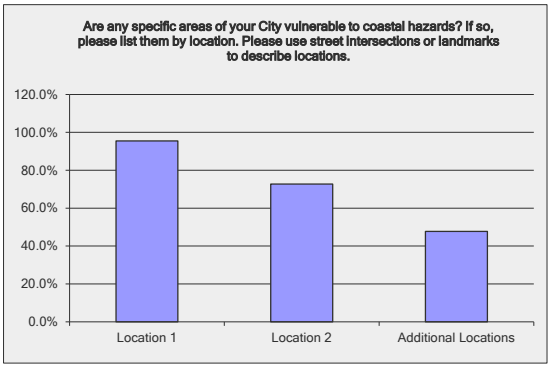


Milford Coastal Resilience

Are any specific areas of your City vulnerable to coastal hazards? If so, please list them by location. Please use street intersections or landmarks to describe locations.

Answer Options	Response Percent	Response Count
Location 1	95.5%	42
Location 2	72.7%	32
Additional Locations	47.7%	21
answered question		44
skipped question		25

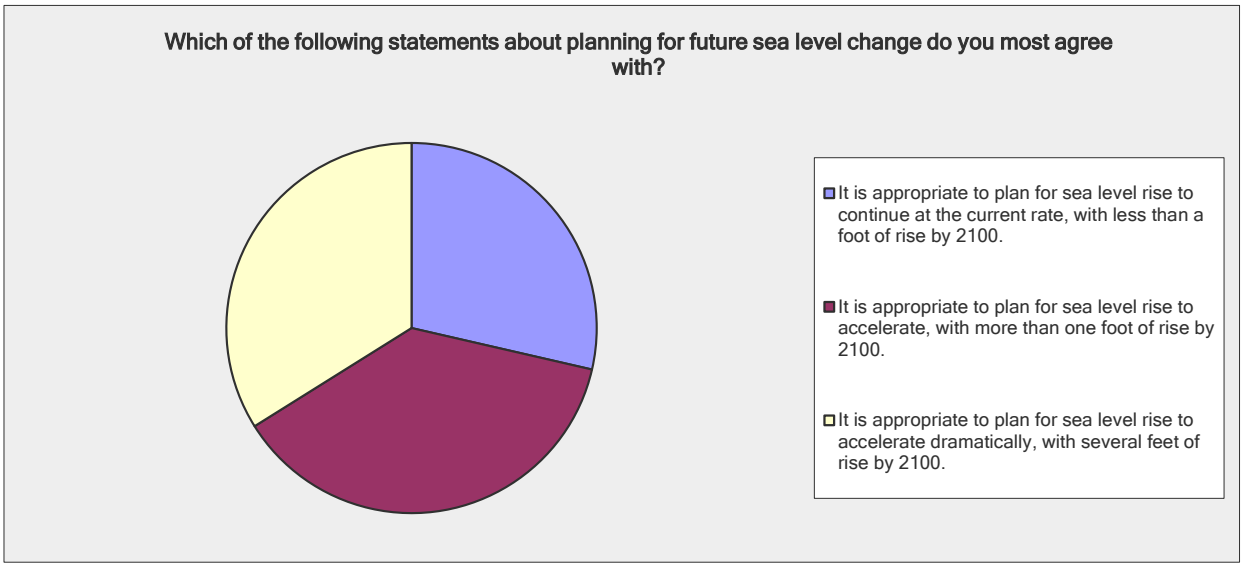
Number	Response Date	Location 1	Categories	Location 2	Categories	Additional Locations	Categories
1	Feb 26, 2016 8:25 PM	costa azzurra restaurant&17 ann		16 bridgewater avenu		and beach properties past bridgewater avenue	
2	Feb 18, 2016 12:18 AM	Bridgewater ave and broadway		waterbury ave anb brc		Walnut beach in general	
3	Feb 16, 2016 7:19 PM	Point Beach		Bayview Beach			
4	Feb 16, 2016 5:04 PM	Wildemere Beach from Naugatuc		Point Beach		Walnut Beach	
5	Feb 16, 2016 1:31 AM	Shorefront at Botsford Avenue		Shorefront at Waterbu		Shorefront at Ann Street	
6	Feb 12, 2016 3:41 PM	Point beach to Bayview					
7	Feb 9, 2016 3:30 AM	Broadway		East Broadway			
8	Feb 8, 2016 11:10 PM	Virginia and Morehouse		Atwater and Richard			
9	Feb 8, 2016 8:20 PM	Wildemere Beach		Point Beach		Bayview Beach	
10	Feb 8, 2016 5:10 PM	Wildemere Beach Stowe Ave to V		Milford Point Road fro		17 miles of Milford Shores	
11	Feb 6, 2016 9:22 PM	Wildemere Beach		Walnut Beach			
12	Feb 6, 2016 6:45 PM	broadway at wood ave		braodway at bitterswe		all of wildemere beach from ann st to fairview ave	
13	Feb 6, 2016 1:10 PM	Botsford Avenue / Shorefront		Broadway		All streets adjacent to Broadway	
14	Feb 5, 2016 8:19 PM	Beach Avenue					
15	Feb 5, 2016 7:08 PM					General storm drain runoff	
16	Feb 4, 2016 4:54 PM	Lower end of East Broadway beginning at Silver Sands				State Park and continuing east halfway up the street before Surf Avenue intersection.	
17	Feb 2, 2016 11:01 PM	Wildermere Beach		Point Beach		Any and all of the shoreline communities in Milford are at high risk with	Laurel Beach being at a medium risk.
18	Feb 2, 2016 5:56 PM	59 Hillside Ave (can be corrected by proper building)					
19	Feb 2, 2016 12:39 PM	Wildemere Beach		Walnut Beach			
20	Feb 1, 2016 10:01 PM	Platt Street and Morehouse Avenue					
21	Feb 1, 2016 6:08 PM	Virginia St		Platt & Moorehouse		Point beach & Melba streets	
22	Feb 1, 2016 2:52 PM	Bay View, East Ave/Summer Plac		Melba St		Orland	
23	Feb 1, 2016 12:32 PM	all along Beach Avenue		Mark St and Kings Hig		Merwin Avenue/Abigail St	
24	Feb 1, 2016 2:36 AM	Point Beach and Virginia Beach i		Richard street			
25	Feb 1, 2016 12:56 AM	Wildemere Beach		Point Beach		Bayview Beach	
26	Jan 31, 2016 10:47 PM	Wildermere Beach shoreline					
27	Jan 31, 2016 10:39 PM	Point Beach area floods when we		Bayview floods when we have a hide tide			
28	Jan 31, 2016 10:38 PM	Beach Ave. The Woodmont secti		Bayview Beach area		Hillside Ave	
29	Jan 31, 2016 6:39 PM	Woodmont beaches					
30	Jan 31, 2016 4:20 PM	All of Beach Avenue and the side streets perpendicular to it such as Chaple Street, Dunbar, Devol, Belmont etc					
31	Jan 31, 2016 3:01 AM	Platt Street		Bay shore Drive			
32	Jan 30, 2016 9:51 PM	end of Naugatuck Avenue					
33	Jan 30, 2016 9:50 PM					all the beach front property and areas near wetlands	
34	Jan 30, 2016 9:25 PM	Anchor beach area -Kings Highw		Beach Rd		All the beaches	
35	Jan 30, 2016 5:56 PM	Westland /Field court		Any intersections alon		Melba/ point beach area	
36	Jan 30, 2016 5:55 PM	Beach Avenue in Woodmont					
37	Jan 30, 2016 4:49 PM	Woodmont		Anchor Beach			
38	Jan 30, 2016 4:36 PM	all homes with LI Sound in front o		homes along East Bro		Bayview area, Cedar Beach with Sound on one side and marsh behind	
39	Jan 30, 2016 4:17 PM	Woodmont Beach (Beach Ave)		Anchor Beach			
40	Jan 29, 2016 6:17 PM	Westland Ave & Field Court		Deerfield Ave & Field		Milesfield Ave & Field Court	
41	Jan 29, 2016 6:10 PM	Point Beach Area		All Coastal Areas of Milford			
42	Jan 29, 2016 6:09 PM	New Haven Ave		Cedar Beach / Milford		Point Road	
43	Jan 29, 2016 6:06 PM	Atwater St and Point Beach Dr		Fowler Field area beh		Gulf Beach area, Bayview	
44	Jan 29, 2016 5:07 PM	Broadway from Bertrose Ave. to M		East Broadway from Naugatuck Ave. to Viscount Drive.			



Milford Coastal Resilience

Which of the following statements about planning for future sea level change do you most agree with?		
Answer Options	**Response Percent**	**Response Count**
It is appropriate to plan for sea level rise to continue at	28.6%	16
It is appropriate to plan for sea level rise to accelerate,	37.5%	21
It is appropriate to plan for sea level rise to accelerate	33.9%	19
Comments		8
	answered question	56
	skipped question	13

Number	Response Date	Comments	Categories
1	Feb 18, 2016 12:18 AM	The shoreline needs to be protected at all cost	
2	Feb 16, 2016 5:04 PM	Assumes the world's countries fail to meet their obligation to reduce carbons as agreed.	
3	Feb 6, 2016 1:10 PM	The time is now to take action!	
4	Jan 31, 2016 10:47 PM	With higher sea levels including from melting glaciers and more violent weather patterns dramatic damage will occur	
5	Jan 30, 2016 9:50 PM	I really do not know	
6	Jan 30, 2016 1:51 PM	Too difficult to predict too far into the future - sea levels will rise, for sure but how much is just a prediction for now	
7	Jan 29, 2016 6:09 PM	All of the above	
8	Jan 29, 2016 5:07 PM	Global warming should be dealt with as soon as possible by the federal government.	

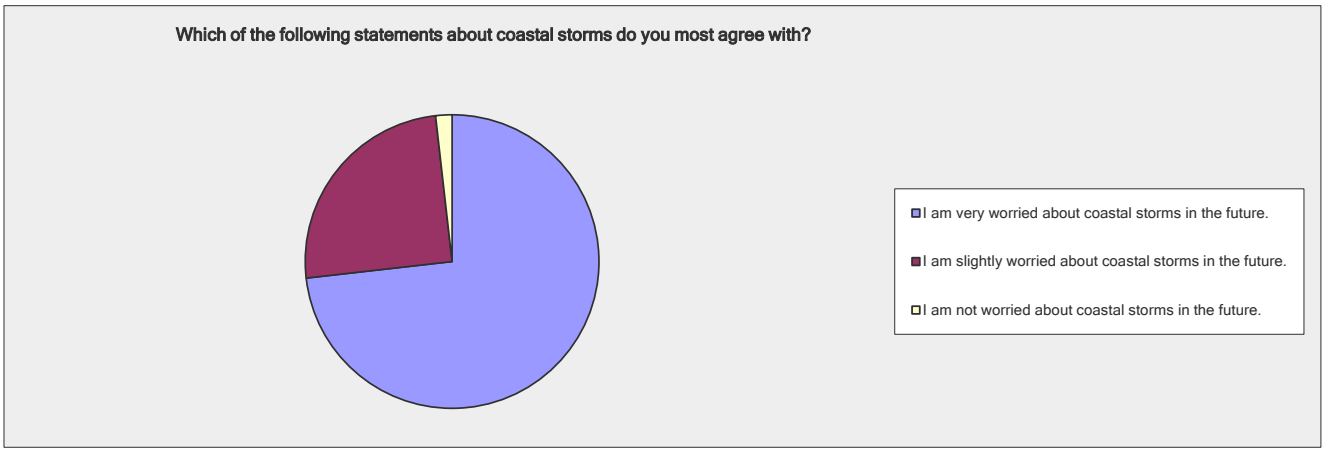


Milford Coastal Resilience

Which of the following statements about coastal storms do you most agree with?

Answer Options	Response Percent	Response Count
I am very worried about coastal storms in the future.	73.2%	41
I am slightly worried about coastal storms in the future.	25.0%	14
I am not worried about coastal storms in the future.	1.8%	1
Comments		7
	answered question	56
	skipped question	13

Number	Response Date	Comments	Categories
1	Feb 18, 2016 12:18 AM	Global warming or earths cycles is changing rapidly My wife and mother in law have lived at Wildemere Beach since 1955 when you could see the beach sand from their home located 600 ft up the street. My mother in law is now 96 yrs old. When Sandy hit, our neighbors and I watched a 15 ft wall of sea water explode and remove the sea wall at the end of our street. It brought the water passed my mother in law's driveway and I had to evacuate her in the evening. Three of our neighbors lost their homes. Many others had the water wall come through their first floors and take everything out to sea or push it to Broadway. We all worry about a category 3 or 4 hurricane hitting the	
2	Feb 16, 2016 5:04 PM	CT shore like years ago. Time is not on our side.	
3	Feb 6, 2016 1:10 PM	The facts speak for themselves. We cannot deny what the future will hold if we fail to prepare. Folks fail to plan; not plan to fail.	
4	Feb 2, 2016 5:56 PM	If I can build the proposed resilient home	
5	Feb 1, 2016 2:36 AM	House is designed to exceed FEMA requirements	
6	Jan 29, 2016 6:17 PM	Street flooding is worse	
7	Jan 29, 2016 6:10 PM	Constantly worried and scared for my family and home	

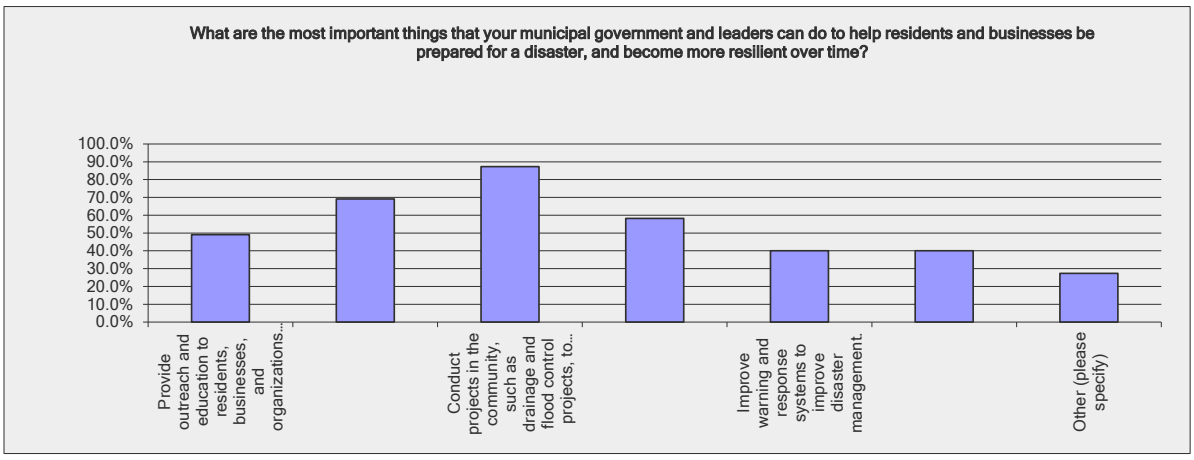


Milford Coastal Resilience

What are the most important things that your municipal government and leaders can do to help residents and businesses be prepared for a disaster, and become more resilient over time?

Answer Options	Response Percent	Response Count
Provide outreach and education to residents,	49.1%	27
Provide technical assistance to residents, businesses,	69.1%	38
Conduct projects in the community, such as drainage	87.3%	48
Make it easier for residents, businesses, and	58.2%	32
Improve warning and response systems to improve	40.0%	22
Enact and enforce regulations, codes, and ordinances	40.0%	22
Other (please specify)	27.3%	15
	answered question	55
	skipped question	14

Number	Response Date	Other (please specify)	Categories
1	Feb 26, 2016 8:50 PM	restore & stabilize beaches to withstand storm water wrath Work with City, State and Federal agencies to develop short and long term plans that TRULY mitigate the problem, not just talk and talk and talk about it. It's not like we are blind and can't see what is happening. When I moved into our home 650 ft from Long Island Sound, Allstate Insurance, who we had for 30+ years would not insure our small Cape Cod home. That was the first signal. Each year, we can actually SEE the water level of the Sound rise. In the late 1950s, we used to have to cross the road and walk 100 ft to the beach to see if it was low or high tide as the water level at the shore was not visible. Today, it looks like it is about to come over and up the road all the time. After Sandy, we and our neighbors watched the National Guard bring shoreline residents to safety with a rubber raft. We saw two elderly resident get out of the raft and walk by us with their small dog and one suitcase. When asked what happened, they said their home was taken out to sea. We ask ourselves	
2	Feb 16, 2016 5:26 PM	all the time, when will we have to face this problem?.	
3	Feb 16, 2016 1:39 AM	replenish the shoreline to mitigate storm damage and danger	
4	Feb 12, 2016 3:41 PM	Restore flood gates under bridge and other protective devices	
5	Feb 8, 2016 5:19 PM	Stop talking and do something to help. Lots of studies with no ACTION!	
6	Feb 6, 2016 6:49 PM	DEEP is a hindrance to repairing/maintaining beachfront properties Having survived Sandy, I believe that the City of Milford did all of the above quite well. In retrospect, I believe that many people remained in the dark, not because of the lack of City efforts, but because of their own failures to keep informed and proactive concerning coastal risks, flood plain changes etc. I was shocked at the number of people who have lived in risk areas for many years, without flood insurance and then complain	
7	Feb 4, 2016 4:54 PM	that the City doesn't do enough.	
8	Feb 2, 2016 11:06 PM	All of the above are important!!!	
9	Feb 2, 2016 6:04 PM	do not force a one size fits all solution. Every situation is different.	
10	Feb 1, 2016 2:55 PM	most flooding in Bay View can be prevented by updating street drain system and flood gates on melba st bridge	
11	Jan 31, 2016 10:43 PM	deal with the flooding we currently have	
12	Jan 30, 2016 1:55 PM	We need to find a way to increase the SAND and find a way to hold onto the sand on our beaches. How do Laurel Beach and West Haven manage to do that?	
13	Jan 29, 2016 6:18 PM	Fix storm drain caps or valves	
14	Jan 29, 2016 6:17 PM	Communication is still KEY for all residents - especially the elderly, many did not know about this event for the presentation itself	
15	Jan 29, 2016 5:18 PM	Provide monetary rebates to people affected by flooding.	

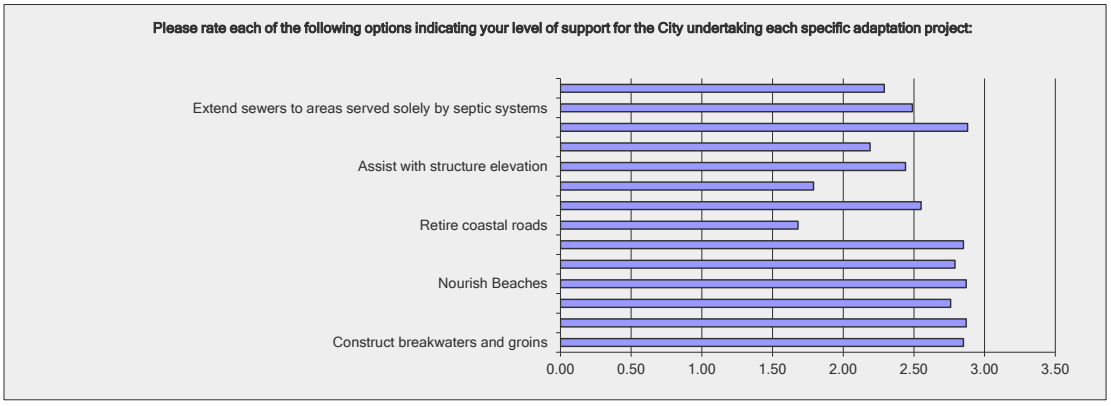


Milford Coastal Resilience

Please rate each of the following options indicating your level of support for the City undertaking each specific adaptation project:

Answer Options	Against	No Opinion	Support	Rating Average	Response Count
Construct breakwaters and groins	1	6	48	2.85	55
Restore Dunes	2	3	47	2.87	52
Create “Living Shorelines”	1	10	40	2.76	51
Nourish Beaches	1	5	48	2.87	54
Build seawalls and bulkheads	3	5	44	2.79	52
Improve drainage systems	1	6	45	2.85	52
Retire coastal roads	27	12	11	1.68	50
Elevate coastal roads	5	12	32	2.55	49
Buyout and retire coastal properties	26	12	15	1.79	53
Assist with structure elevation	7	13	28	2.44	48
Assist with structure relocation	9	21	18	2.19	48
Strengthen coastal utility infrastructure	0	6	46	2.88	52
Extend sewers to areas served solely by septic systems	1	24	26	2.49	51
Extend water service to areas that utilize wells	4	26	18	2.29	48
Other (please specify)					6
				answered question	55
				skipped question	14

Number	Response Date	Other (please specify)	Categories
1	Feb 8, 2016 5:19 PM	Certainly, the city should NOT allow a new structure to be built in an area where there hasn't been a structure in at the minimum 20 years. The example I site is the new home being built IN the MARSH on Milford Point Road. A little common sense and logic could have been put to good use in this case!	
2	Feb 5, 2016 7:13 PM	If building structures in the sound is ecologically sound, then yes	
3	Feb 2, 2016 6:04 PM	Change zoning laws to eliminate penalizing people for trying to rebuild a resilient structure.	
4	Feb 1, 2016 2:41 AM	Seawalls and bulkheads as long as they don't interrupt the natural flow of water. The should be designed to reduce issues in extreme conditions and not cause an impact under normal conditions.	
5	Jan 30, 2016 1:55 PM	Add and maintain SAND on the beaches!!	
6	Jan 29, 2016 6:18 PM	Repair storm drains to cure flooding at hightide	

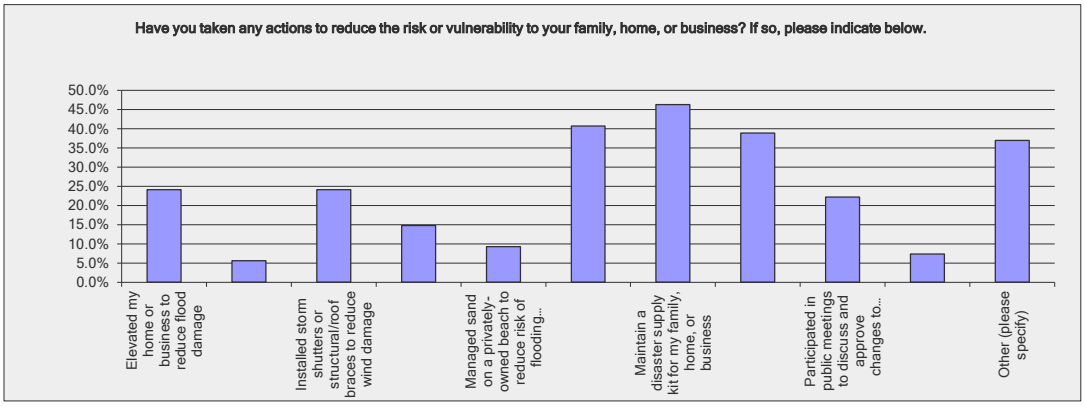


Milford Coastal Resilience

Have you taken any actions to reduce the risk or vulnerability to your family, home, or business? If so, please indicate below.

Answer Options	Response Percent	Response Count
Elevated my home or business to reduce flood damage	24.1%	13
Flood-proofed my business to reduce flood damage	5.6%	3
Installed storm shutters or structural/roof braces to	24.1%	13
Replaced my overhead utility lines with underground	14.8%	8
Managed sand on a privately-owned beach to reduce	9.3%	5
Developed a disaster plan for my family, home, or	40.7%	22
Maintain a disaster supply kit for my family, home, or	46.3%	25
Participated in public meetings to discuss the Plan of	38.9%	21
Participated in public meetings to discuss and approve	22.2%	12
I have not taken any of these actions	7.4%	4
Other (please specify)	37.0%	20
	answered question	**54**
	skipped question	**15**

Number	Response Date	Other (please specify)	Categories
1	Feb 26, 2016 8:50 PM	verbal&written contact with DEEP,senator DeLauro,Wildemere beach association (before 1992 to the present)coastal structures	
2	Feb 18, 2016 12:23 AM	I plan on attending piblic hearings for shoreline rebuilding	
3	Feb 16, 2016 7:29 PM	I don't drive, but I do keep up with public meetings on MGAT	
4	Feb 16, 2016 5:26 PM	Joined a committee within our Beach Association to learn more and take appropriate action to mitigate erosion.	
5	Feb 16, 2016 1:39 AM	reinforced home and seawall to mitigate storm damage and improve drainage	
6	Feb 12, 2016 3:41 PM	Installed new, stronger windows on shore side of home	
7	Feb 9, 2016 3:34 AM	Moved furnance and hot water heater to higher floor.	
8	Feb 8, 2016 5:19 PM	Have been on the board of the Wildemere Beach Association for 17 years all the while working for beach replenishment amongst other things!	
9	Feb 6, 2016 1:17 PM	Researched & purchased custom made vent covers to further eliminate seepage from our crawlspace	
10	Feb 5, 2016 8:25 PM	House was built in 2001 to hurricane standards.	
11	Feb 4, 2016 4:54 PM	My house survived the "38 hurricane. In the course my ownership, I have never had damage to my home, never had water inside, I only lost a deck. After Sandy, we followed all of the FEMA/City recommendations/regulations to minimize damage--short of elevation. I would LOVE to manage my own sand, but DEEP says that I cannot rent a bulldozer to push sand up to the house. Yet, it was okay for them, along with the Army Corps, to build a tidal outlet structure at the State Park, which destroyed the barrier beach protecting my home and the homes of neighbors at least 1500 feet eastward. I have been on East Broadway since the 60's and have experienced winter nor'easters and hurricanes galore. In the past, my neighbors and I might have incurred damage to ours decks. When Sandy hit, the lack of a barrier beach, which eroded as a direct result offending tidal outlet structure, resulted in colossal damage to coastal homes. Please investigate the study conducted in 2012 for DEEP by the Woods Hole Group, Inc. specific to this issue. And please review the Post-Sandy photo-op videos of the Federal, State and Local officials standing in front of our homes, near the offending structure, promising redress... I am well aware that it is not the job of the City to tackle private property issues, but in this case, there is 28 years of damage and fault. We are still awaiting sand replenishment.	
12	Feb 2, 2016 11:06 PM	My home is on the coast and built to the latest standards	
13	Feb 2, 2016 6:04 PM	Tried to do the above but Milford is blocking are attempts	
14	Feb 1, 2016 4:39 AM	I have tried to approach the utility companies without any result to burry their lines.	
15	Jan 31, 2016 10:43 PM	house was steel framed when we bought it	
16	Jan 30, 2016 9:55 PM	purchased flood policy for my condominium	
17	Jan 30, 2016 9:53 PM	I am up high and out of the flood zone. My house was built to hurricane standards	
18	Jan 30, 2016 1:55 PM	repaired my home and strengthened the entire structure	
19	Jan 29, 2016 6:17 PM	Hopefully in the process of getting our home elevated with the awarded grant, we just don't have the funds to pay upfront at the moment and we are working hard to get there	
20	Jan 29, 2016 5:18 PM	Dig a 500' long x 15' wide x 5' deep trench along the shoreline of our waterfront property and fill it water absorbing materials to prevent flooding beyond the trench structure.	



Milford Coastal Resilience

If you could choose one action that could be taken in your community to reduce risks from hazards and the natural events that

Answer Options	Response Count
	44
answered question	44
skipped question	25

Number	Response Date	Response Text	Categories
1	Feb 26, 2016 8:50 PM	restore beaches and install coastal structures and/or proprietary system to stabilize shoreline areas.	
2	Feb 23, 2016 10:41 PM	Sand replenishment	
3	Feb 23, 2016 6:44 AM	we need sand period nothing has been done for the 43 years I have owned my business! Oh yes something has been done taxs keep going up!!!	
4	Feb 18, 2016 12:23 AM	build sea walls	
5	Feb 16, 2016 7:29 PM	elevate homes	
6	Feb 16, 2016 5:26 PM	Plan and support action NOW to resolve the erosion problem and protect our coastline well into the future. The bandaid approach is not an effective or efficient solution for the next generations wishing to enjoy the shoreline.	
7	Feb 16, 2016 1:39 AM	create groins or living systems to hold beach sand and replace missing sand	
8	Feb 12, 2016 3:41 PM	Restore flood gates that were removed and elevate shore roads	
9	Feb 9, 2016 3:34 AM	Create bulkheads and shore up beaches	
10	Feb 8, 2016 11:14 PM	Prevent the tidal waters from flooding through the storm drains.	
11	Feb 8, 2016 8:25 PM	replenish beaches	
12	Feb 8, 2016 5:19 PM	The city should be allowed to move the sand on ALL Milford beaches on a regular basis to help curb the tidal floods.	
13	Feb 6, 2016 9:25 PM	Managing the surging beaches by building sea walls, dunes etc. Assist homeowners in raising their properties.	
14	Feb 6, 2016 6:49 PM	restore and strenghthen beaches!	
15	Feb 6, 2016 1:17 PM	Prioritize action to address risks for neighborhoods where normal high tide levels consistently reach homes on a daily basis.	
16	Feb 5, 2016 8:25 PM	Reconstruct/reinforce sea wall.	
17	Feb 5, 2016 7:13 PM	Reduce development along shore an assure more public access. Protect swamps, marshes, wetlands, and increase habitats for wildlife.	
18	Feb 4, 2016 4:54 PM	Improving drainage relating to tidal marshes and creeks in ways that do not impact the resilience of others. In our case, a man made structure made us less resilient.	
19	Feb 2, 2016 11:06 PM	Work to harden our coastline	
20	Feb 2, 2016 6:04 PM	Help people who want to help make things resilient	
21	Feb 2, 2016 12:42 PM	Save the beaches	
22	Feb 1, 2016 10:03 PM	working on a long range plan for our beach area	
23	Feb 1, 2016 6:13 PM	Control flooding	
24	Feb 1, 2016 6:04 PM	underground utilities	
25	Feb 1, 2016 2:55 PM	invest in updated street drain system and flood gates	
26	Feb 1, 2016 12:35 PM	Support Woodmont's efforts to replace infrastructure, roads and sand to protect shoreline and residents	
27	Feb 1, 2016 4:39 AM	????	
28	Feb 1, 2016 2:41 AM	Reduce water damage through elevation of buildings and roads.	
29	Feb 1, 2016 1:00 AM	Put more sand on beaches & build groins	
30	Jan 31, 2016 10:49 PM	Replenish beaches	
31	Jan 31, 2016 10:44 PM	Replace over head utility lines	
32	Jan 31, 2016 10:43 PM	fix flooding issues so there's more room for the water to go when we have an event. also put utilities underground	
33	Jan 30, 2016 9:53 PM	people need to keep their yards free of items which could become flying debris before a storm is predicted. Also, it keeps garbage out of the water	
34	Jan 30, 2016 5:59 PM	Knowledge and fix storm drains that flood at high tide	
35	Jan 30, 2016 4:54 PM	Building Barriers / Flood Control, Storm Drain Clearing	
36	Jan 30, 2016 4:44 PM	put more sand between LI Sound and my home! Laurel Beach seems to fare much better with their pro-active measures	
37	Jan 30, 2016 4:21 PM	action to stop beach erosion	
38	Jan 30, 2016 1:55 PM	add and maintain the SAND - work to minimize erosion!!!	
39	Jan 29, 2016 6:18 PM	Fix storm drains in Bayview Beach Area	
40	Jan 29, 2016 6:17 PM	I started Storm Victims Unite, an email and facebook communication system where I've passed the word over to residents of anything I've learned, many are still without any direction and many have left Milford with the lack of guidance and the red tape we all have to deal with, with getting help with grants and funding. It's been two year of a struggle for my family. Natural disasters are going to happen regardless of how much you prepare for them, it's what happens after that counts and we haven't had much help with the after parts of each storm - Julie and her team have done what they could but we need more help and FEMA hasn't contacted residents directly about meetings even - and in November many news reports have claimed that there was illegal activity with FEMA funding to Milford and there's an FBI investigation - when you hear that, it's very aggravating and unsettling because these residents need help and we pay a lot in taxes to not get it. I appreciate that these facts are being brought to light but we know we are facing more danger with rising sea levels but we need more direction and help from that. It's time.	
41	Jan 29, 2016 6:12 PM	Breakwaters	
42	Jan 29, 2016 6:10 PM	Flood mitigation in areas that always flood with high tides	
43	Jan 29, 2016 5:18 PM	See previous response for a similar action.	
44	Jan 29, 2016 2:30 PM	Disseminate information	

Milford Coastal Resilience

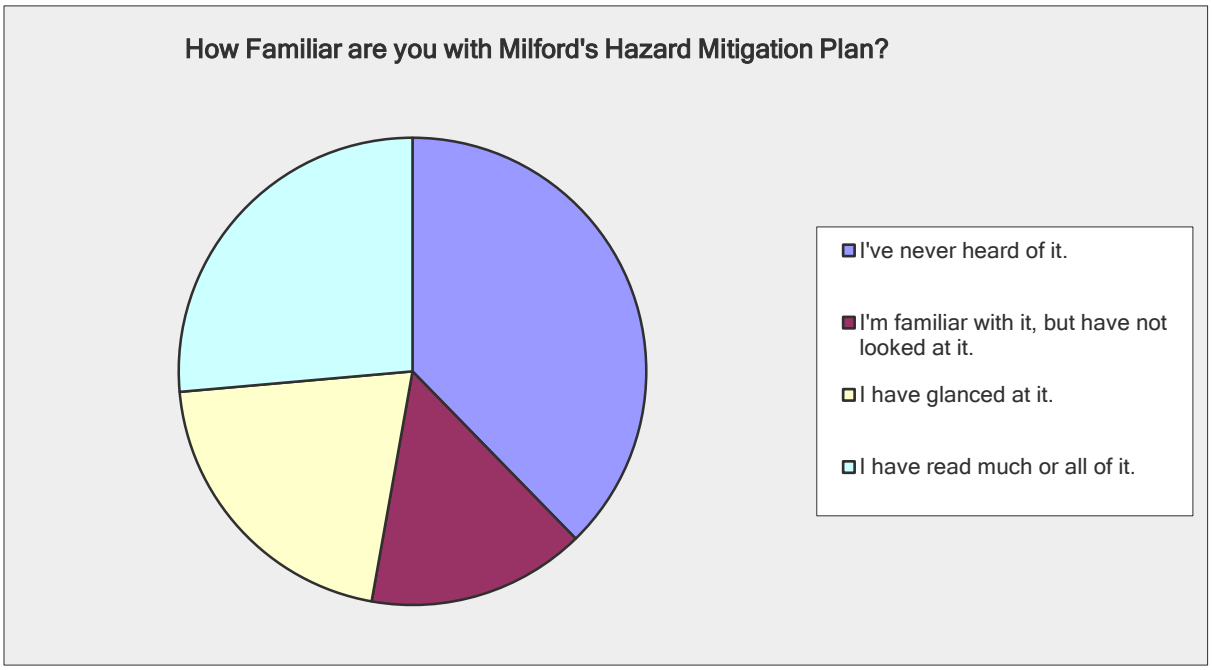
Please provide any additional comments or questions to be addressed as the Coastal Resilience Plan is developed:

Answer Options	Response Count
	21
answered question	21
skipped question	48

Number	Response Date	Response Text	Categories
1	Feb 28, 2016 9:06 PM	am sending packet of material regarding the erosion dilemma in the Wildemere beach area (having reached a crisis point)to aid in the restoration and preservation of this natural resource for all the people of milford.	
2	Feb 23, 2016 9:49 AM	nothing has been done for years. the long island sound has been getting closer. But lets not forget that nothing has been done to the beach for at least 43 years that I have owned my business. We need help not empty promises. we need sand and a lot of it!!	
3	Feb 18, 2016 12:25 AM	How long will this project take from conception ?	
4	Feb 16, 2016 8:36 PM	Our Wildemere Beach Association is and will continue to work with local City officials, Study Groups and Government Agencies to resolve the problem but we all know "effective" action is required sooner than later. The Federal Gov't is broke so sufficient funding is not expected. We need an effective and collaborative regional plan to address the issue seriously. After watching the problem get worse over the past 60 years, discussing band aid solutions is not an interest I can or will support unless they serve as short term solutions to hold the water back while the long term plan is funded and scheduled and a real commitment is on the table.	
5	Feb 16, 2016 1:44 AM	I believe the CITY, as a whole, should have a comprehensive plan to maintain and protect the beaches and shoreline. It should not be left to individuals, businesses, residence owners or beach associations, alone. We should work TOGETHER, with a unified approach to protect all involved. More affluent beaches (such as Laurel Beach) should not have better protection than less affluent areas of our beautiful town. The beaches are Milford's greatest asset - let's keep them existing. (West Haven and Stratford seem to have more complete planning than Milford. Can't we look to their successes to inform our planning?) 30+ years I've spent on these beaches, and I'm watching them wash out into Long Island Sound. It's sad and unnecessary.	
6	Feb 12, 2016 3:47 PM	Allow homeowners to restore yards to previous heights affected by soil erosion. Land that used to be above water level. Not to be used for new home building.	
7	Feb 8, 2016 5:27 PM	My home is directly on Broadway and my driveway is an easement to homes directly on Wildemere Beach. When I moved in 17 years ago, I never had flood water from the sound in my backyard. In the last 7 or so years, we don't need a storm and the water from the sound easily floods several neighbors yards. The end of Smith Ave. has changed dramatically over the years as I am sure many others have as well. As a Board Member of the Wildemere Beach Association I can tell you that we are happy that you are looking into our issues and can only hope there is follow through to help beach front homeowners. Please feel free to contact me if you have any questions I can help answer. We have the availability to contact our 60 or so association members should you have any additional information you'd like to share.	
8	Feb 8, 2016 8:53 PM	Stop studying already and do something! Wildemere beach has been studied multiple times over 35 years always with the same conclusion- the beach needs strengthening and replenishment!	
9	Feb 4, 2016 4:54 PM	Thank you for the meeting of January 28th!	
10	Feb 2, 2016 8:08 PM	We would be willing to share the plans for our proposed resilient home including all Geotechnical reports and bore samples we have done to design a resilient foundation out of the VE zone and in an AE zone on same property.	
11	Feb 1, 2016 2:56 PM	now is the time to invest in hardening shore line AND buying out properties	
12	Feb 1, 2016 12:36 PM	Regulations hamstring corrective actions along the coast.	
13	Feb 1, 2016 4:42 AM	Can not stop nature.	
14	Jan 31, 2016 10:52 PM	Expet opinion is needed to plan the best way. Neighborhoods need to work together to help solve the problem. I believe that replenishing sand on beaches and being smart with groins may be the best way!	
15	Jan 31, 2016 4:31 PM	The beach erosion project done with rocks and sand has failed on Beach avenue near Hawley Avenue playground. It would be nice to see if fixed, if at all possible. I do understand there's no stopping Mother Nature though!	
16	Jan 30, 2016 8:06 PM	It's fine to do a study as to what is needed for the future, however, there are issues with every full moon HIGH TIDE that need to be addressed NOW. If a flapper valve could be fixed after Irene, and knocked off after Sandy. Why can this not be addressed and fixed. If you don't want hazardous waste leeching into the sound, why storm drains that flow directly into that water?? It's time to address the NOW issues and figure out what needs to be done for the future too.	
17	Jan 30, 2016 4:23 PM	Please look at the Beach Ave. beach that was restored with river rock and covered with sand. the sand is gone and only rock remains. Total failure	
18	Jan 30, 2016 1:57 PM	I would love to learn how Lauren Beach and West Haven maintain their erosion-less beaches. And we need to quickly advance to an ACTION plan - too many studies lead nowhere!	
19	Jan 29, 2016 8:18 PM	What options are available for residents and is there any talks of building a better way of communicating with the coastal community?	
20	Jan 29, 2016 8:11 PM	There are many private beach associations in Milford - I would encourage you to meet with each of them to discuss any plans they may have (if any) relative to their respective beach.	
21	Jan 29, 2016 8:22 PM	Please contact me to set up an inspection of the trench structure at our condo which was previously described.	

Milford Coastal Resilience

How Familiar are you with Milford's Hazard Mitigation Plan?		
Answer Options	**Response Percent**	**Response Count**
I've never heard of it.	37.7%	20
I'm familiar with it, but have not looked at it.	15.1%	8
I have glanced at it.	20.8%	11
I have read much or all of it.	26.4%	14
	answered question	**53**
	skipped question	**16**



Milford Coastal Resilience

If you wish to be notified of the progress in developing the Coastal Resilience Plan, please provide your name and email address:

Answer Options	Response Percent	Response Count
Name	100.0%	44
Email Address	100.0%	44
answered question		44
skipped question		25

Number	Response Date	Name	Categories	Email Address	Categories
1	Feb 26, 2016 9:05 PM	Richard H. Ratkiewich		no e-mail / 90 clark hill road,prospect, ct06712-1059	
2	Feb 23, 2016 6:49 AM	Benny Faustini		www.cazura@aol.com	
3	Feb 18, 2016 12:25 AM	Tony Merola		Tonymerola@omelectric.com	
4	Feb 16, 2016 5:35 PM	Bob Williams		rwilli1522@yahoo.com	
5	Feb 16, 2016 1:44 AM	Patricia Pino		pattypino@yahoo.com	
6	Feb 12, 2016 3:47 PM	Ken Crepeau		thevillagew@aol.com	
7	Feb 9, 2016 3:35 AM	Sherry Oblas		soblas@yahoo.com	
8	Feb 8, 2016 8:26 PM	Robert Heerema		bobheerema@yahoo.com	
9	Feb 8, 2016 5:27 PM	Carol Klingele		cklingele@sbcgloabl.net	
10	Feb 6, 2016 9:25 PM	Andrea Coyle		andreatc@charter.net	
11	Feb 6, 2016 6:53 PM	Jonathan Goldberg		jgoldberg@snet.net	
12	Feb 6, 2016 1:18 PM	Theresa Martinsky		tmmartinsky@optonline.net	
13	Feb 5, 2016 8:28 PM	Janette Jurkiewicz		JayJurkiewicz@gmail.com	
14	Feb 5, 2016 8:26 PM	Laurie Fried		lfried@snet.net	
15	Feb 4, 2016 4:54 PM	Sandra Haley		sphaley1@yahoo.com	
16	Feb 2, 2016 11:07 PM	Thom Bach		tbachsr@gmail.com	
17	Feb 2, 2016 6:08 PM	Jack Turek & Donna Weaver		jack@turek.com	
18	Feb 2, 2016 12:43 PM	Michael Lyngaas		mike.lyngaas@gmail.com	
19	Feb 1, 2016 10:04 PM	Marion Morra		morram@earthlink.net	
20	Feb 1, 2016 6:05 PM	Jo Rotondo		jo2002@aol.com	
21	Feb 1, 2016 12:36 PM	Patricia Del Vecchio		delvecchiop@msn.com	
22	Feb 1, 2016 4:42 AM	Robert Markowitz		endobo@yahoo.com	
23	Feb 1, 2016 2:42 AM	Robert Stevens		stevens1@optonline.net	
24	Feb 1, 2016 1:01 AM	Robert Heerema		bobheerema@yahoo.com	
25	Jan 31, 2016 10:52 PM	Mary Heerema		Bobheerema@yahoo.com	
26	Jan 31, 2016 10:44 PM	beth cohen		bethco85@aol.com	
27	Jan 31, 2016 6:42 PM	Mary noonan		16 devol st	
28	Jan 31, 2016 4:31 PM	Allison Bozso		allisonbozso@gmail.com	
29	Jan 31, 2016 3:06 AM	Kathy Walker		hrkthy@yahoo.com	
30	Jan 30, 2016 9:53 PM	ellen twitchell		ellenmtwitchell@gmail.com	
31	Jan 30, 2016 6:24 PM	Laure		noyduda@optonline.net	
32	Jan 30, 2016 6:05 PM	Susan Guttmann		smg741@aol.com	
33	Jan 30, 2016 6:00 PM	Kerry & Joe Tuozzola		tuozzola4@optimum.net	
34	Jan 30, 2016 5:08 PM	Gerald Shenkin		gshenkin@yahoo.com	
35	Jan 30, 2016 4:55 PM	Michele Mikaelian		mmikaelian@optonline.net	
36	Jan 30, 2016 4:46 PM	Catherine Coda		cathy.coda@att.net	
37	Jan 30, 2016 4:37 PM	Michael Campbell		fujimdc@excite.com	
38	Jan 30, 2016 4:23 PM	James Perrotti		james.perrotti@sbcglobal.net	
39	Jan 29, 2016 6:19 PM	Thomas Torello		torelloet@aol.com	
40	Jan 29, 2016 6:18 PM	Paola Goren		paola.goren@gmail.com	
41	Jan 29, 2016 6:11 PM	Doretta Sackville		doretta0806@yahoo.com	
42	Jan 29, 2016 6:02 PM	Mary McCutcheon		mmccutcheon1@optonline.net	
43	Jan 29, 2016 5:22 PM	Marty Lippman, PE		mlpe@snet.net	
44	Jan 29, 2016 2:31 PM	Gordon Leibowitz		lbwtz35@gmail.com