
TOWN OF WATERFORD ANNEX DOCUMENT

Southeastern Connecticut Council of Governments
Multi-Jurisdictional Hazard Mitigation and Climate Adaptation Plan Update

March 2023



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1. Introduction

1.1. Purpose of Annex

The planning process for the multi-jurisdiction hazard mitigation plan update commenced in April 2022 and ended in December 2022, spanning a period of nine months. The planning process included 24 jurisdictions (22 municipalities and two tribal governments) with two participating together (Griswold and Jewett City) for a net total of 23 local planning teams represented. For this 4th edition of the plan, SCCOG elected to link the planning process to a parallel planning process administered by the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) that is known as “Resilient Connecticut 2.0” (stylized as *Resilient Connecticut*). The *Resilient Connecticut* program is described on CIRCA’s web site at <https://resilientconnecticut.uconn.edu/> and the expansion of the program into southeastern Connecticut is described at <https://circa.uconn.edu/2022/02/23/resilient-connecticut-expands-statewide/>.

The linkage of the two planning processes was advantageous for the following reasons:

- Incorporation of climate change into the hazard mitigation plan update
- Increased interest from the local communities, especially for those interested in developing climate adaptation strategies.
- Direct incorporation of climate change vulnerability products developed by CIRCA including the Climate Change Vulnerability Index (CCVI) for flood and extreme heat vulnerabilities.
- Direct incorporation of combined sea level rise and coastal flood inundation simulations from CIRCA
- Positioning of the SCCOG jurisdictions for new funding sources in Connecticut such as the new Department of Energy and Environmental Protection (DEEP) Climate Resilience Fund (DCRF)
- Consistency with the Governor’s Council for Climate Change (GC3) outcomes from the 2020-2021 planning process
- Positioning of the actions for incorporation on the State’s “resilience project pipeline” per Executive Order (EO) 21-3 issued at the end of 2021.

The planning process commenced for the local communities on April 20, 2022, with a presentation to the SCCOG Board. During this presentation, the consultant and CIRCA described the planning process and the approach for incorporating the *Resilient Connecticut* program into the hazard mitigation plan update, and notified the chief elected officials that invitations to local planning meetings would follow at the end of April. Local planning team meetings commenced on May 23, 2022 and ended on July 8, 2022. Workshops with local coordinators were conducted in July and September 2022, and supplemental meetings with water utilities in the region and specific stakeholders continued through November 2022.

The purpose of this HMP annex is to provide an update to the hazard risk assessment and capability assessment provided in the previous HMP, and to evaluate potential hazard mitigation measures and prioritize hazard mitigation projects specific to mitigating the effects of hazards on the Town of Waterford. Background information and the regional effects of pertinent hazards are discussed in the main body of the Southeastern Connecticut Council of Governments (SCCOG) Multi-Jurisdictional Hazard Mitigation and Climate Adaptation Plan. Thus, this annex is designed to supplement the information

presented in the Multi-Jurisdictional HMCAP with more specific details for Waterford and is not to be considered a standalone document.

1.2. Hazard Mitigation and Climate Adaptation Goals

The primary goal of the previous hazard mitigation plans adopted in 2013 and 2018 was to identify risks to hazards and potential mitigation measures for such hazards in order to **reduce the loss of or damage to life, property, infrastructure, and natural, cultural, and economic resources**. This included the reduction of public and private damage costs. Limiting losses of and damage to life and property was also meant to reduce the social, emotional, and economic disruption associated with a natural disaster.

Coinciding with the incorporation of climate adaptation and the alignment of this HMCAP with the *Resilient Connecticut* planning process administered by CIRCA, the five goals of this HMCAP are:

- Ensure that critical facilities are resilient, with special attention to shelters and cooling centers.
- Address risks associated with extreme heat events, especially as they interact with other hazards.
- Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.
- Reduce losses from other hazards.
- Invest in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.

2. Community Profile

The Town of Waterford is a coastal community with a significant inland area located in the southeastern portion of Connecticut. Waterford is approximately 34.2 square miles in land area. The Town is bordered by Montville to the north, Groton and Ledyard across the Thames River to the northeast, New London to the southeast, East Lyme to the west, and Long Island Sound to the south. The Town can be accessed via several major transportation arteries including Interstate 95, Interstate 395, Route 1, Route 85, Route 32, Route 156, and the Amtrak Railroad.

The town is relatively rural to suburban in nature. The population of the Town was 19,517 as of the 2010 census and increased slightly to 19,571 as of the 2020 census. However, the population of the town increases each summer due to the influx of seasonal residents to the beach communities and tourists to the area.

2.1. Physical Setting

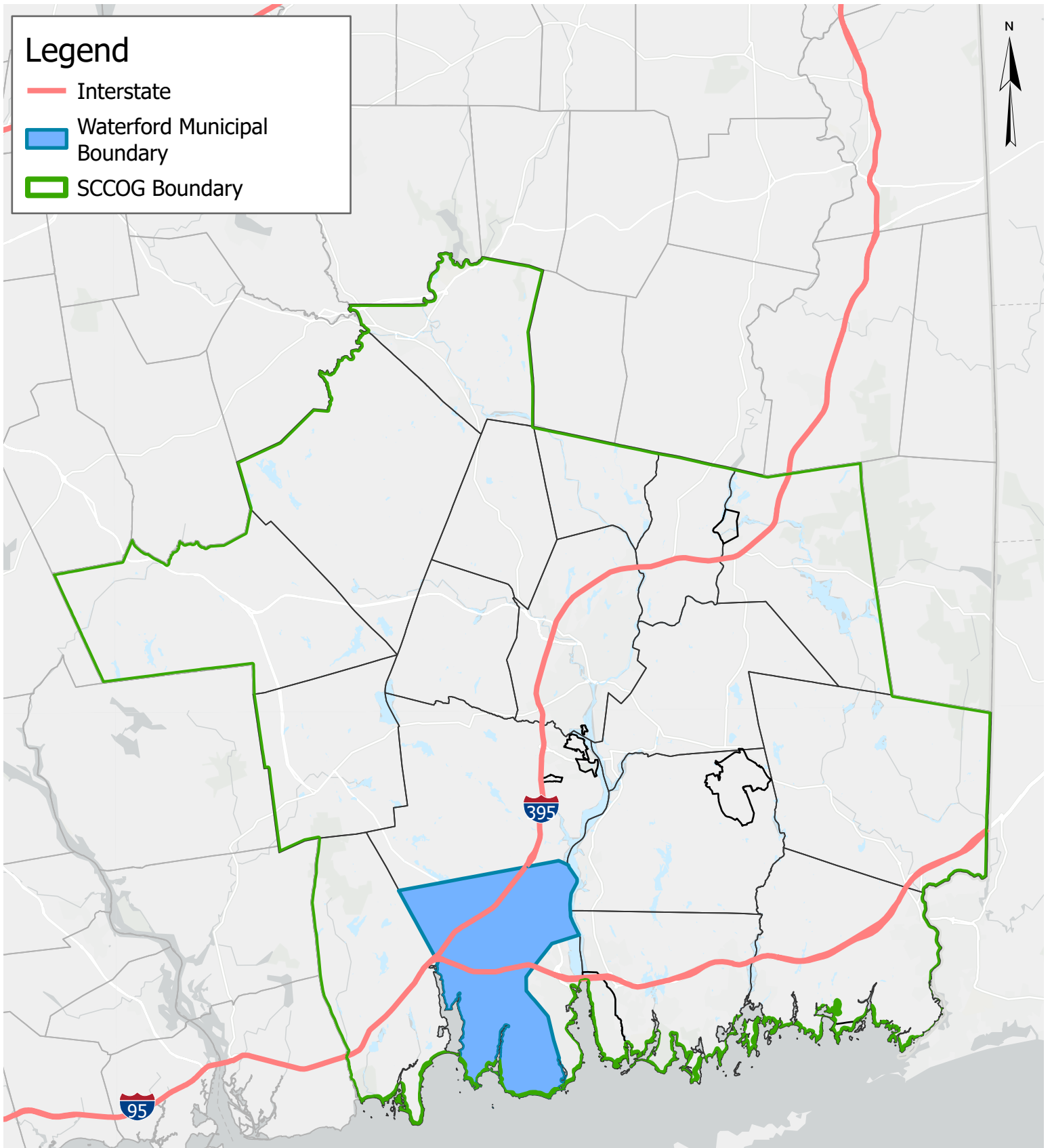
The Town of Waterford is a large community located on the Connecticut shoreline that also has a significant inland area. Elevations range from sea level to just over 400 feet on hilltops in the northwestern portion of town. The Town of Waterford has approximately 7.3 miles of shorefront along Long Island Sound. Approximately one mile of this shorefront is publicly owned. The total tidal shoreline, including the east bank of the Niantic River and the west bank of the Thames River, is approximately 22 miles. This figure includes the shores of various coves along the shoreline such as Jordan Cove and the western shore of Alewife Cove.

Geology is important to the occurrence and relative effects of natural hazards such as earthquakes. Thus, it is important to understand the geologic setting and variation of bedrock and surficial formations in lands underlying the Town of Waterford. The town lays above several bedrock types which trend southwest to northeast across the area. These formations include the Potter Hill Granite Gneiss, the Plainfield Formation (including a quartzite unit), the Hope Valley Gneiss, the Mamacoke Formation, the New London Gneiss, the Rope Ferry Gneiss, Tatnic Hill Formation, and Westerly Granite. Each of these formations consists primarily of gneiss which is a relatively hard metamorphic rock with the exception of the Westerly Granite which is a hard igneous rock. Bedrock fault lines are not known to be mapped in Waterford.

The surficial geologic formations in the town include glacial till, stratified drift, and coastal formations. Refer to the Multi-Jurisdictional HMCAP for a generalized view of surficial materials. The majority of the town is underlain by glacial till. Till contains an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine. Areas along major watercourses are underlain by stratified drift. The amount of stratified drift present is important as areas of stratified materials are generally coincident with floodplains. The amount of stratified drift also has bearing on the relative intensity of earthquakes and the likelihood of soil subsidence in areas of fill.

Legend

- Interstate
- Waterford Municipal Boundary
- SCCOG Boundary

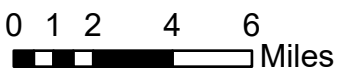


Regional Location of Waterford

SCCOG Hazard Mitigation and Climate Adaptation Plan

Town of Waterford

Date: 7/22/2022



Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS

2.2. Drainage Basins and Hydrology

Waterford is divided among eight sub-regional watersheds. Five of the drainage basins directly or indirectly drain to Long Island Sound, while the remaining three basins drain to the Thames River, eventually discharging to the Sound as well.

Streams in the western portion of the town drain into the Niantic River, discharging to the Long Island Sound at the border of Waterford and East Lyme. Notable watercourses in this drainage area include Latimer Brook, Oxoboxo Brook, Willys Meadow Brook, Oil Mill Brook, Stony Brook, and Lakes Pond Brook.

Streams in the central section of the town drain into Jordan Brook. Jordan Brook bisects the town, extending from the northern town boundary to its discharge to Long Island Sound in Jordan Cove. Jordan Cove is an estuary composed of a long narrow neck feeding into an inner cove and then an outer cove before flowing into Long Island Sound. The inner cove is separated from the outer cove by a large sandbar. Notable watercourses in this drainage area include Nevins Brook and multiple unnamed intermittent watercourses which drain southward to Jordan Brook.

Streams in the northeast section of the town drain generally eastward towards the Thames River. Notable watercourses in this region include Hunts Brook, Green Swamp Brook, Church Brook, in addition to various intermittent unnamed watercourses.

Streams in the southeast section of the town drain eastward toward Alewife Cove and Long Island Sound. Notable watercourses in this region include Fenger Brook and Ledges Brook, in addition to multiple unnamed tributaries.

2.3. Land Cover

According to the 2016 1-meter resolution land cover developed by the NOAA Office of Coastal Management, Waterford is predominantly comprised of mixed forest, with approximately 61.01% of the town classified as such. The second largest land cover type is developed open space, which covers about 10.81%, and next is developed impervious which is about 10.60% of land cover. All land covers and their percent coverage can be found in Table 2-1.

Table 2-1 Town of Waterford Land Cover

Land Cover Type (2016)	% Coverage
Barren Land	0.79
Cultivated Crops	0.03
Developed, Impervious	10.60
Developed, Open Space	10.81
Estuarine Emergent Wetland	0.34
Estuarine Scrub/Shrub Wetland	0.01
Grassland/Herbaceous	3.47
Mixed Forest	61.01
Open Water	3.69
Palustrine Aquatic Bed	0.20
Palustrine Emergent Wetland	0.55

Palustrine Forested Wetland	5.08
Palustrine Scrub/Shrub Wetland	0.45
Pasture Hay	0.62
Scrub/Shrub	2.08
Unconsolidated Shore	0.27

2.4. Population, Demographics, and Development Trends

As noted in the Plan of Preservation, Conservation and Development, Waterford is a suburban community with a strong economic base. Waterford contains over 630 businesses employing about 11,000 people. The northern section of the community is rural with increasing development density towards the coastline. The largest employer in the community is Millstone power generating facility ("Millstone Station").

The greater New London area was first settled around 1646. Due to the natural harbor, this village soon became a bustling seaport and the growing population pushed out into the surrounding areas. While the economy of New London was primarily focused on maritime trade and whaling, surrounding areas were devoted to subsistence agriculture, fishing, quarrying, and similar occupations. Over time, residents of the outlying areas banded together and submitted petitions to the State legislature to establish a separate town. Several requests were denied before approval was granted in 1801, and the Town of Waterford became the 109th town in Connecticut.

The arrival of railroads in the mid-1800s helped to transform Waterford. The railroad helped make Waterford a popular shoreline and resort area. Several waterfront estates were built in Waterford during this period and summer hotels and beach cottage colonies were created. Many of these changes were aided and accelerated by the creation of a trolley system followed by the expansion of the road system and the proliferation of the automobile.

After the completion of Interstate 95, suburban expansion followed in the 1960s through the 1980s with many residential homes built during this time period. In the 1960s and 1970s, three nuclear power plants were established at Millstone Point. The property tax benefits of these plants enabled Waterford to undertake significant community improvements and provide substantial tax benefits to residents over the next few decades.

The extensive Waterford shoreline attracts tourists during the summer months. The Eugene O'Neill Theater Center and summer music at Harkness State Park also attract many visitors as well. Major commercial development is located within the Waterford Business Triangle (formed by Route 85 and Interstates 95 and 395), including large retail developments. Industrial development is generally found along Route 85 north of Interstate Route 95, and along Industrial Drive north of I-395. Two of the largest employers in Waterford are the Millstone Nuclear Power Plant and Sonalysts, a sonar/audio studio.

According to the 2012 *Plan of Preservation, Conservation and Development*, about 41% of Waterford's land area is developed, built upon, or used for some social or economic purpose (including land preserved as open space). The remainder is land that may be developable in the future. As many housing units predate 1990, it is believed that many structures do not meet current building codes. Such structures may be more susceptible to damage from natural hazards. Fortunately, many homes

have undergone recent renovation, and many have performed flood mitigation such as elevating heating and electrical utilities above the base flood elevation and / or wind mitigation measures such as shutters.

Development within the town is ongoing and consists of a combination of residential and commercial projects, including the following possible, approved, or pending projects:

- Waterford Park on Miner Lane is a 72-unit multi-family complex.
- Willetts Avenue complex is adding 300 units for a total of 400 units.
- There are plans for about 300 units to be developed at Route 85 and Clark Lane.
- The Pequot Apartments near the Target are adding 40 units.
- There is also a high level discussion surrounding the Waterford Mall and its potential conversion into a 1,200 unit building. However, it is likely the site will end up as mixed-use.

When necessary, the Town incorporates elements of hazard mitigation into development projects. Special provisions are in place for flood damage prevention by requiring (1) buildings to be setback from the SFHA and (2) only passive recreation being allowed in SFHAs.

As of the 2020 Decennial Census, the population for town is 19,571, which equates to about 598 people per square mile. The 2020 American Community Survey 5-year estimates identified the annual average median income for Waterford to be \$98,439, with an average of 40.8% of the population holding a bachelor's degree or higher, and an average unemployment rate of 5.4% throughout the town.

2.5. Governmental Structure

Waterford is governed by a Representative Town Meeting and Board of Selectmen form of government. The Representative Town Meeting is the legislative body of the Town, and the Board of Selectmen is responsible for the administration of Town policies. The authority of Town officials is granted by Connecticut General Statutes. Various Boards and Commissions are composed of elected or appointed officials who supervise, manage and organize the diverse functions of local government. Many municipal departments, commissions, and boards are involved with natural hazard mitigation. The various town departments, boards and commissions that may play a role in the implementation of this plan include:

- | | |
|---|--|
| ○ Emergency Management Advisory Council | ○ Public Works |
| ○ Fire Service | ○ Planning & Zoning Commission & Staff |
| ○ Police Department and the Board of Police Commissioners | ○ Building Department |
| | ○ Conservation Commission |
| | ○ Utility Commission |

The general roles of most of these departments and commissions are common to most municipalities in SCCOG and were described in Section 2.9 of the Multi-Jurisdictional HMP. More specific information for certain departments and commissions of the Town of Waterford is noted below:

- The Emergency Management Advisory Council was created by a Town Ordinance 2.108.050 and its members are appointed by the First Selectman. Point members include the First Selectman, Chief of Police/Emergency Management Director, Administrator of Fire Services, Director of Public Works, and Superintendent of Schools. The mission of the Emergency Management Office is to maximize survival of people, prevent and/or minimize injuries, and preserve property

and resources in the Town by making use of all available manpower, equipment, and other resources in the event of natural or technological disasters or national security threats. In addition to coordinating activities during disasters, the Council coordinates all early warning activities and is involved in educating the public on how to react during emergency situations. The information available to the public on the Town's website is primarily concerned with evacuation due to an incident at the Millstone Nuclear Power Station, and includes pertinent information regarding alert signals and evacuation routes.

- The Fire Service is the primary agency involved with hazard mitigation through emergency services and public education. The Town currently has five neighborhood fire stations including Cohanzie Fire Company, Goshen Fire Department, Jordan Fire Company, Oswegatchie Fire Company, and Quaker Hill Fire Company.
- The Board of Police Commissioners has jurisdiction and general control of the Police Department. Day-to-day duties of the Police Department include crime prevention, criminal investigations, traffic enforcement, motor vehicle accident investigations, and patrols. Duties related to natural hazard mitigation include planning and coordination of personnel, equipment, shelters, and other resources necessary during an emergency. The types of mitigation that are directly administered by the Police Department include mainly emergency services and public education. Communication and coordination with the Fire Service and individual companies is critical before, during, and after natural hazard emergencies.
- The Public Works Department responsibilities include solid waste collection, recycling and disposal, and maintenance of safe and efficient infrastructure of roads, bridges and stormwater systems. As is common throughout Connecticut, the Public Works Department is often charged with implementing numerous structural projects that are related to hazard mitigation. Specifically, roadway/infrastructure maintenance and complaint logging/tracking are the two primary duties of the Public Work Department. The Public Works Department also conducts snow removal and deicing on roads; tree and tree limb removal in rights-of-way; and maintains and upgrades storm drainage systems to prevent flooding caused by rainfall. Because of the duties described above, the Public Works Department is often the de facto first responder during emergencies. The Public Works Department must maintain access for the Police and Fire Departments to respond to emergencies.
- The Planning and Zoning Commission administers the local Zoning Regulations and is responsible for completing and updating the Town's Plan of Preservation, Conservation, and Development. The staff of the Planning and Zoning Department assist the Planning and Zoning Commission, the Conservation Commission, Zoning Board of Appeals, and Economic Development Commission as well as perform long-term planning activities related to land use and community development. The Zoning Enforcement Officer maintains elevation certificates and enforces the Town's Zoning Regulations including flood zone regulations and enforcement and coastal site plan decisions on issues of zoning compliance.
- The Building Official is within the Permitting Office and administers the Town's building inspection program adhering to and enforcing all code requirements of the State of Connecticut relating to building construction. Additional responsibilities include administering and enforcing all related state codes for the safety, health, and welfare of persons and properties in Town, supervising departmental policies and procedures, and providing technical assistance to Town officials. The Building Official has a unique responsibility when it comes to hazard mitigation as

he or she is responsible for overseeing a number of codes such as those related to wind damage prevention as well as those related to inland and coastal flood damage prevention. Although other departments and commissions may review development plans and develop or revise regulations, many important types of pre-disaster mitigation are funneled through and enforced by the Building Department. For example, the Building Department works with the Zoning Enforcement officer to enforce A- and V-zone standards for floodproof construction and building elevations and enforces building codes that protect against wind and fire damage.

- The Conservation Commission serves as the agency that administers the Inland Wetland Regulations. The Environmental Planner assists the commission in administering the Inland Wetlands Regulations.
- The Flood and Erosion Control Board is comprised of seven members who are electors of the town and are appointed by the Board of Selectmen. The Flood & Erosion Board's role in hazard mitigation is very important. Wetlands preservation is one of the purest forms of hazard mitigation due to the natural functions and values of wetlands, including stream bank and shoreline stabilization, and flood water storage.
- The Waterford Utility Commission oversees the orderly development and maintenance of sanitary sewer and public water service in the town. The Utility Commission staff are considered key officials in the context of hazard mitigation due to the important functions of the water and sewer systems.

2.6. Review of Existing Plans and Regulations

The Town has several Plans and regulations that suggest or create policies related to hazard mitigation. These policies and regulations are outlined in the Emergency Operations Plan, Plan of Preservation, Conservation and Development, Inland Wetland and Watercourse Regulations, Subdivision Regulations, and Zoning Regulations.

Emergency Operations Plan

The Town has an Emergency Operations Plan (EOP) that is updated annually. This document provides general procedures to be instituted by the First Selectman, Emergency Management Director, and/or designee in case of an emergency. Emergencies can include but are not limited to natural hazard events such as hurricanes and nor'easters. The EOP is directly related to providing emergency services prior to, during, and following a natural hazard event.

Plan of Preservation, Conservation and Development (2012)

The POCD was most recently updated in 2012 with contributions from local boards, commissions, committees, citizens and citizen groups. An amendment was added in 2015. The Plan seeks to be a statement of policies, goals and standards for the physical and economic development of the Town and recommends the most desirable uses types and population densities in various parts of the municipality.

The Coastal Resources section of the plan notes *"In coastal areas, flooding potential is influenced by a number of factors including land elevation, wind intensity, wind direction, storm surge, tidal fluctuation, and shore configuration. Several studies (www.coastalresilience.org and other studies by the federal government) have evaluated the potential for coastal flooding and identified areas most at risk due to*

possible sea level rise the confluence of these different factors affecting flooding potential. Waterford will continue to manage activities in shoreline areas in recognition of the potential for coastal flooding."

The Sustainability/Resiliency section of the plan includes the following (with underlines added for emphasis):

- *Continue Hazard Mitigation Planning – One of the ways that Waterford can enhance its preparedness and resiliency is through hazard mitigation planning. This process, undertaken at the regional level, involves identifying potential hazards, understanding their potential impact, assessing the overall risk, and preparing avoidance and mitigation strategies. Hazard mitigation planning can help reduce losses from a potential hazard and develop strategies to help avoid repetitive damage associated from recurring events. The overall goal is to reduce or eliminate long-term risk to people, property, the economy, and the region from recognized hazards. This can occur from natural hazards (such as hurricanes or flooding) or from other events (hazardous material spills, rail accidents, events at Millstone, etc.). While Waterford has historically focused on man-made hazards, recent flooding events have indicated that equal or greater attention needs to be focused on natural events, especially if storm events become more severe or more frequent.*
- *The most recent Hazard Mitigation Plan for Southeast Connecticut was adopted in June 2005. Waterford participated in that effort and will continue to participate in such efforts in the future. The strategies from such hazard mitigation planning efforts (both current and future) are hereby incorporated into this Plan. As part of this, Waterford intends to participate in the "Community Rating System" whereby Waterford residents will be able to pay lower flood insurance premiums if the Town increases flood protections efforts.*

Thus, the initial HMP annex from 2005, the annex from 2012, and this annex are incorporated into the Plan of Preservation, Conservation and Development.

The Sustainability/Resiliency section of the plan continues with the following (with underlines added for emphasis):

- *Prepare for Possible Sea Level Rise / Climate Change – There are some indications of a possible long-term increase in sea levels. While the rate of this increase cannot be forecast, the possible implications for Waterford and other coastal communities mean that this trend should not be ignored. Certain areas of Waterford may be more at risk than other areas due to low-lying elevations. Waterford should monitor sea level trends and consider the need for a gradual phasing in of new policies related to sea level rise.*
- *In addition, there are indications of other impacts (such as flooding) which may result from climate changes. If there is an increase in the frequency or severity of flooding, Waterford should be prepared to address the possible implications including preventing or minimizing losses in flood-prone areas, preparing for flooding events, and responding to flooding events.*

In the context of drainage systems, the plan states "*Waterford has experienced some significant flooding events in recent years. Whether caused by climatic changes, evolving storm frequency or intensity, or increasing development activity, it has brought new attention to the need to evaluate existing drainage structures and approaches to help prevent flooding which threatens life or property. It also supports the strategy of continuing the hazard mitigation planning process.*"

The following recommendations from the POCD also pertain to hazards:

- Continue to manage activities in coastal areas in recognition of the potential for coastal flooding.
- Continue to participate in hazard mitigation efforts in the future.
- Seek to become part of the FEMA "Community Rating System" in order to reduce flood plain insurance premiums in the community.
- Consider the potential need for a gradual phasing in of new policies related to sea level rise.
- Evaluate and address the susceptibility of key roads to be affected by flooding.
- Evaluate existing drainage structures and approaches to help prevent flooding which threatens life or property.

Therefore, the Waterford POCD is considered consistent with the current goals and actions of the hazard mitigation plan, as it directly references the HMP. The next update to the POCD (scheduled for 2025, within the life of the current hazard mitigation plan) will continue to incorporate the elements of the hazard mitigation plan.

Zoning Regulations

In Waterford, the Planning and Zoning Commission is charged with administering the Zoning Regulations. Current Zoning Regulations were amended through May 18, 2022, and include the required amendments coincident with the DFIRM adopted in August 2013. Section 25, "Environmental Protection" addresses requirements for development in Flood Plain Zone, Flood Hazard Areas, and the Coastal Area Boundary; construction adjacent to bodies of water and in wetland areas; and design standards in special flood hazard areas in conformance with NFIP regulations. The Town's local articulation of the NFIP regulations is included in Section 25.3, although Waterford is more stringent because the town requires one foot of freeboard above the base flood elevation for construction of new structures in the AE and VE zones. Stormwater regulations have also been updated since the previous HMP.

Inland Wetland and Watercourses Regulations

The Inland Wetlands and Watercourses Regulations in the Town of Waterford have been revised through June 1, 2011. The regulations require a permit for certain regulated activities which take place within 100 feet of a wetland or watercourse or that may impact a wetland or watercourse. These regulations build on the preventative flood mitigation provided by the Zoning Regulations and Subdivision Regulations by preventing fill and sedimentation that could lead to increased flood stages.

Subdivision Regulations

The Waterford Subdivision Regulations were first effective in 1948. The current version has been revised through April 5, 2018. In Waterford, the Planning and Zoning Commission is charged with administering Subdivision Regulations. Components of the regulations that directly or indirectly address hazard mitigation (flooding, public safety, etc.) are listed below:

- Section 3.2, Plans Including Regulated Wetlands/Watercourses: Requires review by Waterford Conservation Commission and an inland wetlands permit.

- Section 5.2, Land Subject to Flooding: Requires proper provisions for protective flood control measures, dealing specifically with water supply, sewage disposal systems, gas and electrical equipment, transmission lines and drainage systems.
- The regulations require installation of fire hydrants for fire suppression.

Stormwater management regulations will be updated in the new version to be consistent with new State MS4 requirements.

2.7. Critical Facilities, Sheltering Capacity, and Evacuation

The Town of Waterford considers several facilities to be critical to ensure that emergencies are addressed while day-to-day management of the Town continues. These include both buildings and utility infrastructure. Critical facilities that are buildings are presented on figures throughout this annex and summarized in Table 2-2. As shown in Table 2-2, few critical structures in Waterford are located within SFHAs or hurricane surge zones. Note that several sewer pumping stations are partially located in the floodplain and could also be impacted by hurricane storm surge. These facilities are described in more detail below.

Fire Department, Public Safety, and Police Services

The Police and Public Safety Complex are in two buildings. The Police Department Headquarters is located at 41 Avery Lane. The Public Safety Complex is located at 204 Boston Post Road and is the headquarters for the 911 Center, Fire Marshal, and Emergency Management. Waterford utilizes the "regional task force model" for its local EOC. The Town has five task forces addressing different aspects of emergency management during an event.

The five fire stations are located at 53 Dayton Road (Cohanzie Fire Company), 63 Goshen Road (Goshen Fire Department), 89 Rope Ferry Road (Jordan Fire Company), 441 Boston Post Road (Oswegatchie Fire Company), and 17 Old Colchester Road (Quaker Hill Fire Company). None of the fire stations are located in flood zones. The Quaker Hill Fire Company is located in a Category 3 hurricane surge zone.

SCCOG completed an assessment of critical facilities in the region in 2017, fulfilling an action listed in the 2012 edition of the multi-jurisdiction hazard mitigation plan. The Quaker Hill Fire Company facility was addressed in this study. The assessment determined that the site is at risk of both riverine and coastal flooding.

Municipal Complex (Public Works)

The Public Works Department, Utility Commission, and a bus lot are located at 1000 Hartford Road (Route 85) outside of any hurricane surge or flood zones. A portion of Hartford Road at the entrance driveway to the facility is located within the 1% annual chance floodplain of Jordan Brook. Flooding of the roadway could lead to difficulties in accessing the facility during or after a disaster.

A Regional Distribution Center at this site is considered a critical facility because it serves the entire region (including East Lyme, Montville, and New London). Water and blankets are available at this site for use in emergencies. The Town has a plan in place to utilize the Community Center if it feels this site will be difficult to access.

A new salt shed has been constructed at the Public Works.

Town Hall

The Waterford Town Hall houses records, plans, the IT systems, and other documents important for administering the Town. A generator is desired for this facility.

Water and Sewer Utilities

The Town of Waterford provides public water throughout the town from New London's Lake Konomoc water treatment plant and distribution system. All six water storage tanks for the combined Waterford/New London system are located in Waterford, with three owned by New London and three owned by Waterford. Even though New London owns the water treatment plant and three tanks, the Town of Waterford must respond to emergencies at these facilities. Three new water towers have been constructed in the last five years.

The Town of Waterford has 28 sewer pumping stations and associated infrastructure that they consider to be critical facilities. Sewage is directed to the New London Waste Water Treatment Facility. Many of these pumping stations are also located in the 1% annual chance floodplain and/or coastal surge zones. The town has reportedly floodproofed and elevated electric systems at some pump stations., however, there are still improvements that need to be made.

Health Care and Senior Living Facilities

Town officials noted a number of critical facilities providing health care, ongoing care and special needs to care for Waterford citizens. Four rental senior housing complexes are located within the town (Ahepa, Twin Havens, Yorkshire, and Victoria Gardens). Camp Harkness is a critical facility because of its vulnerable population and limited egress. Seaside (a group home) is considered a critical facility for the same reasons as Camp Harkness. Assisted living is provided at "Bridges at Crossroads" on Park Lane, which has 150 beds in one building and 40 homes. There are also three nursing homes: New London Convalescent on Clark Lane, Greentree, and Bayview. Of all these facilities, only one (Seaside) is partially located in a hurricane surge zone.

Table 2-2 Town of Waterford Critical Facilities

Facility	Address or Location	Emergency Power	Shelter	Cooling Center	In SFHA	In Hurricane Surge Zone
Emergency Services						
Police Station	41 Avery Lane	✓				
Public Safety Complex	204 Boston Post Rd	✓				
Cohanzie Fire Company	53 Dayton Road	✓				
Goshen Fire Department	63 Goshen Road	✓				
Jordan Fire Company	89 Rope Ferry Road	✓			✘	✘

Oswegatchie Fire Company	441 Boston Post Road	✓					
Quaker Hill Fire Company	17 Old Colchester Road	✓					✓
Municipal Facilities							
Town Hall	15 Rope Ferry Road						
Public Works	1000 Route 85						
Regional Distribution Center	1000 Route 85						
Community Center	24 Rope Ferry Road	✓	**	✓			
Clark Lane School	105 Clark Lane	✓	**				
Quaker Hill School	285 Bloomingdale Road	✓	**				
Oswegatchie Elem. School	470 Boston Post Road	✓	**				
Waterford High School	20 Rope Ferry Road	✓	**				
Health Care/Senior Living							
Ahepa Sr. Housing	95 Clark Lane						
Twin Havens Sr. Housing	36 Mary Street						
Yorkshire Sr. Housing	55 Yorkshire Drive						
Camp Harkness	301 Great Neck Road						⊗
Seaside Sanatorium group home (Closed)	Woodsea Place						✓
Bridges at Crossroads	1 Beechwood Drive						
New London Convalescent	88 Clark Lane						
Greentree nursing home	4 Greentree Drive						
Bayview nursing home	301 Rope Ferry Road					✓	
Victoria Gardens	105 Boston Post Road						
Other Infrastructure/Facilities							
Lake Konomoc WTP	Route 85	✓				✓	
Water pumping stations (3)	Various	✓					
Water tanks (3 owned by town)	Various						
Water tanks (3 owned by New London)	Various						
Sewer pumping stations (27)	Various	✓				*	*
Communication towers (5)	Various	✓					

⊗ Part of the property is in the flood or surge zone but not any buildings

* Some of these utilities are located in flood or surge zones

** These facilities can be used as “stations” during events for power, charging, showers, etc.

Shelters

Emergency shelters are considered to be an important subset of critical facilities as they are needed in emergency situations. These are not to be confused with safe rooms or individual storm shelters, such as designated rooms in certain buildings that are meant to provide increased levels of protection from winds. The town also relies on the East Lyme Middle School, which is a regional shelter. Town officials have designated the Community Center and four public schools as shelters; the community center has also acted as a cooling center in the past and can do so in the future.

Evacuation Routes

The Town's Emergency Management website contains an evacuation route map for residents to use in the event of an alert regarding the Millstone Power Station. The map directs residents to East Harford, the host community to Waterford in the event of a nuclear emergency. This map is somewhat

applicable for other hazards in the town as well, although evacuation to East Hartford would not be necessary.

A more locally based natural hazard evacuation map should be tied to the concept of evacuation routes connected to primary shelters throughout the town, and evacuation routes should not include roads that can become submerged during coastal storms and riverine flooding. Any changes in shelter status or shelter locations will necessarily require modifications to the evacuation map. In addition, any changes in routing will necessarily require modifications to the evacuation map. The town does not have evacuation signs at the present time but would like them placed throughout the coastal neighborhoods.

Waterford has particular vulnerability at Gardiners Wood Road, an evacuation route, because it continually floods along an unnamed brook. The town has a complete design for this roadway, with an estimated cost of \$4 million to make changes. These changes include resurfacing the road and elevating six to eight inches in the proves, placing pipes at the low points of the road and elevating about a foot at this low location. Route 156 at Gardiners Wood Road also floods from the same unnamed brook. Without the ability of residents near Millstone to evacuate through Jordan Cove Road or Gardiners Wood Road during severe flooding, they may be able to evacuate through an old access road on the Millstone land. However, the road is blocked with barriers that would need to be moved, and part of the access to this road lies within the 1% annual chance floodplain. The Town must continue to make evacuation routes in this area more resilient and useable.

Another particular vulnerability is the intersection of Route 156 and Route 213. The roads in this area are susceptible to both the 1% annual chance flood as well as storm surge from a Category Three hurricane. Route 213 is the primary mode of egress from most of this section of Waterford and residents would be stranded if this area floods. This is because the other potential mode of egress, Niles Hill Road (Route 213) into New London, is also in the 100-year floodplain and would be overtopped by storm surge from a Category Two hurricane. The Town should encourage the State to make improvements at the intersection of Route 156 and Route 213 to make it less likely to be overtopped by flooding. Additionally, the Town should consider creating an emergency access road through Laurel Crest Drive to the former landfill site or an adjacent property on Miner Lane, as Miner Lane is the only other road in the area that has access across the railroad tracks.

Communication

Waterford's emergency services communicate internally over radio. There are five radio towers in Town that provide adequate radio coverage. Five new generators (enough for all five towers) to maintain service at these towers during a power outage have been purchased through the National Defense Authorization Act of Fiscal Year 1997's 1033 program.

Residents can sign up for the Connecticut Alerts "Everbridge" Reverse 9-1-1 system to receive warnings when hazards are imminent. The Town can telephone warnings into potentially affected areas using this system. Dam failure inundation areas for Miller Pond dam have been incorporated into the database; these areas can easily be targeted for emergency information in the event the dam was compromised.

2.8. Repetitive Loss Properties

A repetitive loss (RL) property is defined as any insurable building that has had two or more claims exceeding \$1,000 that were paid by the National Flood Insurance Program (NFIP) within a ten-year period. As of June 2022, the Town of Waterford has 10 RL properties, all of which are residential, and have had a total of \$223,559.01 of claims payments. Of these 10 properties, it is thought that six are affected by coastal flooding. This is the same number of RL properties reported in the 2017 HMP.

2.9. Exposure to Climate-Affected Natural Hazards

Properties, people, historic resources, and critical facilities in the Town are exposed to natural hazards affected by climate change (i.e., severe storms, coastal flooding, droughts) as well as hazards that are not affected by climate change (i.e., earthquakes). As an initial screening of exposure to hazards, areas of risk have been overlaid onto parcel and point data in a GIS to understand the maximum potential exposure to hazards. The results of this analysis are found in Table 2-3.

Table 2-3 Town of Waterford Exposure Analysis

Hazard	At-Risk Parcels		At-Risk Facilities		At-Risk Historic Assets	
	Value	Number	Value	Number	Value	Number
Hurricane/Tropical Storm	\$2,214,198,921	9,323	\$147,086,490	18	\$138,027,860	256
Severe Thunderstorm	\$2,214,198,921	9,323	\$147,086,490	18	\$138,027,860	256
Severe Winter Storm	\$2,214,198,921	9,323	\$147,086,490	18	\$138,027,860	256
Tornado	\$2,214,198,921	9,323	\$147,086,490	18	\$138,027,860	256
Drought	\$198,963,139	825	\$16,307,800	3	\$263,230	2
Flood						
1% Annual Chance,	\$466,536,694	1,287	\$17,063,530	3	\$104,902,640	103
Coastal (VE)	\$175,242,060	340	\$2,524,910	1	\$72,146,810	37
0.2% Annual Chance	\$827,724,674	2,206	\$133,158,660	11	\$111,196,810	128
Storm Surge						
Category 1	\$228,101,720	632	\$2,524,910	1	\$76,091,410	56
Category 2	\$321,125,940	900	\$15,752,100	2	\$97,638,380	84
Category 3	\$416,460,280	1,117	\$66,346,660	5	\$102,853,430	102
Category 4	\$462,136,820	1,347	\$66,346,660	5	\$105,565,570	112
Earthquakes	\$2,214,198,921	9,323			\$138,027,860	256
Wildfire	\$93,900,120	478	\$16,307,800	3	\$263,230	2

2.10. Community Climate Change Challenges

As is with all of the SCCOG communities, the Town of Waterford has several concerns regarding climate change challenges. Most communities in the region are typically most concerned with the impacts of increased flooding and extreme heat events, however, there are often concerns about other climate driven hazards. The following summary sheet identifies the top flooding, heat, and other climate change concerns for the town, along with the hazard mitigation and climate adaptation actions that will work to address these concerns.

Climate Change Summary Sheet for Town of Waterford

What are the Town's Top Climate Change Concerns?

Flooding: Coastal flood risk is a major concern for the Town. Coastal floods and riverine floods can both isolate specific areas by inundating roads, and sea level rise and increasing precipitation intensity may cause more frequent isolation.

Extreme Heat: Large elderly populations are present in Waterford, many of which live alone without air conditioning. The cooling center is not centrally located in the community.

Others: Erosion of the Niantic River shoreline is a unique concern in Waterford. Private properties are affected.

Which Hazard Mitigation and Climate Adaptation Actions Will Address Climate Change Concerns?

Flooding: Identify needs and funding sources for roadway and infrastructural improvements needed to reduce isolation risk in areas including Quaker Hill, West Neck, Great Neck, and Gardiners Wood. This action should result in a written report or statement prior to the update of this HMCAP in 2027-2028.

Extreme Heat: Identify at least one secondary cooling center in a more accessible, centrally located position; ensure that it has appropriate standby power to operate AC and is accessible using transit or alternate transportation options.

Others: Partner with CIRCA and CT DEEP to identify solutions for areas experiencing high erosion rates along the shore and Niantic River.

3. Extreme and Severe Storms

3.1. Climate Change Impacts

Climate change projections indicate varying changes in the frequency and intensity of severe storms and their relative hazards like precipitation and wind. It is expected that as global mean temperatures continue to rise, storms like hurricanes, tropical storms, and severe thunderstorms, may become more frequent and more intense. The degree to which these events might change, and the confidence levels in the models, vary by event type.

Hurricanes and tropical storms are likely to be accompanied by higher wind speeds and an overall increase in intensity. Warm water and air temperatures are essentially the fuel source for the storm, therefore warmer temperatures mean an increase in fuel which can produce more intense winds and high precipitation levels.

While the future behavior of tornado and high wind events is a little more challenging to predict in comparison to hurricanes, it has been noted that the number of days of tornadic activity has decreased in recent decades, though the number of tornadoes in a single day has increased.¹ There is a similar lack in confidence when projecting severe thunderstorm and wind events. Because these events are short-lived and relatively small-scale, monitoring and modeling are more challenging. Overall, however, future climate conditions are likely to become more conducive to the development of such events, therefore increasing the potential for occurrence.

Severe winter storm events, similar to hurricanes, are expected to become more intense under future climate conditions, however they are expected to become less frequent. These storms will continue to be capable of producing large amounts of precipitation, though in future decades this precipitation will consist of less snow and more wintry mix or rain.

These changes in storms could mean an increase in risk throughout town or for specific populations, more severe storm damage and impacts, or an increase in flooding occurrences.

3.2. Hurricanes and Tropical Storms

3.2.1 Setting and Recent Occurrences

Several types of hazards may be associated with tropical storms and hurricanes including heavy winds, heavy rains, and flooding. Flooding and storm surge hazards are discussed in Section 0 and Section 4.2 of this annex. Wind hazards are widespread and can affect any part of the town. However, some buildings and areas in the town are more susceptible to wind damage than others. Some of the most impactful events in the past decade include Tropical Storm Irene and Hurricane Sandy.

Tropical Storm Irene impacted the region in August 2011. Trees fell throughout the town and the region, and the power outage lasted two to eight days in Waterford.

In 2012, Sandy, a hybrid storm with both tropical and extra-tropical characteristics, brought high winds and coastal flooding to southern New England. Record breaking high tides and wave action was

¹ <https://nca2018.globalchange.gov/chapter/2/>

combined with sustained winds of 40 to 60 mph and wind gusts of 80 to 90 mph. Widespread significant statewide power outages of 667,598 lasted up to 8 days. Power was out in Waterford for 5-8 days. The Town received over \$272,000 in disaster relief from FEMA to cover the cost of damages from the storm. The shelter and regional distribution center at the Waterford Municipal Complex were open.

The town has, however, experienced multiple tropical events in the past 5 years. On August 2, 2020, Tropical Storm Isaias swept through the State bringing severe winds which resulted in the highest number of outage events Connecticut has ever experienced. With over 620,000 outages reported by Eversource alone, the state's largest electric supplier, residents across the SCCOG region were without power, cable, and internet for extended periods of time. While this storm did not generate typical amounts of rainfall experienced during a tropical storm event, the wind damage exceeded expectations bringing down trees and power lines across the state. After Isaias, the town endured several days of power outages.

In 2021, there were four tropical storm events that passed through, or within 50 miles of, the state. Some of these events, which are described in more detail below, resulted in flooding along several brooks and stream crossings, including roadway washouts. The town reported a significant amount of roadway flooding with these 2021 storms.

The 2021 events included Elsa, Fred, Henri, and Ida.

- July 9, 2021 (T.S. Elsa) – Elsa made landfall as a tropical storm in Florida and traveled along the eastern seaboard. It passed through Southeastern New England bringing high winds and rainfall. Gusts were reported over 40 mph, and residents throughout the region and state were left without power.
- August 19, 2021 (Extratropical Storm Fred) – This tropical event passed north of the state bringing heavy rain to some areas in Connecticut; there was a reported 5.14 inches in West Hartford. Fred also produced an EF-0 tornado in Windham County.
- August 22, 2021 (T.D. Henri) – Hurricane Henri made landfall in Rhode Island as a tropical storm and then traveled northwest across the State of Connecticut. While the impacts for Henri were projected to be more severe than they actually were, the storm did result in heavy rainfall and thousands of power outages.
- September 1, 2021 (T.S. Ida) – Though Hurricane Ida made landfall in Louisiana as a category 1, the storm moved south of Long Island as an extratropical storm and is reported to be costliest storm even since Hurricane Sandy a decade earlier. Ida caused major flooding across Connecticut and the Southeastern Region. For the first time, a statewide flash flood warning was issued. Several communities in the state, including the City of Norwich, warned residents to have minimal contact with surface waters due to the discharge of untreated sewage. There were reports of 7 to 8 inches of rainfall in the Southeastern Region, and as high as 8.58 inches in Uncasville. Interstate 395 northbound was reportedly impassable due to flooding and Millstone nuclear power complex experienced minor flooding at the facility during Ida as there were reported delays in activating storm protection protocols due to conflicting weather forecasts.

3.2.2 Existing Capabilities

Wind loading requirements are addressed through the state building code. The Connecticut State Building Code was most recently adopted with an effective date of October 1, 2022. The code specifies the design wind speed for construction in all the Connecticut municipalities. The basic design wind speed for Waterford ranges from 120 to 140 miles per hour, and the ultimate design wind speed is 127 miles per hour. Design speed used varies depending on the building use (for example, hospitals must be designed to the higher wind speed). Note that changes in design wind speed figures since the previous HMP are largely the result of a shift from "nominal" to "ultimate" wind speeds, for compatibility purposes; see the Connecticut Building Code or the American Society of Civil Engineers website for more information. Waterford has adopted the Connecticut Building Code as its building code.

Parts of trees (limbs) or entire tall and older trees may fall during heavy wind events, potentially damaging structures, utility lines, and vehicles. Waterford has a full-time Tree Warden. Tree trimming on municipally owned property is conducted on an as-needed basis or following complaints by residents. He can post and remove trees in rights of way or town land, but hazards can be removed without notice.

In response to the major power-outages caused by Tropical Storm Irene and Hurricane Sandy, as well as significant winter storm events, Eversource has taken an aggressive approach to tree maintenance and has improved communication and coordination with municipalities. Municipal staff report that Eversource has enhanced its tree clearing efforts, has updated its facilities, and has been working to strengthen the power grid and build in redundancies. Communication and coordination have improved due to Eversource's liaison program. The Eversource liaison is stationed at the Waterford EOC during events, helping to identify critical areas and respond to problems. Waterford's Public Works Department and Eversource have a Clear and Make-Safe protocol with regards to downed power lines that has been effective.

Waterford has designated the landfill as the location for its brush-disposal operation. Debris is brought to that site after a storm for storage, disposal, and reuse. Backup locations have also been designated in case the landfill reaches capacity. The Town also participates in the regional Southeastern Connecticut Regional Resources Recovery Authority (SCRRRA) agreement, and will have that organization grind excess debris and return it to the Town as mulch.

All utilities in new subdivisions and developments must be located underground in order to mitigate storm-related wind damages. However, utility lines are located underground in only a few areas of the town. Burial of utilities is not a high priority for the Town.

Warning is one of the best ways to prevent damage from hurricanes and tropical storms, as these storms often are tracked well in advance of reaching Connecticut. The Town can access National Weather Service forecasts via the internet as well as listen to local media outlets (television, radio) to receive information about the relative strength of the approaching storm. This information allows the Town to activate its EOP and encourage residents to take protective or evacuation measures if appropriate. During Tropical Storm Irene, a voluntary evacuation notice was issued for areas of the town, and many people heeded the evacuation and moved inland.

Prior to severe storm events, the Town ensures that warning/notification systems and communication equipment are working properly and prepares for the possible evacuation of impacted areas. The statewide CT "Everbridge" Reverse 9-1-1 system can be utilized to warn coastal residents of an impending evacuation. Although hurricanes that have impacted the Town have historically passed in a day's time, power outages can last for several days following a storm. Additional shelters could be outfitted following a storm with the assistance of the American Red Cross on an as-needed basis for long-term evacuees.

Summary

In general, municipal capabilities to mitigate hurricane damage have not increased significantly since the 2017 edition of the hazard mitigation plan was adopted. This is likely because the Town increased its capabilities slightly in response to the damage from Tropical Storm Irene in 2011 and Hurricane Sandy in 2012 and continues to operate at this level.

3.2.3 Vulnerabilities and Risk Assessment

The entire town is vulnerable to hurricane and tropical storm wind damage and from any tornadoes (Section 3.3) accompanying the storm, as well as inland flooding (Section 0) and coastal flooding and storm surge (Section 4.2). Of particular concern are the blockage of roads and the damage to the electrical power supply from falling trees and tree limbs. The town is also susceptible to damage occurring in other communities cutting off the electrical supply as occurred following Tropical Storm Irene.

Direct wind damage to newer buildings from hurricane or tropical storm-level winds is rare in the town since the new buildings were constructed to meet or exceed current building codes. Many buildings in the town are greater than 50 years old and do not meet current building codes. Older buildings in the town are particularly susceptible to roof and window damage from high wind events, although this risk will be reduced with time as these buildings are remodeled or replaced with buildings that meet current codes. For example, many homes have been renovated recently and some property owners have installed shutters and other wind mitigation measures.

Waterford has a diverse housing stock including rental properties and two trailer parks. These areas are also at particular risk of damage during a hurricane or tropical storm because rental properties are not owner-occupied and therefore may not be properly maintained, and because trailer parks contain manufactured homes that are not as structurally sound as permanent buildings. Fortunately, the typical long lead time prior to a hurricane or tropical storm event can provide adequate warning time to evacuate these types of structures.

The strength of a large hurricane could cause a significant economic impact to the town. The potential economic effect of wind damage to SCSOG was evaluated in the Multi-Jurisdictional HMCAP. A separate analysis was not performed specifically for the Town of Waterford.

3.2.3.1 Hazard Losses

The Town of Waterford received \$27,813 in FEMA PA funds for project costs of \$37,085. These funds were received for debris removal and protective resources. In the past decade, the town has received a total of \$324,550 in FEMA PA funds for hurricane events.

In addition to PA, FEMA offers property owners and renters Individual Assistance in the wake of a declared disaster. At Hurricane Ida, eight property owners received a total of \$34,308 in IA funds.

FEMA HAZUS-MH 6.0 was used to develop losses associated with seven probabilistic hurricane scenarios from the 10 year to 1,000 year return period. Losses include economic loss, building damages, debris, and sheltering needs. Table 3-1 through Table 3-3 presents hurricane related damages for the Town of Waterford. Additional HAZUS-generated losses for the town and region can be found in the Multi-Jurisdictional document.

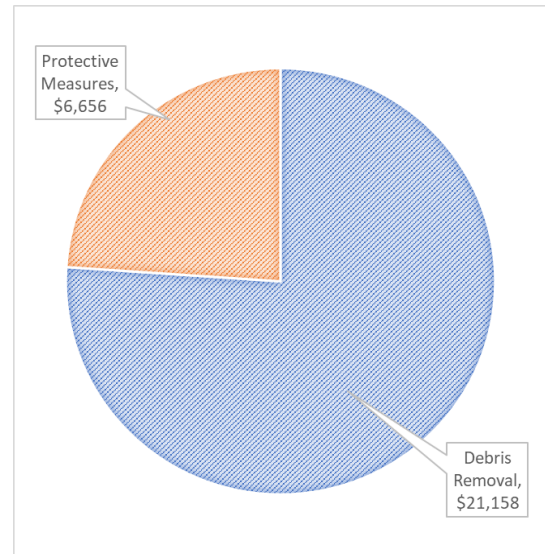


Figure 3-1 Hurricane Isaias Funding Categories

Downscaled tropical storm losses based on the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi-Jurisdictional document.

Table 3-1 HAZUS-MH Hurricane Related Economic Impacts

Waterford	Return Period	Residential	Commercial	Industrial	Others	Total
	10-year	\$208,010	\$20	\$0	\$0	\$208,030
	20-year	\$4,742,730	\$141,900	\$12,910	\$47,670	\$4,945,210
	50-year	\$23,489,060	\$1,874,910	\$211,370	\$654,630	\$26,229,970
	100-year	\$51,244,760	\$5,940,210	\$824,400	\$3,347,210	\$61,356,580
	200-year	\$101,650,090	\$13,963,110	\$2,058,000	\$8,247,910	\$125,919,110
	500-year	\$210,247,950	\$31,264,420	\$4,780,860	\$17,192,440	\$263,485,670
	1,000-year	\$309,003,140	\$51,269,970	\$7,696,120	\$25,379,350	\$393,348,580

Table 3-2 HAZUS-MH Hurricane Related Building Damage

Waterford	Return Period	Minor	Moderate	Severe	Destruction	Total
	10-year	3	0	0	0	3
	20-year	41	1	0	0	42
	50-year	539	47	1	0	587
	100-year	1,228	182	11	6	1,427
	200-year	1,929	423	42	23	2,417

	500-year	2,583	830	142	80	3,635
	1,000-year	2,876	1,129	248	143	4,396

Table 3-3 HAZUS-MH Hurricane Related Debris and Sheltering Needs

Waterford	Return Period	Debris Generated (Tons)	Households Displaced	Individuals Seeking Temporary Shelter
	10-year	22	0	0
	20-year	386	0	0
	50-year	3,918	0	0
	100-year	7,316	6	0
	200-year	13,280	33	9
	500-year	24,122	104	34
	1,000-year	33,549	192	71

3.3. Tornadoes and High Wind Events

3.3.1 Setting and Recent Occurrences

Similar to hurricanes and winter storms, wind damage associated with severe thunder or summer storms and tornadoes has the potential to affect any area of the town. Furthermore, because these types of storms and the hazards that result (flash flooding, wind, hail, and lightning) might have limited geographic extent, it is possible for a summer storm to harm one area within the town without harming another. Such storms occur in the town each year, although hail and direct lightning strikes to the town are rarer. No tornadoes have occurred in the town since the last HMP.

Some recent severe storm events include:

- On September 6, 2017, a cold front triggered severe storms in the county and caused tree damage in multiple communities in the region. Nearby Colchester reported trees and wires down, and the Groton-New London Airport measured sustained winds at 44 mph and gusts of 56 mph.
- On April 13, 2020, a low pressure system resulted in high winds throughout New London County.
- On November 13, 2021, a tornado touched down in Pawcatuck, and another in Plainfield. There were reports of uplifted trampolines, downed trees and powerlines, and an uplifted metal shed. This same storm also caused damage in other surrounding communities.

3.3.2 Existing Capabilities

Warning is the most viable and therefore the primary method of existing mitigation for tornadoes and thunderstorm-related hazards. The NOAA National Weather Service issues watches and warnings when severe weather is likely to develop or has developed, respectively. The Town can access National Weather Service forecasts via the internet as well as listen to local media outlets (television, radio) to receive information about the relative strength of the approaching storm. This information allows the Town to activate its EOP and encourage residents to take protective measures if appropriate.

Aside from warnings, several other methods of mitigation for wind damage are employed by the Town as explained in Section 3.2.2 within the context of hurricanes and tropical storms. In addition, the Connecticut Building Code includes guidelines for the proper grounding of buildings and electrical boxes to protect against lightning damage.

Summary

In general, municipal capabilities to mitigate thunderstorm and tornado damage have not increased significantly since the 2017 edition of the hazard mitigation plan was adopted.

3.3.3 Vulnerabilities and Risk Assessment

Summer storms are expected to occur each year and are expected to at times produce heavy winds, heavy rainfall, lightning, and hail. All areas of the town are equally likely to experience the effects of summer storms. The density of damage is expected to be greater near the more densely populated sections of the town.

Most thunderstorm damage is caused by straight-line winds exceeding 100 mph. Experience has generally shown that wind in excess of 50 miles per hour (mph) will cause significant tree damage during the summer season as the effects of wind on trees are exacerbated when the trees are in full leaf. The damage to buildings and overhead utilities due to downed trees has historically been the biggest problem associated with wind storms. Heavy winds can take down trees near power lines, leading to the start and spread of fires. Such fires can be extremely dangerous during the summer months during dry and drought conditions. Fortunately, most fires are quickly extinguished due to the Town's strong fire response.

Lightning and hail are generally associated with severe thunderstorms and can produce damaging effects. All areas of the town are equally susceptible to damage from lightning and hail, although lightning damage is typically mitigated by warnings and proper grounding of buildings and equipment. Hail is primarily mitigated by warning, although vehicles and watercraft can often not be secured prior to the relatively sudden onset of a hailstorm. Lightning and hail are considered likely events each year, but typically cause limited damage in the town. Older buildings are most susceptible to lightning and hail damage since they were constructed prior to current building codes.

Although tornadoes pose a threat to all areas of Connecticut, their occurrence is least frequent in New London County as compared with the rest of the State. Thus, while the possibility of a tornado striking the town exists, it is considered to be an event with a very low probability of occurrence.

3.3.3.1 Hazard Losses

Since 2017, there has been one NOAA reported event associated with a severe thunderstorm and wind event that occurred in September 2017. The storm caused a reported \$15,000 in damage. Downscaled losses based on the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi-Jurisdictional document.

3.4. Severe Winter Storms

3.4.1 Setting and Recent Occurrences

Similar to hurricanes and summer storms, winter storms have the potential to affect any area of the town. However, unlike summer storms, winter storms and the hazards that result (wind, snow, and ice) have more widespread geographic extent. In general, winter storms are considered highly likely to occur each year (major storms are less frequent), and the hazards that result (nor'easter winds, snow, and blizzard conditions) can potentially have a significant effect over a large area of the town. Some of the more significant events in the past decade include:

- Winter storms and nor'easters have affected the town since the last HMP, with the storms occurring in the winter of 2010-2011 having the most significant effect. The town checked town-owned roofs in January 2011 because of snow accumulations, and the Police Department roof was cleared. A Shell gasoline station canopy failed, and Aaron's (located within a shopping center) experienced a partial collapse as well. The roof on the Butler Building on Route 85 almost failed, but removal of the snow after recommendation by the Town prevented a collapse.
- Winter Storm Alfred in October 2011 caused tree damage and power outages due to heavy, wet snow.

- The year 2013 featured exceptional snow events that severely taxed snow removal abilities of towns in the region. The blizzard of 2013 in early February dumped two feet of snow on the region. Another snowstorm struck the region in mid-March 2013 dumping upwards of one to two feet of snow in some parts of the county. Although New London County escaped the three feet and higher totals of some areas in the mid-Atlantic, the vast quantity of snow was still a major disruption to the town. Waterford received nearly \$150,000 in federal aid from FEMA to cover storm cleanup costs. The Town had to hire contractors with larger vehicles to assist with snow removal.

Some of the more recent significant winter events include:

- A heavy storm came through the region on February 9, 2017, bringing blizzard conditions and heavy snowfall. The Town of Colchester reported 14.5 inches of snow, and 13 inches were reported along the coast in Groton.
- A late winter storm on March 12, 2018, resulted in 23 inches of snowfall in Oakdale, with reports of one to two feet in other parts of Northern New London County. The southern part of the region experienced 10 to 18 inches of snow, and strong wind gusts. There were also reports of downed trees throughout the region as a result of this storm.
- On January 28, 2022, the region was hit by a heavy snowstorm and blizzard like conditions. Parts of the region reported up to 22 inches of snowfall, and gusts up to 65 mph. There were also several hours of less than ¼ mile visibility. Snow drifts were also reported to be a challenge, with some areas experiencing drifts up to three and a half feet deep.

3.4.2 Existing Capabilities

Existing programs applicable to winter storm winds are the same as those discussed in Sections 3.2.2 and 3.3.2. Programs that are specific to winter storms are generally those related to preparing plows and sand and salt trucks; tree trimming and maintenance to protect power lines, roads, and structures; and other associated snow removal and response preparations. The Waterford Community Center/Senior Center maintains a "vulnerable populations list" populated voluntarily by Town residents. The list can be used to perform outreach and to check on vulnerable residents prior, during, or after winter storms. The Town provides emergency heating oil when necessary. The town has also drafted a written plan for inspecting and prioritizing snow removal from town-owned structures.

As it is almost guaranteed that winter storms will occur annually in Connecticut, it is important to locally budget fiscal resources toward snow management. Snow is the most common natural hazard requiring additional overtime effort from Town staff, as parking lots and roadways need constant maintenance during storms. This is particularly important in areas where on-street parking is frequently utilized for businesses.

The Public Works Department oversees snow removal in the town and along 120 miles of town roads. Salt and sand are stored at the Town of Waterford Public Works facility; a new salt shed has been constructed and increased the Town's salt stockpile. The Town has established plowing routes that prioritize access to and from critical facilities. Main roads are plowed before secondary roads. The Town has one vehicle that can handle very large snow events, and contracts out to private companies

for assistance as needed. After Winter-storm Alfred the Town designated specific local contractors as their go-to backup plows. Plows are diverted to address emergency service needs whenever necessary. The Connecticut Department of Transportation plows the State roads in the town.

The Connecticut Building Code specifies that a pressure of 30 pounds per square foot be used as the base "ground snow load" for computing snow loading for roofs. The Town performed visual assessments of many buildings during the winter of 2010-2011 as noted above and cleared several town-owned roofs. Many residents also shoveled their own roofs or hired contractors to clear their roofs of excessive snow.

Summary

In general, municipal capabilities to mitigate snowstorm damage have increased slightly since the 2017 edition of the hazard mitigation plan was adopted. This is because the Town continues to experience heavy snow each winter, and has developed a plan for snow removal from town owned structures.

3.4.3 Vulnerabilities and Risk Assessment

Severe winter storms can produce an array of hazardous weather conditions, including heavy snow, blizzards, freezing rain and ice pellets, flooding, heavy winds, and extreme cold. Further "flood" damage could be caused by flooding from frozen water pipes. Often, tree limbs on roadways are not suited to withstand high wind and snow or ice loads.

This section focuses on those effects commonly associated with winter storms, including those from blizzards, ice storms, heavy snow, freezing rain, and extreme cold. Warning and education can prevent most injuries from winter storms. This is particularly important as the town includes many residents who are elderly and additional elderly developments are proposed. Most deaths from winter storms are indirectly related to the storm, such as from traffic accidents on icy roads and hypothermia from prolonged exposure to cold. Damage to trees and tree limbs and the resultant downing of utility cables are a common effect of these types of events. Secondary effects can include loss of power and heat.

The majority of buildings in the town have been recently constructed and therefore not susceptible to damage from heavy snow. While some Town buildings could be susceptible to heavy snow loads, they will be cleared quickly if safety is a concern. Some buildings in the town have flat roofs which are more susceptible to damage from heavy snow than sloped roofs. A more detailed response plan is necessary to ensure that town buildings, including schools, are properly inspected and cleared if excessive snow is an issue in the future.

Icing is not a significant issue in the town. In general, there are few steep slopes such that extra sanding and salting of the roadways in necessary locations alleviates any trouble spots.

3.4.3.1 Hazard Losses

There have been no reported winter storm losses for the Town of Waterford since 2017. In the past decade, the town has received FEMA PA funds in the amount of \$299,754 for winter storms.

Downscaled losses based on the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi-Jurisdictional document.

4. Sea Level Rise

4.1. Climate Change Impacts

Sea levels are rising at an increased rate across the globe. These rising waters are attributed to melting glaciers and ice sheets, as well as thermal expansion from warming ocean waters. Global sea level rise takes into account the major causes of rise, and the averages of rise around the world. Local sea level rise estimates consider the global changes, but also characterizes what is happening more locally such as changes in currents or land subsidence.

The University of Connecticut, Connecticut Institute for Resilience and Climate Adaptation (CIRCA) has, in accordance with state statute, developed local sea level rise projections for communities to use as a planning threshold (Figure 4-1). CIRCA recommends that communities plan for 0.5 meter (1.64 feet) of sea level rise above 2001 levels by 2050. CIRCA intends to revisit this estimate and update the planning thresholds in the lifespan of this plan (2023-2028).

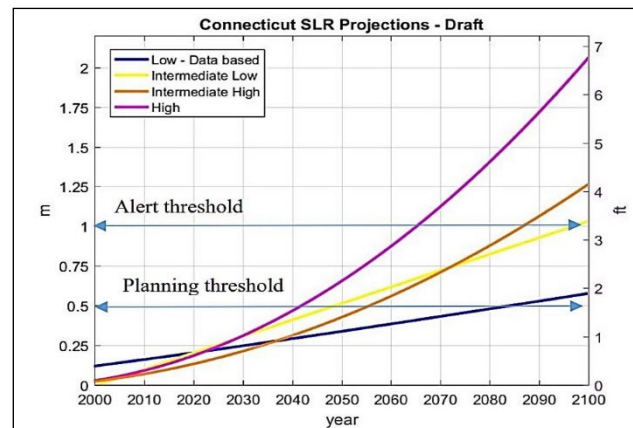


Figure 4-1 Four Localized Sea Level Rise Scenarios for Connecticut

Even though sea level rise occurs over a longer time period than other hazards, coastal communities are becoming increasingly concerned with the cascading impacts. Increased sea levels can cause a greater geographic reach for coastal flooding events, an increase in frequency or extent of “sunny day” flooding, an increase in storm surge extent, and saltwater inundation along the shoreline. All of these impacts can damage properties, deteriorate infrastructure, cause access and egress challenges, and exacerbate coastal erosion processes.

4.2. Coastal Flooding

4.2.1 Setting and Recent Occurrences

The shorefront of Waterford primarily contains coastal bluffs and escarpments, rocky shorefront, modified bluffs and escarpments, and beaches and dunes. Developed shorefront and tidal wetlands are also present but are more limited in area. Jordan Cove is an estuarine embayment. The coastal resources found in Connecticut and described by DEEP are defined in the Multi-Jurisdictional HMP.

Homes are located in close proximity to the coastline along much of the shoreline of Waterford. Millstone Station is located on the waterfront, as well. Structures and infrastructure in the southern section of the town are closer to sea level than in northern areas and are therefore more susceptible to coastal flooding. Hurricanes, tropical storms, and nor'easters have the potential to induce coastal flooding and storm surge that can impact structures, and these types of storms have caused the greatest amount of flood damage to the town in the past. Astronomical high tides can also cause coastal flooding of low-lying areas.

Roadway closures are the most common result of coastal flooding although structures are also affected during moderate events. For example, part of Jordan Cove Road was destroyed during Tropical Storm Irene. The Public Works Department oversaw its replacement with a barrier curb that was reimbursed (75%) by FEMA. The total project cost was \$110,000. Only a few structures are known to have been damaged by coastal floodwaters since 2005. However, the Town is concerned with the potential long-term effects of sea level rise and its potential to exacerbate flooding conditions in the future.

Hurricane Sandy struck Waterford on October 29, 2012. Coastal communities along Southern New London County experienced two successive tidal cycles with at least moderate coastal flooding. Widespread major coastal flooding occurring along the Southern New London County coast. Peak storm tides surpassed water levels from Hurricane Irene in 2011, only being topped by Hurricane Carol in 1954 and the 1938 Hurricane. The record storm tide levels along Eastern Long Island Sound resulted from a peak storm surge of about 5 to 7 feet that coincided with normal high tides. In Waterford, two barrier beaches were breached by floodwaters, and the seawall at Seaside started to fail (a sewer line is located behind this wall and is a major concern for Town staff). Flooding occurred at Mago Point and Miner Lane, and many other roads were closed.

Though the Town has experienced coastal storms in recent years, few major coastal flooding events have occurred in the last five to ten years. While some of the 2021 storm events were forecast to have extensive storm surge, most resulted in heavier rain, with surges not as severe as anticipated. However, a significant coastal flood event occurred on December 23, 2022 during the final stages of the planning process for this document. The coastal water surface elevation at the New London tide gauge was reportedly the sixth highest on record. Numerous roads and structures experienced flooding in coastal southeastern Connecticut, including parts of Waterford.

4.2.2 Existing Capabilities

The Town primarily attempts to mitigate coastal flood damage and flood hazards by controlling and restricting activities in floodprone areas, encouraging the elevation of homes and roadways, maintaining hard structures in good condition, and providing signage and warning systems. Many of the Existing Capabilities utilized in the Town for inland flood mitigation (Section 5.2.2) are also applicable to coastal flood mitigation.

As noted in Section 0 and Section 2.6, the Town utilizes the 1% annual chance floodplains delineated by FEMA. These consist of the 1% annual chance floodplain with elevations (Zone AE), and the 1% annual chance floodplain subject to wave velocity (Zone VE) for coastal flooding areas. Waterford recognizes Coastal AE zones, AE zones seaward of the Limit of Moderate Wave Action, as zones of higher hazard than other AE zones. VE zone floodplain construction standards are applied in the Coastal AE zone.

As noted by the Zoning Regulations and the Subdivision Regulations, building activities in these areas are restricted and new construction or substantial redevelopment must prove that the lowest horizontal member of the new construction will be more than one foot above the base flood elevation (freeboard). In addition, flood hazard areas are considered non-buildable and therefore cannot be included when subdividing property. The Zoning Enforcement Officer and the Building Official are required to review and approve portions of applications that involve structures within FEMA Special Flood Hazard Areas. In addition, a separate coastal site plan application is required to be submitted to the Planning and Zoning Commission for most development types within the coastal management area defined by the State.

As explained elsewhere in this HMCAP, the National Weather Service issues a flood watch or a flash flood watch for an area when conditions in or near the area are favorable for a flood or flash flood, respectively. A flash flood watch or flood watch does not necessarily mean that flooding will occur. The National Weather Service issues a flood warning or a flash flood warning for an area when parts of the area are either currently flooding, highly likely to flood, or when flooding is imminent. The Town of Waterford utilizes these warnings and forecasts to prepare emergency responders for flooding events.

The shoreline of Waterford contains many coastal flood control structures. Small, private seawalls and bulkheads can be found in many of the residentially developed coastal neighborhoods. Groins and jetties are also common in beach areas. Most of these structures were designed to retain land as well as protect against wave action but have the secondary effect of reducing coastal erosion.

"The Bar" that carries Route 156 and the Amtrak Railroad is an important mitigation structure that helps to protect areas along the Niantic River. Amtrak is currently replacing the bridge leading from The Bar to Waterford. The replacement includes the construction of a protective wall, a stone scour protection system, and relocation of a beach seaward of its existing location. Approximately 2,500 feet of beach will be restored as part of the project.

Climate Change Vulnerability, Risk Assessment, and Adaptation

The Town of Waterford hired Kleinfelder, Inc. to prepare a Climate Change Vulnerability, Risk Assessment, and Adaptation Study. A town-wide vulnerability assessment has been completed. The Town will use this information, and future recommendations that result from this project, to help guide future plans and actions intended to mitigate sea level rise and Climate Change. In addition, the Town participated in a resiliency planning initiative with SCCOG and TNC in 2016-2017².

Historic and Cultural Resources Resiliency Planning

As explained in the regional part of this multi-jurisdiction hazard mitigation plan, the State Historic Preservation Office (SHPO) embarked on a resiliency planning study for historic and cultural resources beginning in 2016. During winter 2016-2017, individual meetings were held with the shoreline SCCOG communities. Reports were issued to these communities in December 2017. The Town of Waterford report outlines eight strategies that can be employed to make historic and cultural resources more resilient:

- Identify Historic Resources
- Revisit Historic District Zoning Regulations
- Strengthen Recovery Planning
- Incorporate Historic Preservation into Planning Documents
- Revisit Floodplain Regulations and Ordinances
- Coordinate Regionally and with the State
- Structural Adaptation Measures
- Educate

² <https://tnc.app.box.com/s/8nne60yjk2g3m1mgzkfa86rndxyjiawf>

Subsequently, a best practice guide for planning techniques to make historic resources more resilient was distributed in September 2017.

Summary

Municipal capabilities to mitigate coastal flood damage have not increased significantly since the 2017 edition of the hazard mitigation plan was adopted.

4.2.3 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk of coastal flooding within the Town. This flooding can be the result of astronomical high tides, hurricanes, nor'easters, or storm surge. As shown by the historic record, coastal flooding can impact many roads and neighborhoods, potentially cause severe damage, and impede transportation in the Town. Refer to Figure 5-1 for a depiction of areas susceptible to coastal flooding, and Figure 4-3 for areas susceptible to storm surge from hurricanes.

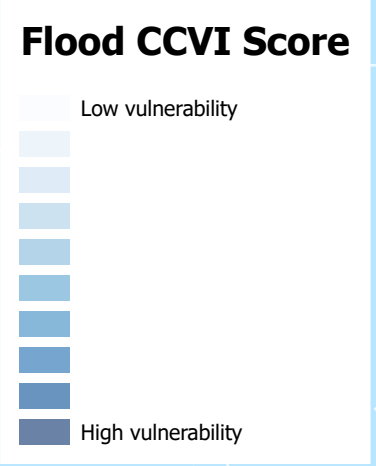
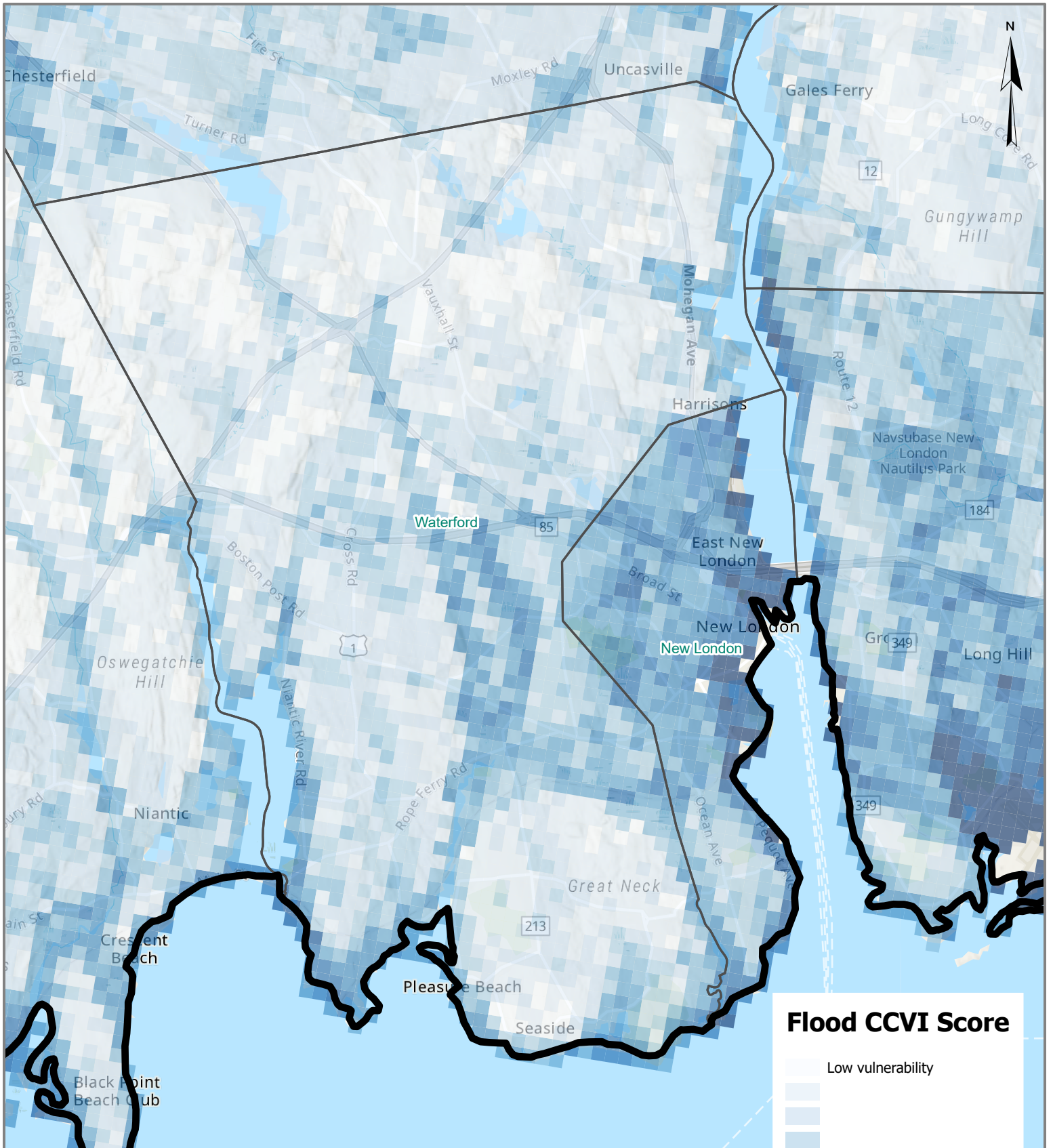
UConn CIRCA has developed a tool to aid in understanding flood vulnerability for communities across the state. This tool, known as the Climate Change Vulnerability Index (CCVI), is comprised of dozens of factors that contribute to a community's flood sensitivity, exposure, adaptive capacity, and ultimately the overall flood vulnerability. The CCVI has been used as a tool to characterize flood vulnerability for the Town. The distribution of flood vulnerability throughout the community can be seen in Figure 4-2. The CCVI demonstrates that flood vulnerability in town ranges from moderate to high. Most of the vulnerability score is due to coastal flood exposure, and the Jordan River.

Vulnerability Analysis of Areas along Coastal Waters

The low-lying shoreline areas of the town are subject to periodic flooding. The most severe flooding in Waterford occurs during hurricanes or coastal storms which can occur during any season. Such storms have intense winds and rainfall that can create high tidal surges, wave runoff, and peak runoff to drainage systems where coastal outlets are submerged. Areas along Long Island Sound, Jordan Cove, and the Niantic River are at the highest risk of experiencing damage from coastal flooding. FEMA has defined 1% annual chance and 0.2% annual chance floodplains associated with coastal flooding, as well as 1% annual chance floodplains with wave velocity for the Town.

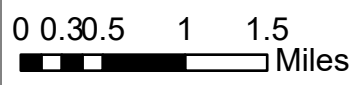
The FEMA mapping implies some level of flooding for areas adjacent to the Route 156 crossing of the Niantic River, and in areas adjacent to Jordan Cove and Goshen Cove during 1% annual chance coastal flood events.

The areas of Waterford that are vulnerable to sea level rise are the same as those vulnerable to coastal flood hazards. In general, a quick view of the coastal floodplain maps reveals the areas that are most vulnerable to sea level rise. These include at-grade roads, certain neighborhoods, and larger areas adjacent to marshes.



Flood CCVI Score

SCCOG Hazard Mitigation and Climate Adaptation Plan
 Town of Waterford
 1/17/2023



Esri, NASA, NGA, USGS, Town of Waterford, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc.

As noted earlier, TNC and several partner agencies have developed a hazard planning tool and a risk assessment process designed to help communities identify and prioritize steps to reduce risks in a community. TNC has been promoting this tool in coastal Connecticut communities, with a focused effort in Waterford. TNC hosted an "Eastern Connecticut Climate Risk Assessment Workshop" in the Waterford Town Hall auditorium on January 11, 2012. This workshop was geared toward assisting with planning and hazard mitigation efforts. During the day-long event, Waterford planners and municipal officials were introduced to the coastal resilience tool and encouraged to complete a vulnerability assessment survey. The results of the survey were later forwarded to aid the development of this plan update and have been incorporated herein.

As shown on Figure 4-3, areas of storm surge are generally coincident with the areas of coastal flooding described above. In general, a Category Two Hurricane is expected to produce storm surges that are equivalent to the 1% annual chance flood event, while a Category Three Hurricane is expected to produce storm surges that approximate the 0.2% annual chance flood event. Storm surge from a Category Four Hurricane would affect additional areas, while storm surge from a Category One Hurricane is expected to affect many low-lying coastal areas to a slightly lesser extent than those from a Category Two hurricane. Areas potentially affected by storm surge from a Category One Hurricane include the edges of Jordan Cove, the lower Niantic River, and low-lying areas on either side of Harkness State Park.

Vulnerability Analysis of Private Properties

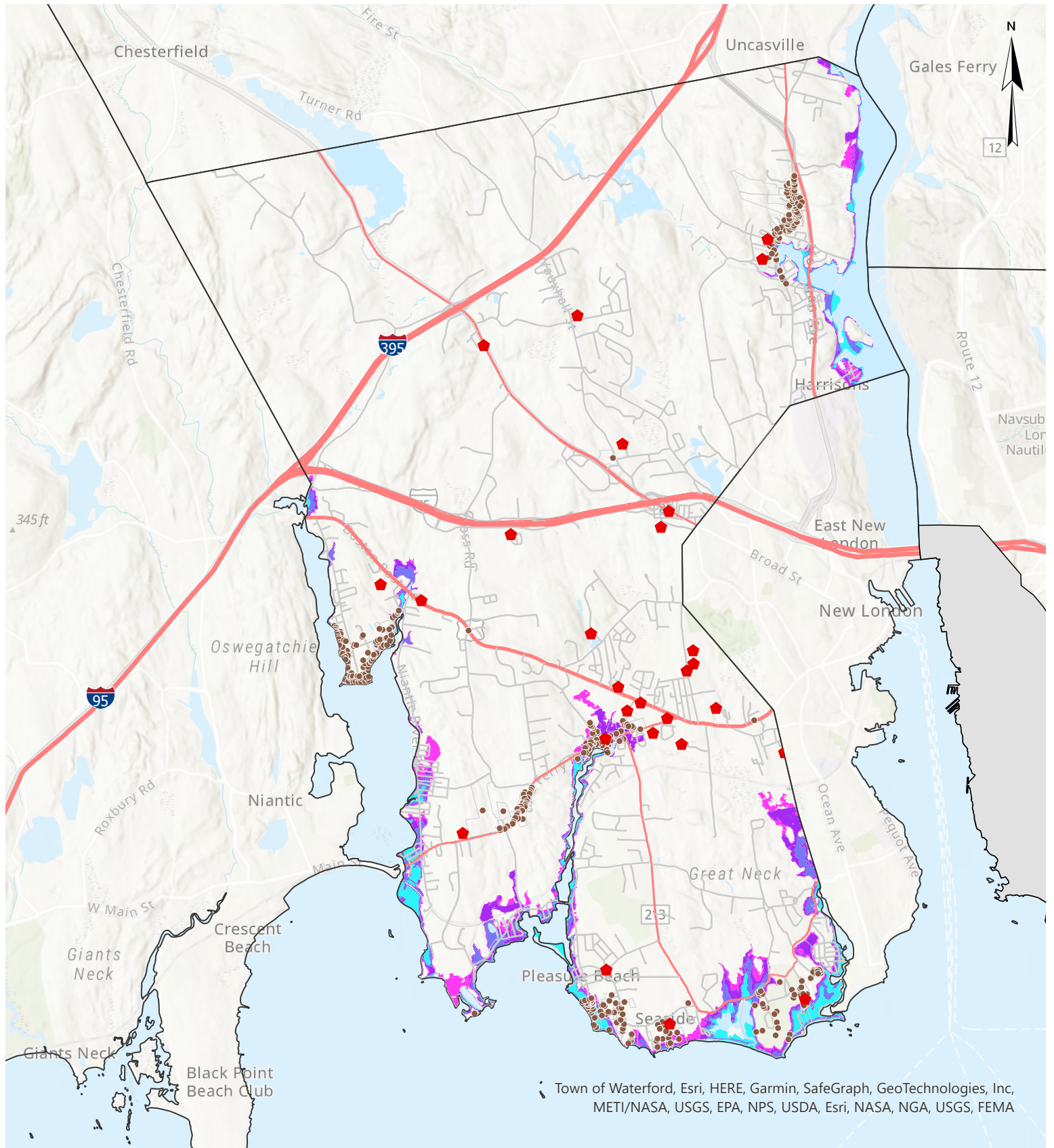
The coastal areas of the Town of Waterford have properties that are inhabited year-round. This intensifies risk to life and property in coastal areas. Waterfront properties are very susceptible to damage, not only as a result of flooding but also due to the velocity zones located along the shoreline. Although shoreline erosion is a relatively minor concern for some private property owners because they have seawalls or rocky shorefront protecting their structures, many property owners suffered damage from Tropical Storm Irene as seawalls overtopped and collapsed.

Buildings located in flood hazard areas are primarily residential. Most of the structures that are threatened by flooding are located within the 1% annual chance floodplain, but some are also in the coastal velocity zone. Location in the velocity zone poses an increased threat to structures due to high wind and potential wave damage, as well as inundation by flood waters. Other areas located more inland or behind protective seawalls are only subject to coastal flooding without wave action. Drainage systems in low-lying areas can also backup during coastal storms, resulting in flooding along roadways.

Floodprone residences are located throughout the coastal areas of Waterford. Areas located in the coastal velocity zone are believed to be particularly at risk.

As of June 2022, ten repetitive loss properties were reported in Waterford. Six were related to coastal flood zones. These properties are located near Jordan Cove, Goshen Cove, and Alewife Cove.

These properties are each located at a low elevation close to sea level. The dates of the recent losses confirm that the March 2010 and October 2005 floods (both declared disasters) were damaging in Waterford. While the property near Jordan Cove could be associated with flooding from a nearby estuary and tidal marsh, the properties near Goshen Cove and Alewife Cove may be affected by nuisance or basement flooding.



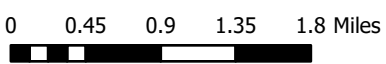
Town of Waterford, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, Esri, NASA, NGA, USGS, FEMA

Hurricane Storm Surge Inundation Areas

SCCOG Hazard Mitigation and Climate Adaptation Plan

Town of Waterford

Date: 8/3/2022



Legend

- Historic Resources
- ⬠ Critical Facilities

Hurricane Category

- 1
- 2
- 3
- 4

As of 2017, three additional repetitive loss properties were listed in Waterford, and all three of the new entries are affected by coastal flooding. Two are located near the tidal Niantic River and the third is near Alewife Cove. These likely represent flood claims associated with Tropical Storm Irene and Hurricane Sandy.

Most recently, as of June 2022, the town still has ten RL properties, with six of those being affected by coastal flooding. All ten properties are residential.

Although property owners are not currently interested in acquisitions or elevations, the Town should continue to provide outreach to those property owners regarding elevation, relocation of utilities, and other potential mitigation measures.

The Town further recognizes that many private properties may suffer coastal flood damage that is not reported because the structures are not insured under the NFIP, or because they choose to not report the damage. These residents and business owners are likely repairing structures on their own. Coastal flood mitigation as recommended in this HMCAP will likely assist many of these property owners. The Town of Waterford is interested in all forms of flood mitigation, including acquisitions, elevations, drainage upgrades, and other structural projects provided property owners are interested and funding is available.

The Town of Waterford has no formalized program currently in place to identify the location or the number of structures that are susceptible to flooding. Such information would be valuable in directing hazard mitigation efforts to locations with the greatest risk. Town planning staff should use the recently released DFIRM to identify the approximately 269 structures in the town that are located in the AE zone (with or without wave velocity). This could provide a list of areas to inspect following a storm event and allow for the town to track building permits from repairs following a natural hazard. This information, in turn, would provide supporting data for future grant applications.

Vulnerability Analysis of Critical Facilities

As noted in Section 2.7, critical facilities in Waterford that are located within the 1% annual chance floodplain include several sewer pumping stations. These facilities can become inundated during coastal flooding and storm surge events resulting in sewer backups. However, most of the critical facility buildings in Waterford are not located in a hurricane surge zone, the coastal SFHA, or 500-year floodplain. One fire station is believed to be located in a surge zone.

Storm surge flooding can also hinder emergency response, particularly in low-lying roads located along the coastline. For example, streets such as Shore Road, Great Neck Road, Jordan Cove Road, and Gardiner Wood Road are the only modes of egress for coastal neighborhoods. The timing of evacuations from these areas of the town prior to a hurricane event is therefore very important as the majority of the roads in this area will be flooded or washed out by a major hurricane.

As noted earlier, SCCOG completed an assessment of critical facilities in the region in 2017. The Quaker Hill Fire Company facility was addressed. The assessment found that the facility has a complex flood risk profile due to the placement of an unnamed stream in a culvert that bisects the site combined with the coastal flood risk from Smith Cove/Hunts Brook; and would be at increased risk to both riverine and

coastal flooding due to increasing precipitation intensities and sea level rise, respectively. The assessment recommended:

- In the short term, wet floodproofing should be used for the floor located below the estimated 0.2% annual chance flood elevation
- In the long-term, relocating the facility may eventually be warranted due to the combination of stream/culvert and coastal/storm surge flood risk, coupled with the significant expense associated with replacing the very long culvert.
- Another possible option for reducing risk could be construction of berms along each side of Sunshine Road, which could keep overflowing stream floodwaters from flooding the facilities. However, the berms would affect vehicle access.

4.2.3.1 Hazard Losses

There are no reported losses for the Town of Waterford related to coastal flooding. However, as of June 30, 2022, NFIP records show 124 flood related losses in Waterford, with a total of \$1,520,355 paid towards the claims. It is likely that some of these losses and claims are attributable to coastal flooding events.

Table 4-1 presents the direct and business interruption related losses for the 100-year coastal flood event. Additional HAZUS-generated loss estimates for coastal floods and downscaled flood losses based on the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi-Jurisdictional document.

Table 4-1 HAZUS-MH Coastal Flood Related Economic Impacts

Waterford	2022 Results				
	Residential	Commercial	Industrial	Other	Total
Direct					
Building	\$56,780,000	\$8,300,000	\$1,610,000	\$7,010,000	\$73,700,000
Contents	\$53,990,000	\$26,640,000	\$2,290,000	\$42,640,000	\$125,560,000
Inventory	\$0	\$4,050,000	\$330,000	\$200,000	\$4,580,000
Subtotal	\$110,770,000	\$38,990,000	\$4,230,000	\$49,850,000	\$203,840,000
Business Interruption					
Income	\$1,770,000	\$20,860,000	\$110,000	\$14,570,000	\$37,300,000
Relocation	\$21,410,000	\$5,210,000	\$90,000	\$10,270,000	\$36,980,000
Rental Income	\$8,290,000	\$3,640,000	\$0	\$1,860,000	\$13,790,000
Wage	\$4,150,000	\$20,160,000	\$210,000	\$137,180,000	\$161,700,000
Subtotal	\$35,620,000	\$49,870,000	\$410,000	\$163,880,000	\$249,770,000
TOTAL	\$146,390,000	\$88,860,000	\$4,640,000	\$213,730,000	\$453,610,000

4.3. Shoreline Change

4.3.1 Setting and Recent Occurrences

Shoreline change is primarily a natural process caused by wind, waves, and currents; however it can also be attributed to human driven processes such as development, grading, and beach armoring or

nourishment. As climate change impacts hazards such as severe storms, hurricanes and tropical storms, and sea level rise, shorelines have the potential to change at different rates than in decades past. As tidal ranges increase, and storm surge becomes higher and potentially more intense, these processes may become exacerbated. Rapidly changing shorelines can have an impact on coastal ecosystem (particularly those that provide natural buffers), erode natural shorelines resulting in encroaching seas onto developed land, and may alter those shorelines that have been hardened to protect development and infrastructure.

4.3.2 Existing Capabilities

Like many communities, the town does not have specific mechanisms to address the impacts of shoreline change, however, there are several regulatory standards and planning efforts that address smart shoreline development and conservation, in addition to flood control structures that also aid in mitigating and reducing shoreline change.

The Zoning Regulations Section 25.3, Developing in Flood Hazard Areas, are designed to restrict uses which are dangerous to erosion or those that may increase erosion, and to control actions such as grading, dredging, and filling that may increase erosion.

4.3.3 Vulnerabilities and Risk Assessment

The town considers erosion to be one of their top three challenges in town. There is reportedly a strong fetch across the Niantic River which seems to be impacting the shoreline at a severe rate. Hardening for properties in this and other areas is not easy to do, and the town is concerned with options.

Coastal erosion is an important issue in Waterford. Much of the shoreline includes either developed, rocky shorefronts consisting of stones and boulders; or modified bluffs and escarpments consisting of seawalls, bulkheads, or revetments. However, four coastal barrier resource systems are present in Waterford. These coastal barriers and associated beaches are susceptible to coastal erosion. One of them (the Jordan Cove barrier) has eroded significantly. In some places, they may be protected from direct wave action by local islands, groins, jetties, and breakwaters. However, as sea level rises, the effectiveness of these structures will be undermined such that erosion will be able to occur more easily during coastal flooding events.

In general, it is assumed that as sea level rises, the frequency and magnitude of coastal flooding in the Town will increase with structures and roadways closest to existing sea level being affected more quickly. In addition, tidal marshes will either migrate inland or be eroded by constant inundation. Some tidal wetlands could disappear completely.

A secondary impact of shoreline change in town is the turnover of properties; the character of the coastline is changing. As erosion impacts properties, current cottage owners cannot afford to mitigate or upgrade. Properties are then sold, and larger homes are built, however, the root of the problem is not being solved.

4.3.3.1 Hazard Losses

There are no reported losses for the Town of Waterford related to shoreline change. Despite the record of past events, shoreline changes losses such as coastal erosion are difficult to quantify because they are

not reported via the tools typically reviewed for plan updates such as the NCEI Severe Storm database and the NFIP. Shoreline change losses are not quantified in the 2019 Connecticut Natural Hazard Mitigation Plan.

One representation of loss is the total cost of implementing mitigation and adaptation strategies to mitigate future shoreline change. The Waterford Climate Change Risk Vulnerability, Risk Assessment and Adaptation Study (2018) has identified several opportunities for mitigation and adaptation in town.

- The barrier beach in Alewife cove has been damaged in past storms and is vulnerable to future damage. The first step in mitigation is to conduct a coastal processes study to determine stabilization methods. This could range from \$50,000 to \$100,000.
- A Beach Management and Habitat Conservation Plan for Town Beach, also recommended in the 2018 plan, could range from \$25,000 to \$50,000 for development.
- A marsh assessment for Pleasure Beach/White Point Marsh, Millstone/Jordan Cove Marsh, and for Mago Point could range from \$20,000 to \$40,000 for each location.

5. Changing Precipitation

5.1. Climate Change Impacts

Across the United States, annual precipitation has increased in the past century, however, this change *is* dependent upon the region. Here in the northeast, precipitation totals and intensity are believed to have increased, and are projected to continue to increase during spring and winter months. However, climate change has also been linked to a reduction in snow cover extent, and an earlier spring melt. Winter precipitation may also change from snow to a wintry mix or rainfall due to warmer temperatures; so, while precipitation may increase it may not necessarily be an increase in snow.

Changes in precipitation can also shift the frequency and severity of droughts. As the climate warms, surface soil moisture is likely to decrease as evaporation rates rise. This decrease in soil moisture, and potentially longer periods of time between intense precipitation events, could potentially mean longer and stronger droughts.

These changes in precipitation can have various types of impacts. With an increase in intense precipitation, flooding events may become more frequent, damage to crops may occur, and spring flood trends may shift with less snow and more rain. Droughts on the other hand can also cause damage to crops, stress livestock and agricultural operations, and also reduce drinking water supplies or private wells.

5.2. Riverine and Pluvial Floods

5.2.1 Setting and Recent Occurrences

Flooding is the primary hazard that impacts the town each year as documented in the previous HMP. While riverine flooding is a concern, nuisance flooding and poor drainage have also created flooding issues at several locations in the town. Flooding is typically caused by heavy rainstorms, but can also be caused by relatively light rains falling on frozen ground. Flooding of roadways is more common than damage to structures. For example, the June 1982 rainfall damaged many roads in Waterford and Town personnel report that flooding damage was as severe as that experienced in East Lyme and Montville

Sustained heavy rainfall in late March 2010 caused a 1% annual chance flood throughout southeastern Connecticut and remains one of the most impactful events in over a decade. This is now considered the flood of record for Waterford. Many roads throughout the community were closed, and sewer trenches were flooded leading to collapsed roads and sewer lines. The sewer issue involved an increase in ground water elevations that drew fines away from the bedding and caused the trenches to fail. The following flooding issues were observed throughout the town:

- Two key roads for evacuation were flooded. These included Route 156 (Rope Ferry Road) at Jordan Brook where two to three feet of water covered the road at Jordan Brook and back to the intersection of Route 156 and Route 213 (Great Neck Road); and Gardiners Wood Road along an unnamed brook.
- Route 156 at Gardiners Wood Road flooded from the same unnamed brook.
- The southern part of Route 213 had many crossings closed during the March 2010 flooding that were coincidental with mapped 1% annual chance floodplains.

- Braman Road flooded at the headwaters of one of the streams that flows into Goshen Cove.
- An unnamed brook near Niantic River Road flooded, affecting the numbered streets (First Avenue through Seventh Avenue).
- Oil Mill Road at Oil Mill Brook flooded at two locations.
- Way Hill Road at Oil Mill Brook flooded.
- Niles Hill Road at Fenger Brook (head of Alewife Cove) flooded.
- The Boston Post Road at Jordan Brook flooded.
- Hunts Brook flooded at Bloomingdale Road and Old Norwich Road (see below for more about Hunts Brook).

Heavy rainfall events continued to affect Waterford after 2010. On September 10, 2015, a wave of low pressure riding along a cold front stalled just south of Long Island. It brought heavy rain and isolated flash flooding to New London County, Connecticut.

The region has, however, seen some severe rainstorm events since the 2017 plan, with many neighboring communities having experienced serious flooding as a result.

The September 2018 rain event caused severe flooding throughout the state, with several communities in the SCCOG region receiving FEMA funding for the event. Neighboring Norwich received 4.85 inches of rainfall and Lebanon had a reported 6.79 inches.

Hurricane Ida, which produced several inches of rain across the state, caused flooding in many SCCOG communities. Norwich Public Utilities recorded 6.34 inches of rainfall and Groton-New London Airport recorded 2.05 inches. Washouts did occur in Town as a result of flooding near the former State Hospital and the future Riverwalk development.

After a period of prolonged drought, a severe rainstorm event on September 5, 2022, caused flooding throughout southeastern Connecticut. Lebanon experienced road closures and washouts, while Norwich Public Utilities observed 5.85 inches of rainfall. There were flood and flash flood warnings throughout the region and across the state. Neighboring Rhode Island reported 11 inches of rainfall in some communities.

5.2.2 Existing Capabilities

The Town attempts to mitigate inland flood damage and flood hazards by utilizing a wide range of measures including restricting activities in floodprone areas, replacing bridges and culverts, promoting flood insurance, acquiring floodprone structures, maintaining drainage systems, through education and outreach, and by utilizing warning systems. Many mitigation measures are common to all hazards and therefore were listed in Section 2.6 and Section 2.7. No major inland flood control structural projects are in place within or upstream of Waterford.

Bridge Replacements, Drainage, and Maintenance

The Department of Public Works cleans and inspects catch basins and culverts at least annually or more often if problems are noted. The Town fields phone calls related to drainage complaints. Roadway drainage complaints are directed to the Director of Public Works. When flooding occurs, the Public Works department or the Fire Department would handle complaints depending on the location. For

example, Public Works would inspect bridges and culverts and erect barricades to close roads, while the Fire Department responds to calls requesting help for flooded basements.

Many old culverts throughout the town are corrugated pipes. Those that have been replaced now have box culverts, with positive results relative to reduced frequency of flooding. For example, Way Hill Road reportedly has not experienced flooding anymore from Oil Mill Brook since its culvert was replaced.

An unnamed brook near Niantic River Road previously flooded the numbered streets (First Avenue through Seventh Avenue). The culverts along the entire length of this brook were recently replaced as part of the Cooperative Road Reconstruction Project with proper sizing regarding adjacent restrictions (houses and other structures).

Regulations, Codes, and Ordinances

The Town of Waterford has planning and zoning tools in place that incorporate floodplain management. The Town has recently updated its flood protection regulations in its Zoning and Regulations as noted in Section 2.6. The most recent update to the flood protection regulations was completed July 8, 2019. The Town utilizes the 1% annual chance floodplain as defined by FEMA (with the recent maps published in July 2011 and August 2013 specifically referenced) to regulate floodplain and floodway activities and requires 100 percent compensatory storage for any encroachment in the floodplain. The Town also requires new construction or substantial renovations to be located at an elevation greater than one foot above the base flood elevation (freeboard). The Town defines substantial improvement cumulatively within a two-year period.

The Town's Subdivision Regulations require that adequate drainage be provided to reduce exposure to flood hazards and that buildings and utilities are located to minimize the effects of flood damage. Regulations covering development in or within 100 feet of inland wetland or watercourse areas are enforced by the Town's Conservation Commission.

Acquisitions, Elevations, and Property Protection

To date, the Town of Waterford has not performed elevations of floodprone property. The Town has performed acquisition of property located within the 1% annual chance floodplain but not to reduce future flooding damages (although floodplains are a consideration when the Town is purchasing open space). Property protection has focused instead on preventive measures and maintaining and upgrading drainage systems. The Town is not opposed to performing acquisitions, elevations, or relocations if property owners were willing and grant funding was available. For example, the Town is hoping to acquire and remove a home on Bloomingdale Road as noted below.

The West Farms Land Trust was founded in 1974 by local residents striving to preserve the natural charm of the undeveloped lands and irreplaceable resources of Waterford and Montville. State law also enables this trust to accept donations of land, easements, and other grants in furtherance of these purposes. Over the past 26 years, the Trust has conserved and managed 17 properties, ranging in size from 1/4 of an acre to 338 acres. This is believed to have included properties with potential flood hazards.

Flood Watches and Warnings

The Public Safety Director and the Fire Department access weather reports through the National Weather Service and local media. Residents can also sign up for the Connecticut Alerts "Everbridge" Reverse 9-1-1 system to receive warnings when storms are imminent. The Town can telephone warnings into potentially affected areas using this system.

Community Rating System

The Town of Waterford does not participate in the Community Rating System (CRS), nor is there much public support for joining the program. Waterford has the technical and administrative capacities to conduct many of the actions required to join the program but would need the support of residents first.

Stormwater Management

The Town is in the early stages of potentially organizing and implementing a stormwater utility. To help understand the benefits of implementing a stormwater utility, the Town participated in a stormwater utility feasibility study in fall 2022. A final report was issued to SCCOG and the Town in 2023, and one of the proposed hazard mitigation and climate adaptation actions builds on the completion of the study.

Summary

In general, municipal capabilities to mitigate flood damage have not significantly increased since the 2017 edition of the hazard mitigation plan was adopted.

5.2.3 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk of inland flooding within the Town. Overbank flooding is the most common type of flooding experienced in Waterford, although poor drainage and nuisance flooding also occur.

Vulnerability Analysis of Areas along Watercourses

Major inland watercourses and water bodies in Waterford have the 1% annual chance floodplain defined by FEMA on a Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS). The FIRM delineates areas within Waterford that are vulnerable to flooding and was most recently published on July 18, 2011 with the remainder of New London County. Many of the inland watercourses and water bodies in Waterford are mapped as Zone AE with the exception of Willys Meadow Brook, Oil Mill Brook, Lakes Pond Brook, Hunts Brook, a portion of Green Swamp Brook, and Fenger Brook, which are mapped as Zone A. Refer to Figure 5-1 for the location of the 1% annual chance floodplains related to inland flooding within Waterford.

Based on the information in the previous HMP editions, and as provided by Town officials, the following areas along watercourses and roads are vulnerable to flooding:

- Gardiners Wood Road (an evacuation route) continually floods along an unnamed brook. The road likely needs to be elevated with two culverts replaced. Route 156 at Gardiners Wood Road floods from the same unnamed brook. The town will be resurfacing this roadway in the near future which will allow it to be raised an estimated six to eight inches and will also be installing pipes at low points. Designs are complete for this project, and the town is pursuing the estimated \$4 million for the project.

- The southern part of Route 213 had many crossings closed during the March 2010 flooding. Several unnamed streams flow into Goshen Cove in this area and repeated flooding is a problem.
- Braman Road floods at the headwaters of one of the streams that flow into Goshen Cove. The road likely needs to be elevated concurrent with a culvert upgrade. This project will be added to the Town's Capital Improvement Plan.
- Oil Mill Road at Oil Mill Brook floods in at least two locations. The road likely needs to be elevated in these areas concurrent with a culvert upgrade. This project will be added to the Town's Capital Improvement Plan.
- Niles Hill Road floods at Fenger Brook (head of Alewife Cove). The road likely needs to be elevated concurrent with a culvert upgrade. This project will be added to the Town's Capital Improvement Plan.
- The Boston Post Road floods at Jordan Brook. This is a State Road, and the Connecticut Department of Transportation has scheduled a culvert replacement for 2012-2013.

As noted in Section 2.7, without the ability to evacuate through Jordan Cove Road or Gardiners Wood Road during severe flooding, residents near Millstone may be able to evacuate through an old access road on Millstone land. The road is blocked with barriers that would need to be moved. Permission to utilize this access road for emergency evacuation is something the Town would like to address with Millstone. A grant for the replacement of the Jordan Cove Road Bridge from the Federal Local Bridge Program was approved in the summer of 2012 for 80% funding. The design will be initiated in 2012 and construction is scheduled for 2014. This bridge replacement will reduce the potential for residents in this area to be unable to evacuate during a flood.

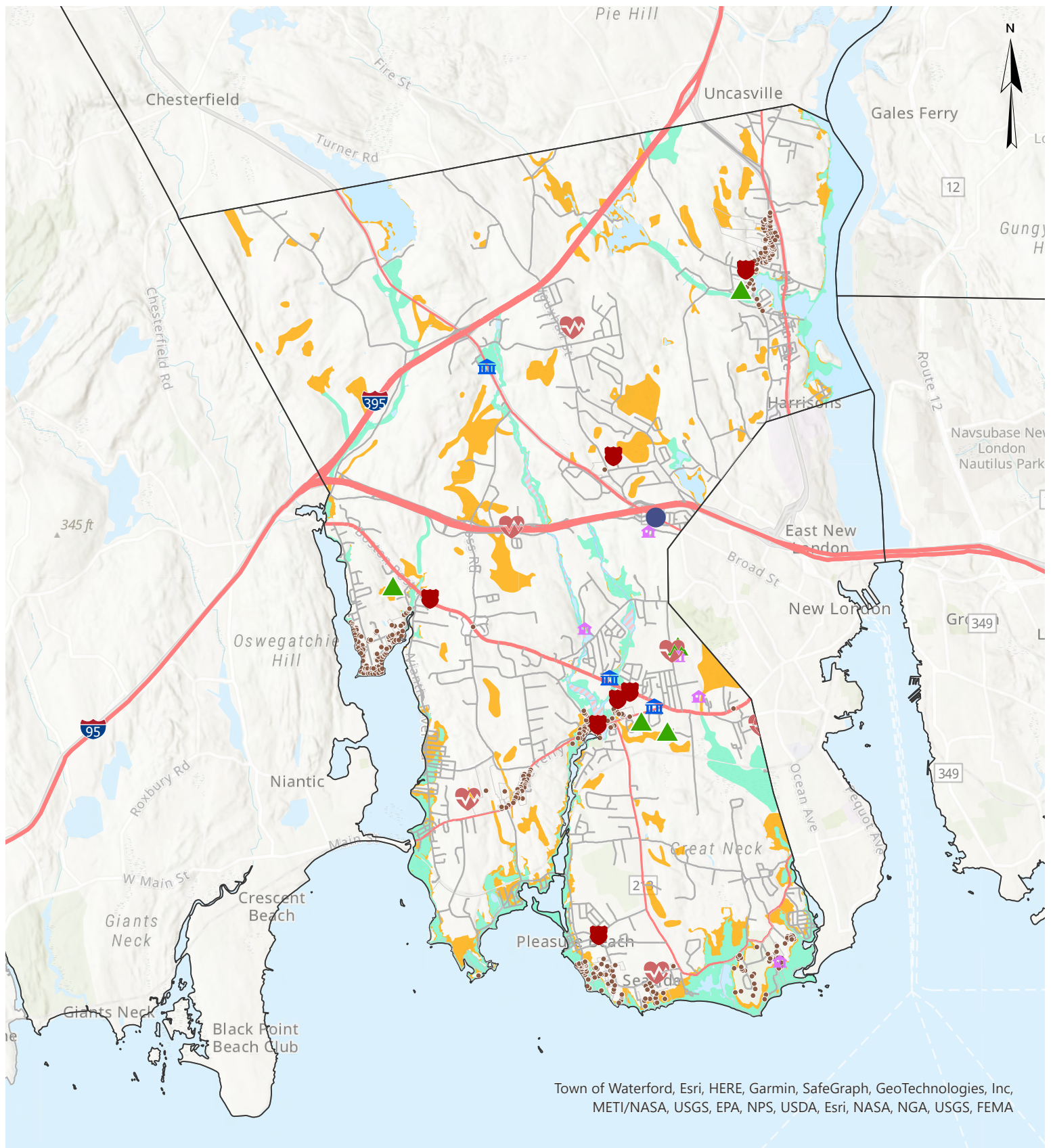
The Hunts Brook corridor is a significant problem area for the Town of Waterford because it floods but is an A zone – without assigned base flood elevation – rather than AE. The town needs information about flood elevations along Hunts Brook. FEMA is currently working through the RiskMAP process for that corridor, which should help the Town access flood depth information. This will facilitate a benefit-cost analysis (BCA) using the flood module and, in general, would assist with planning and project prioritization in the watershed.

Town staff note that beaver activity has begun to be a problem with regards to inland flooding. There is one location where beavers have been observed constructing a dam inside a double-culvert. The Town does not have the capacity to manage beavers effectively at this time.

A twin box-culvert under Cross Road was recently inspected by the State and found to be only three feet high and half full of sediment. The Town does not have the equipment to clean this culvert out.

In general, the town is concerned with isolation during floods along many of the roadways previously mentioned, and others. Specific locations that pose the greatest challenge are:

- Great Neck at Avery (intersection floods during heavy rainstorms)
- West Neck,
- Chapman (cuts off Quaker Hill)
- Gardiners Wood



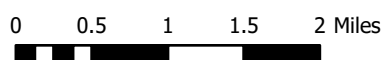
Town of Waterford, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, Esri, NASA, NGA, USGS, FEMA

Critical Facilities and Historic Resources with Flood Zones

SCCOG Hazard Mitigation and Climate Adaptation Plan

Town of Waterford

Date: 8/1/2022



Legend

- Historic Resources
- 🏠 Senior Housing
- ❤️ Emergency Services
- 🏛️ Municipal
- Other Infrastructure and Facilities
- ▲ Shelter or Cooling Center
- ❤️ Care and Medical Facility
- 🌊 1% Annual Chance Flood Hazard Area
- 🌊 .2% Annual Chance Flood Hazard Area
- 🌊 Floodway

Vulnerability Analysis of Private Properties

Most of the structures located in Zone AE are vulnerable to inland flooding, with the remainder being vulnerable to coastal flooding (although some may be susceptible to both types of flooding). The Town of Waterford should make an effort to identify properties within the 1% annual chance floodplain and distribute information regarding floodproofing and home elevation to the owners of these properties.

As of November 2012, seven repetitive loss properties were reported in Waterford. Four were related to inland flooding damage. These properties lie along Jordan Brook (two), Nevins Brook, and Green Swamp Brook. Each of the structures is located within the 1% annual chance floodplain except for the structure flooded by Green Swamp Brook where there is not a mapped SFHA. Historic claim-related damage events are listed in Table 5-1.

Table 5-1 Historic Inland Repetitive Loss Damage Claims in Waterford

Repetitive Loss Property	Most Recent NFIP Loss
"Jordan Brook 1"	March 2010
"Jordan Brook 2"	October 2005
"Nevins Brook"	March 2010
"Green Swamp"	March 1988

As of 2017, Waterford has ten repetitive loss properties, an increase of three, but the three new listings are at risk of coastal flooding and will be addressed in Chapter 4. As of June 2022, the Town still has ten RL properties, with four being primarily impacted by inland flooding.

The dates of the historic losses confirm that the March 2010 and October 2005 floods (both presidentially-declared disasters in Connecticut) were likewise damaging in Waterford. These properties are each low-lying near the respective stream and while property owners are not currently interested in acquisitions or elevations, the Town should continue to provide outreach to those property owners regarding floodproofing and other potential mitigation measures.

Two notable structures were damaged in the March 2010 floods. These structures are located on Bloomingdale Road and Old Norwich Road, along Hunts Brook. The house on Bloomingdale Road was the subject of an HMGP application that requested funding for acquisition and conversion to open space. The home was not insured prior to the flood but suffered damage during the flood and is now insured. The house is in the SFHA. The other flooded structure is a store known as the Greens. The owners paid for the necessary repairs, however much of the parking lot for the Greens was washed into the downstream cove.

Vulnerability Analysis of Critical Facilities

Waterford experienced a unique problem during the March 2010 flooding. High groundwater flowing along the gravel around many sewer lines caused the collapse of the overlying roads. A few miles of roads and sewer lines were lost, leading to great expenditures for repairs and replacements of sewer sections and roadways. The March 2010 flood caused the following sewer/roadway collapses:

A potential mitigation for preventing future losses to the sewer system and the overlying roadways is to upgrade drainage systems (thus conveying waters elsewhere) and provide engineered controls and different trench materials to prevent future preferential groundwater flows. However, this may not be effective in all cases. Waterford will need to evaluate mitigation solutions on an area-by-area basis. To this end, the Utilities Commission will be reviewing the design of all future sewer installations with specific consideration of this potential flooding issue.

Table 5-2 Sewer Collapses During the March 2010 Flood

13 Jodry	Old Colchester Rd., #88- #108	28 Connshire
Quinley Way	Dogwood Drive	10 Farmstead Lane
41 - 44 Beacon Hill Road	Vauxhall St. Ext. (Grabner to Silva La.)	69-71 Cross Road
Beacon Hill toward end	143 Spithead Rd.	40 Devonshire Drive
Glenvale	146 Spithead Rd.	45 Devonshire Drive
Robin Hill	5, 9, 13, 15 Rogers Hill Rd.	6 Alice Street
Wallace	7 Farmstead La.	378 Glenwood Ave. Ext.
Clark Lane (near #150-#160)	Fairlawn @ Glenvale intersection to next MH	6-8 Quaker Lane
Clark Lane near Miner's & AHEPA	205/207 Old Norwich Rd.	8- 18 Crown Street
Oswegatchie Rd. across from #63	Mullen Hill Rd., #5- #37	26 Lincoln to the Intersection of Wallace
Oswegatchie Rd. @ intersection of Deborah St.	Briarwood	213 Old Norwich Road
Oswegatchie Rd. @ #62	28 Cross Road	91 Philips St.
Oswegatchie Rd. @ Indian Valley	Old Colchester Rd., #40-#50	834 Vauxhall St. Ext.
92 Oswegatchie	Coolidge Court	14- 18 Whaling Drive
74 Oswegatchie	#10- #16 Rockridge Rd	9 Wallace
71 Oswegatchie	Great Neck Road (Rte 213)	Glenwood Ave. Extension
Indian Valley, #3 to Oswegatchie	621 Vauxhall St.	138 & 163 Niles Hill Road
Raymond La., near #2	16 Mary St.	Trumbull Road @ Seymour Lane
210 Niantic River Road	4 Trumbull Road to Griswold Court	9, 11 Trumbull Road
Albacore Drive	Rockwood	Foot Court
High Ridge @ Croyden Ct.	Diane Drive near intersection of Rockwood to #3	Almond Road
Connshire @ Warwick	8 Maple Terrace	Ridgewood @ Cozy Court
Connshire @ Quinley	56 Kenyon Road	7 Ellen Ward Road

As noted in Section 2.7, critical facilities in Waterford are not located within the 1% annual chance floodplain. While some of the water and wastewater facilities appear to be located within the 1% annual chance floodplain, Town officials note that the pump stations were built above the base flood elevation as required. In addition, these facilities are not designed for permanent habitation. The associated infrastructure can withstand minor flooding or can be floodproofed.

SCCOG completed an assessment of critical facilities in the region in 2017, fulfilling an action listed in the 2012 edition of the multi-jurisdiction hazard mitigation plan. The Quaker Hill Fire Company facility was

addressed in this study. The assessment determined that the site is currently at risk of both riverine and coastal flooding. Specifically, the assessment found that the facility has a complex flood risk profile due to the placement of an unnamed stream in a culvert that bisects the site combined with the coastal flood risk from Smith Cove/Hunts Brook; and would be at increased risk to both riverine and coastal flooding due to increasing precipitation intensities and sea level rise, respectively. The assessment recommended:

- In the short term, wet floodproofing should be used for the floor located below the estimated 0.2% annual chance flood elevation.
- In the long-term, relocating the facility may eventually be warranted due to the combination of stream/culvert and coastal/storm surge flood risk, coupled with the significant expense associated with replacing the very long culvert.
- Another possible option for reducing risk could be construction of berms along each side of Sunshine Road, which could keep overflowing stream floodwaters from flooding the facilities. However, the berms would affect vehicle access.

5.2.3.1 Hazard Losses

According to NFIP statistics, as of June 30, 2022, the Town of Waterford has had a total of 124 flood related losses, with a total of \$1,520,355 paid towards the claims.

Since 2017 there has also been one NOAA reported flash flood event, which occurred in September 2021. There were several road closures, however there were no reported financial losses associated with the damage.

FEMA HAZUS-MH 6.0 was used to develop losses associated with the 100-year riverine flood event. Table 5-3 presents flood related damages for the Town of Waterford. Additional HAZUS-generated losses for the town and region can be found in the Multi-Jurisdictional document.

Table 5-3 HAZUS-MH Riverine Flood Related Economic Impacts

Waterford	2022 Results				
	Residential	Commercial	Industrial	Other	Total
Direct					
Building	\$5,740,000	\$2,120,000	\$280,000	\$910,000	\$9,050,000
Contents	\$2,750,000	\$7,390,000	\$430,000	\$5,170,000	\$15,740,000
Inventory	\$0	\$1,400,000	\$60,000	\$40,000	\$1,500,000
Subtotal	\$8,490,000	\$10,910,000	\$770,000	\$6,120,000	\$26,290,000
Business Interruption					
Income	\$70,000	\$11,280,000	\$30,000	\$4,840,000	\$16,220,000
Relocation	\$3,110,000	\$3,540,000	\$50,000	\$2,920,000	\$9,620,000
Rental Income	\$1,300,000	\$2,540,000	\$0	\$320,000	\$4,160,000
Wage	\$170,000	\$13,370,000	\$60,000	\$27,300,000	\$40,900,000
Subtotal	\$4,650,000	\$30,730,000	\$140,000	\$35,380,000	\$70,900,000
Total	\$13,140,000	\$41,640,000	\$910,000	\$41,500,000	\$97,190,000

5.3. Drought

5.3.1 Setting and Recent Occurrences

A drought can occur during any season when there is a long, abnormally dry period of time. These events naturally occurring during periods of limited precipitation. The effects of drought may vary throughout Town, with some sectors impacted more than others.

In recent years, droughts have become flashier and more frequent throughout the region. During recent events, there have been reports in the region of wells going dry on residential and farming properties. Some of the more severe and impactful events include:

- **2016** – A statewide drought that lasted almost two years and peaked in 2016, resulted in water conservation efforts throughout the southeastern part of the region, elevated fire risks in some areas, and was noted as the 11th driest spring on record.
- **2020** – From June to December, New London County experienced a moderate to severe drought, with the county being declared a Stage 3 by the Connecticut Interagency Drought Work Group.
- **2022** – During the development of this plan, the region was in an ongoing drought, with severe drought conditions in August 2022. New London County was declared a Stage 3 drought emergency on August 18, 2022.

5.3.2 Existing Capabilities

The Town of Waterford, like many communities, does not have specific regulations geared toward drought mitigation. However, the town does encourage the use of drought tolerant, native landscaping throughout development. While this may seem more aesthetic, drought tolerant and native vegetation can aid in groundwater retention.

The U.S. Drought Monitor is a national resource that many state and local entities use to monitor regional conditions in relation to drought development. The weekly reporting issued by the partnership includes a drought intensity scale which includes five stages from “abnormally dry” to “exceptional drought”. While this resource is available to Town for determining drought conditions, the Connecticut Interagency Drought Workgroup (IDW) uses this and other resources to monitor drought conditions specifically for the state. The Town of Waterford has this IDW and state-specific drought emergency declarations as a resource to prepare for, and respond to, droughts.

5.3.3 Vulnerabilities and Risk Assessment

The entire Town of Waterford is vulnerable to drought, but the degree of vulnerability varies. A number of the properties in the northern parts of town rely on private wells for their residential or commercial drinking water. These private well users may face challenges relative to water supply during periods of drought. Those that rely on public water supply may have a more resilient system, however, during periods of drought they may be faced with water use restrictions.

Agricultural operations in town are also more vulnerable as irrigation and watering during these times may be challenging due to either private well limitations, or water use restrictions.

5.3.3.1 Hazard Losses

There have been no reported drought losses for the Town of Waterford. Downscaled drought losses from the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi Jurisdiction document.

5.4. Dam Failure

5.4.1 Setting and Recent Occurrences

Dam failures can be triggered suddenly with little or no warning and often in connection with natural disasters such as floods and earthquakes. Dam failures can occur during flooding when the dam breaks under the additional force of floodwater. In addition, a dam failure can cause a chain reaction where the sudden release of floodwater causes the next dam downstream to fail. While flooding from a dam failure generally has a limited geographic extent, the effects are potentially catastrophic depending on the downstream population. A dam failure affecting Waterford is considered a possible event each year with potentially significant effects. No dam failures have impacted the town since the previous HMP.

5.4.2 Existing Capabilities

The Connecticut DEEP administers the Dam Safety Section and designates a classification to each state-registered dam based on its potential hazard. According to the "Connecticut Dams" data file that was published in 1996, there were 20 DEEP-registered dams within Waterford, of which eight were Class A, one was Class BB, two were Class B, and one was class C. As of September 2022, there is still one Class C, two Class B, and one Class BB, however there are now nine Class A dams, and one Class AA in Town. There is a total of 14 registered dams in Town. All dams registered in Waterford are listed in Table 5-4. This HMP section primarily discusses the possible effects of failure of both high potential hazard (Class C) dams and significant hazard (Class B) dams.

Table 5-4 Dams Registered with DEEP in the Town of Waterford

CT Dam#	Dam Name	Dam Class	Owner Type
15206	Jordan Brook Dam Douglass Lane	A	Private
15209	Southern Pond Dam	A	Private
15210	Lake Cuheca Dam	A	Private Corporation
15212	Pilgrim Road Pond Dam	A	Private
15213	Jordan Mill Pond Dam	A	Private Corporation
15214	Braman Road Pond Dam	A	Private
15216	Shawandasee Pond Dam	A	Private
15217	Banks Pond Dam	A	Private
15220	Morningside Farms Pond Dam	A	Private
15207	Lucky Pond Dam	AA	Private
15204	Brandagee Lake Dam	B	Municipal
15205	Miller Pond Dam	B	Private Corporation
15219	Duck Pond Dam	BB	Municipal
15201	Lake Konomoc Dam	C	Municipal

Dams in the region whose failure could impact Waterford are under the jurisdiction of the Connecticut DEEP. The dam safety statutes are codified in Section 22a-401 through 22a-411 inclusive of the Connecticut General Statutes. Sections 22a-409-1 and 22a-409-2 of the Regulations of Connecticut State Agencies have been enacted, which govern the registration, classification, and inspection of dams. Dams must be registered by the owner with the DEEP according to Connecticut Public Act 83-38.

Owners of high and significant hazard dams are required to maintain EAPs for such dams. EAPs are not on file for the three high and significant hazard dams listed in Table 5-4. Despite its hazard class, concerns about the overtopping of the Lake Konomoc Dam are minimal as water does not typically flow over the spillway. The Town requests that the owners of Millers Pond lower the level of the impoundment before rain events, and the owners reportedly comply.

Summary

In general, municipal capabilities to mitigate dam failure damage have not increased since the 2017 edition of the hazard mitigation plan was adopted. However, changes in the State's regulation of dams have increased Statewide capabilities.

5.4.3 Vulnerabilities and Risk Assessment

The potential impacts related to the failure of Class C and B dams within or upstream of Waterford are described below. Where information was available, the descriptions below are based on information available at the Connecticut DEEP Dam Safety files.

- Lake Konomoc Dam is a Class C dam located on Lakes Pond Brook at the southern end of the 363-acre impoundment. According to the 1979 USACE inspection, the dam is an earthfill structure with a concrete core, having a length of 540 feet and maximum height of 23 feet. The dam is abutted by an earthfill dike at each end. The Davis Pond Dike at the north end of the lake and the Great Swamp Dike at the northeast end of the lake form the lake closure. A double side channel "U" shaped spillway (reinforced concrete) is located at approximately the mid-point of the dam. It is used as a water storage facility for New London and has a surface of 299 acres at the spillway crest.

The dam is considered a high hazard because a breach could affect several homes, two local roads, two state highways and I-95. The most recent inspection was completed by the CT DEEP in May 2003. The inspection noted that the earthen dam embankments appeared to be in good condition. The Great Swamp Dike also appeared to be in good condition.

- Brandagee Lake Dam is a Class B dam located on Great Swamp Brook at the southern end of the impoundment. According to a 2004 Condition Assessment and Repair Recommendations by Karl F. Acimovic, P.E., the dam was originally constructed in the late 1800s as a water supply reservoir. The Phase I Inspection Report notes that the dam is a 450-foot long earth fill structure with a concrete core wall. The dam has a crest width of 12 feet, an upstream slope of 2:1 and a downstream slope of 1.5:1. The spillway is 28 feet long with a trapezoidal weir. The maximum height of the dam is 15 feet. The dam's impoundment capacity is 530 acre-feet at the top of the dam and is used for recreation.

The dam is classified as small in size but a significant hazard structure in accordance with recommended guidelines established by the USACE. An Inundation Map is on file which indicates the "Limit of Impact Area" from the Drainage Basin & Dam Failure Impact Area.

Recent inspections of the dam in July and September 2004 noted that it was in overall fair condition but lacking a long-term maintenance program. The dam is heavily vegetated both at the structure and adjacent to it. It is noted that failure to implement a program coupled with access to the public could cause major problems.

- Millers Pond Dam is a Class B dam located on Hunts Brook at the southeast end of the 73-acre impoundment, approximately one mile upstream of the discharge to Smith Cove on the Thames River. The dam was reportedly constructed around 1873 for supplying water to a factory located downstream of the dam. There are no records of alterations of the dam prior to 1983. According to the 1985 Phase II Inspection by Lenard Engineering, Inc., the dam is a masonry and earthfill gravity dam, likely placed on bedrock. The dam is 425 feet long with a dogleg-shaped earthfill section of approximately 335 feet in length, and masonry work on the upstream & downstream faces of the dam. The dam is composed of masonry and concrete walls with earth fill embankments and includes two spillway sections (one stone masonry with a low flow notch/channel and one concrete). The dam was modified in 1999 to provide the 140-foot long emergency spillway constructed with a standard riprap emergency spillway outlet channel near the left abutment. A new gate structure & gate were installed and a concrete wall was placed down to bedrock on a substantial portion of the upstream slope of the dam. The dam has a maximum height of 19.5 feet and a top elevation 3.5 feet above the crest of the spillway. The dam section is approximately 14 feet wide near the left end widening to a maximum of 40 feet near the center. The storage capacity of the pond is approximately 410 acre-feet at the spillway elevation.

A 2005 Inspection Report by Karl Acimovic, P.E. noted that the dam was in good condition and had been well maintained. There was small brush growth upstream of the secondary spillway as well as the toe areas and the right abutment area. There was some seepage reported and the riprap downstream of the embankment and stone masonry were in good condition. The primary spillway was in very good condition and the emergency spillway was in generally good condition overall.

The 1985 Phase II Inspection included an EOP, but it did not discuss impacts of dam breach or failure and did not include any mapping of inundation area(s). At least one abutting property owner has cited flooding during high rain events. The position of this property in the floodplain of Hunts Brook may be the cause of this flooding.

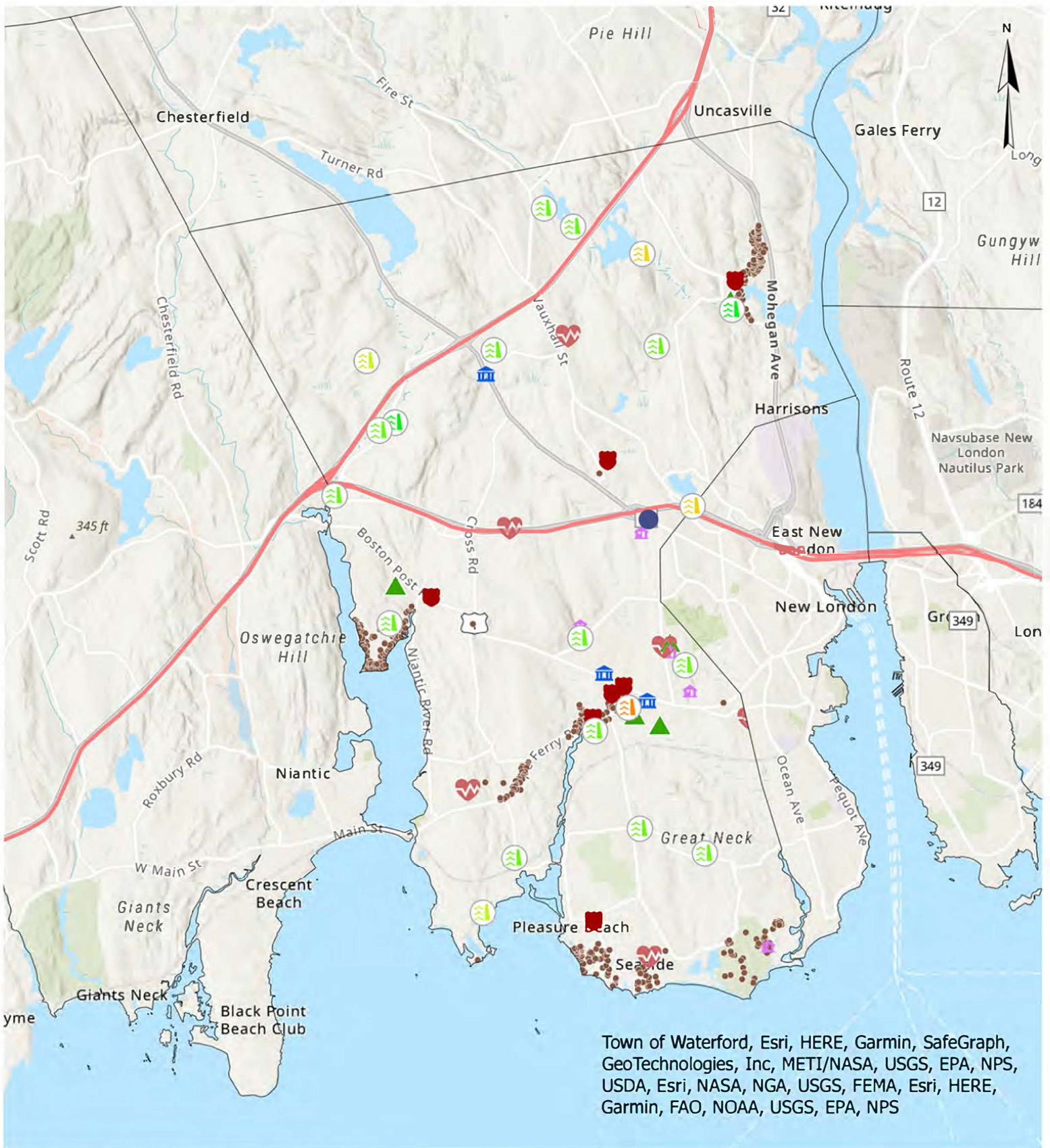
There is no EAP available for Millers Pond Dam.

In addition to the Class C and B dams in the town, officials note concern regarding a dam near Route 156 that may be owned by CT DOT. The town will evaluate conditions near this dam if it appears to become a developing hazard. The spillway of this dam was cleared just prior to the data collection meeting held with Waterford staff in 2016, indicating that the dam owner is performing regular maintenance.

The Town reports that the State recently performed a major outreach effort to notify dam owners about resources available. The Town maintains an inventory of minor dams and provides assistance on a case-by-case basis.

5.4.3.1 Hazard Losses

There are no reported losses for the Town of Waterford related to dam failure. Downscaled losses from the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi Jurisdiction document.



Town of Waterford, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, Esri, NASA, NGA, USGS, FEMA, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS

Dams and Dam Failure Inundation Areas

Southeastern Connecticut Council of Governments
 Town of Waterford
 Date: 2/23/2023

Legend

	Unknown/Unclassified		Senior Housing
	A		Emergency Services
	AA		Municipal
	B		Other Infrastructure and Facilities
	BB		Shelter or Cooling Center
	Historic Resources		Care and Medical Facility
			Dam Failure Inundation Area

6. Rising Temperatures

6.1. Climate Change Impacts

On average, the annual temperature across the U.S. has increased by 1.8 degrees Fahrenheit when looking at the entire period of record (1895-2016). Accelerated warming patterns between 1979 and 2016 have been observed with satellite and surface data, and paleoclimate records show that some of the recent decades have been the warmest in the past 1,500 years.³

In general, periods of freeze and frost have decreased, therefore lengthening the period of time between the first winter freeze and spring thaw, since the early 1900's. These warming temperatures impact snowfall and accumulation, alter seasonal patterns, and can disrupt certain natural processes. In addition, warming temperatures can act as fuel for other natural hazards such as wildfires, droughts, hurricanes and severe storms, and also play a role in changing precipitation patterns.

In addition to exacerbating some natural hazards, extreme heat waves are becoming more frequent, which can also have a serious impact on public health. In recent years, the region has experience numerous heat waves, with several consecutive days of extremely hot temperatures and high heat indexes. Infrastructure can also be at risk during heat waves as some components, such as roadways or bridges, have not been designed to withstand ongoing, extreme temperatures.

6.2. Extreme Heat

6.2.1 Setting and Recent Occurrences

An extreme heat event can occur at any time during the warmer months and can be defined as temperatures that hover 10 degrees or more above the average high temperature for the region. These events typically last for a prolonged period of time and are accompanied by high humidity. A heat wave typically lasts three or more days with temperatures over 90 degrees for those days.

Since 2012, 480 days over 85 degrees have been recorded at the Norwich Public Utilities weather stations, 165 of which were over 90 degrees. During the summer of 2022, 45 days over 85 degrees were recorded, 21 of which were at least 90 degrees. A majority of these high temperature days occurred in July and August, with some of these extreme temperatures occurring outside summer months in May and October. Table 6-1 presents the daily maximum temperatures recorded at the Groton New London Airport and Norwich Public Utilities weather stations. Those values that are bold are above 90 degrees.

Table 6-1 Daily Maximum Temperatures from May to September Since 2017

	May		June		July		August		September	
	GNL	NPU	GNL	NPU	GNL	NPU	GNL	NPU	GNL	NPU
2017	85	93	89	94	88	92	87	89	86	89
2018	80	91	87	90	89	101	91	94	90	92
2019	83	85	88	91	94	96	88	91	87	84
2020	75	81	82	91	92	96	89	92	87	87
2021	88	87	86	96	86	94	88	96	82	85
2022	93	92	85	92	91	96	91	94	94	85

GNL = Groton New London station & NPU = Norwich Public Utilities station

³ <https://nca201758.globalchange.gov/chapter/2/>

6.2.2 Existing Capabilities

Similar to the monitoring methods used for hurricanes, severe storms, and winter storms, the Town monitors National Weather Service and local forecasts for anticipated extreme heat event, and also monitors for NWS heat warnings and advisories. The Town of Waterford has identified the Community Center as a cooling center in town. Because there is a large elderly population in Waterford, many of whom live alone without in-home cooling, the town has the ability to coordinate with Senior Services to arrange shuttle rides for residents who are seeking access to cooling. In the event of a projected heat event or heat wave, the Town is prepared to open up the cooling centers for resident use.

Summary

In general, the capabilities of mitigating extreme heat have increased since the 2017 edition of this plan as the town has identified multiple cooling centers for use during an extreme heat event.

6.2.3 Vulnerabilities and Risk Assessment

While the entire town is at risk of an extreme heat event, vulnerability can widely vary based on age, health, or the type of property owned in Waterford. The elderly populations in town are more vulnerable to extreme heat events, particularly when in home cooling is not available. The community center, which is the cooling center, is also not centrally located, therefore making access potentially more challenging for some populations. Also, those in town with certain health conditions may also be more vulnerable to the health factors associated with extreme temperatures.

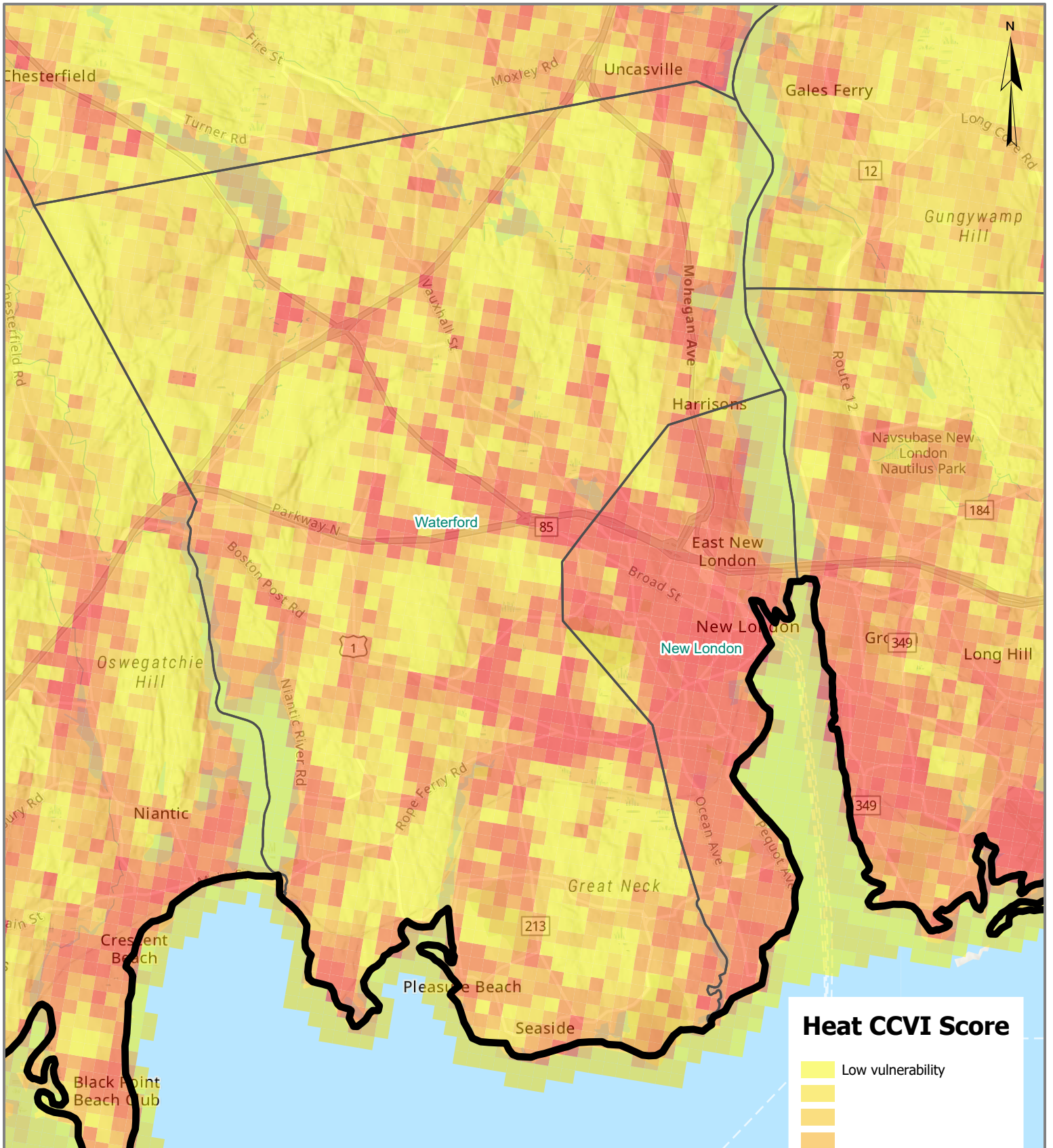
Similar to drought, the town is concerned about livestock operations during these heat events. These operations, particularly the larger chicken farms, rely on fans to cool their animals. If an extreme heat event coincided with a power outage, there could be a serious public health concern and economic impact to the farmers.

The UConn Connecticut Institute for Resilience and Climate Adaptation (CIRCA) has developed a tool to aid in understanding extreme heat vulnerability for communities across the state. This tool, known as the Climate Change Vulnerability Index (CCVI), is comprised of dozens of factors that contribute to a community's heat sensitivity, exposure, adaptive capacity, and ultimately their overall heat vulnerability. The CCVI has been used as an additional tool to characterize heat vulnerability for Waterford. The distribution of heat vulnerability throughout the community can be seen in Figure 6-1.

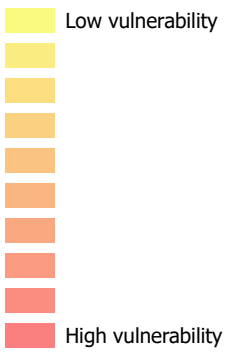
Heat exposure and sensitivity is low to moderate across most of Waterford, with a few notable exceptions including the Millstone power station, the Crystal Mall, and the areas along major transportation routes such as I-95, Rt 1, and Rt 85. The southern part of the town has access to coastal waters as well as the community center, resulting in strong adaptive capacity. Therefore, the overall heat vulnerability for Waterford is moderate.

6.2.3.1 Hazard Losses

There are no reported losses for the Town of Waterford related to extreme temperatures. Future editions of this plan will revisit this topic.



Heat CCVI Score



Heat CCVI Score

SCCOG Hazard Mitigation and Climate Adaptation Plan
 Town of Waterford
 12/9/2022



Town of Waterford, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS,

6.3. Wildfires

6.3.1 Setting and Recent Occurrences

Wildfires are considered to be highly destructive, uncontrollable fires. The most common causes of wildfires are arson, lightning strikes, and fires started from downed trees hitting electrical lines. Thus, wildfires have the potential to occur anywhere and at any time in both undeveloped and lightly developed areas of the town.

Stenger Farm Field park was the site of many fires more than 50 years ago. More recent wildfire incidents in the town include a suspicious fire off Douglas Lane near the power lines in 1985. Another fire in the 1980s occurred on town-owned land between Old Barry Road and Quinly Way. The fire lasted many days and was the largest wildfire in Waterford's history. It occurred during a moderate drought.

On May 9, 2021, a brush fire was reported on the side of the southbound side of Interstate 95. The right lane was closed to traffic during the event. The cause of the fire is unknown, however there were reports of arson.

6.3.2 Existing Capabilities

Some of the Waterford town parks have intentional fire breaks. An example is Stenger Farm Field, a town park off Clark Lane mentioned above. This unique method of mitigation is not common in Connecticut but has proven to be effective in many parts of the United States. The State of Connecticut owns 150 acres north of Harkness Park and they conduct controlled burns. This is another method of wildfire mitigation.

Monitoring of potential fire conditions is an important part of mitigation. The Connecticut DEEP Forestry Division uses the rainfall data recorded by the Automated Flood Warning system to compile forest fire probability forecasts. This allows the DEEP to monitor drier areas to be prepared for forest fire conditions. The Town can access this information over the internet. The Town also receives "Red Flag" warnings via local media outlets.

Additional mitigation for wildland fire control is typically focused on building codes, public education, Fire Department training, and maintaining an adequate supply of equipment. Fire protection water is obtained from the Town's public water system. Three new water towers have been constructed in the last five years, increasing firefighting capacity. Two booster stations have been retrofitted and rehabilitated, and new mid-pressure zone developed for the Quaker Hill area. The Water & Sewer Department tests fire flows regularly and informs the fire departments of the pressure available.

The town owns ATV fire response vehicles for access to fires in wooded areas where ATV trails are common.

The level of fire protection afforded by the existing public water service and other water sources in outlying areas is considered to be good for the development level of the Town. The Fire Department will continue to evaluate the level of risk and the need for additional public water system hydrants or other water sources in the future.

The Connecticut DEEP has recently changed its Open Burning Program. It now requires individuals to be nominated and designated by the Chief Executive Officer in each municipality that allows open burning and to take an online training course and exam to become certified as an "Open Burning Official."

Permit template forms were also revised to provide permit requirements so that the applicant/permittee is made aware of the requirements prior to, during, and after burn activity. The regulated activity is then overseen by the Town.

Summary

In general, municipal capabilities to mitigate wildfire damage have remained consistent since the 2017 edition of the hazard mitigation plan was adopted.

6.3.3 Vulnerabilities and Risk Assessment

The town has many wooded areas with ATV trails and therefore believes that it has a moderate risk for wildfires. The most vulnerable areas for wildfires are those described above including park land, State land, and the two regions that experienced large fires in the 1980s. The remaining areas of the town that are located nearby water sources are considered to be at lower risk for wildfires. Refer to Figure 3-6 in the Multi-Jurisdictional HMP for a general depiction of wildfire risk areas within Waterford.

6.3.3.1 Hazard Losses

There are no reported losses for the Town of Waterford related to wildfires. Downscaled losses from the 2019 Connecticut Natural Hazard Mitigation Plan using WUI acreage are developed in the Multi-Jurisdictional document.

7. Earthquakes

7.1. Climate Change Impacts

Earthquakes are not a climate related hazard, therefore there are no expected impacts as a result of climate change. There are however secondary impacts that could be a concern and amplify the damages of an earthquake. The deterioration of infrastructure from extreme heat or salt water as a result of coastal flooding or sea level rise may weaken certain components making them more prone to damage or collapse during an earthquake event. Flooding events can also leave some landscapes at a higher risk of landslides; an earthquake could potentially prompt a landslide in post-flooded areas.

7.2. Earthquakes

7.2.1 Setting and Recent Occurrences

An earthquake is a sudden rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Earthquakes can cause buildings and bridges to collapse; disrupt gas, electric, and telephone lines; and often cause landslides, flash floods, fires, avalanches, and tsunamis. Earthquakes can occur at any time and often without warning. Detailed descriptions of earthquakes, scales, and effects can be found in Section 3.3.5 of the Multi-Jurisdictional HMCAP. Despite the low probability of an earthquake occurrence, earthquake damage presents a potentially catastrophic hazard to the town. However, it is very unlikely that the town would be at the epicenter of such a damaging earthquake. No major earthquakes have affected the town since the last HMP.

7.2.2 Existing Capabilities

The Connecticut Building Codes include design criteria for buildings specific to each region as adopted by Building Officials and Code Administrators (BOCA). These include the seismic coefficients for building design in the Town of Waterford. The Town has adopted these codes for new construction, and they are enforced by the Building Official.

Due to the infrequent nature of damaging earthquakes, Town land use policies do not directly address earthquake hazards. However, the potential for an earthquake and emergency response procedures is addressed in the Town's EOP.

In general, municipal capabilities to mitigate earthquake damage have not increased since the 2012 edition of the hazard mitigation plan was adopted. This is because the hazard continues to pose a low risk of damage to the Town.

7.2.3 Vulnerabilities and Risk Assessment

Surficial earth materials behave differently in response to seismic activity. Unconsolidated materials such as sand and artificial fill can amplify the shaking associated with an earthquake. As noted in Section 2.1, a several areas of the town (particularly near watercourses) are underlain by stratified drift. These areas are potentially more at risk for earthquake damage than the areas of the town underlain by glacial till. The best mitigation for future development in areas of sandy material is the application of the most stringent standards in the Connecticut Building Code, exceeding the building code requirements, or, if the Town deems necessary, the possible prohibition of new construction. The areas

that are not at increased risk during an earthquake due to unstable soils are the areas underlain by glacial till.

Bedrock fault lines have not been mapped in the vicinity of Waterford. Unlike seismic activity in California, earthquakes in Connecticut are not associated with specific known active faults. However, bedrock in Connecticut and New England in general is typically formed from relatively hard metamorphic rock that is highly capable of transmitting seismic energy over great distances. For example, the relatively strong earthquake that occurred recently in Virginia was felt in Connecticut because the energy was transmitted over a great distance through such hard bedrock.

The built environment in the town primarily includes some more recent construction that is seismically designed. However, most buildings were built before the 1980's and therefore are not built to current building codes. Thus, it is believed that most buildings would be at least moderately damaged by a significant earthquake. Those residents who live or work in older, non-reinforced masonry buildings are at the highest risk for experiencing earthquake damage.

Areas of steep slopes can collapse during an earthquake, creating landslides. The town has numerous areas with steep slopes greater than 15% located throughout the town and these areas have already prevented significant development. While landslides are not a particular concern in the town, areas beneath steep slopes could be vulnerable to landslide damage during a major earthquake.

Seismic activity can also break utility lines such as water mains, gas mains, electric and telephone lines, and stormwater management systems. Damage to utility lines can lead to fires, especially in electric and gas mains. Dam failure can also pose a significant threat to developed areas during an earthquake. For this HMP, dam failure has been addressed separately in Section 5.4. As noted previously, most utility infrastructure in the town is located above ground. A quick and coordinated response with Connecticut Light & Power and other utilities will be necessary to inspect damaged utilities following an earthquake, to isolate damaged areas, and to bring backup systems online. This is covered in the EOPs for these entities.

7.2.4 Hazard Losses

There are no reported losses for the Town of Water related to earthquakes. Downscaled losses from the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi-Jurisdictional document. In addition, a HAZUS-MH analysis of the potential economic and societal impacts to the SCCOG region from earthquake damage is detailed in the Multi-Jurisdictional HMCAP. The analysis addresses a range of potential impacts from any earthquake scenario, estimated damage to buildings by building type, potential damage to utilities and infrastructure, predicted sheltering requirements, estimated casualties, and total estimated losses and direct economic impact that may result from various earthquake scenarios. Potential economic impacts can be seen in Table 7-1, with additional information developed in the Multi-Jurisdictional document.

Table 7-1 HAZUS-MH Earthquake Related Economic Impacts

Waterford	Residential	Commercial	Industrial	Others	Total
	\$249,240,000	\$481,060,000	\$55,160,000	\$189,060,000	974,520,000

8. Mitigation Strategies and Actions

8.1. Status of Mitigation Strategies and Actions

A total of 22 hazard mitigation actions were developed in the previous edition of this plan. The status of each is listed below.

#	Mitigation Actions and Strategies for Waterford 2016 - 2021	Status	Status Details
1	Acquire and install evacuation signs in coastal flood hazard areas	Carry Forward	Evacuation signs have not been added. The population in Waterford is relatively senior, so signs might still be useful. This action can remain but should be made more specific.
2	Continue to make evacuation routes in the Gardiners Wood Road area more resilient through elevation, culvert upgrades, etc.	Carry Forward with Revisions	The town does not own the land underneath the road but has an easement. The road will be resurfaced, will be able to be raised about 6-8 inches in the process. Pipes will be placed under the road at a low point, and the road will be elevated about one foot in this location. The full design is complete, but the funding is not yet there – estimate \$4 million. The low point of the railroad bridge is a concern too. This is still a high priority; a neighborhood is cut off when this road floods. This might fit well with <i>Resilient Connecticut</i> . Revise to indicate the progress and make the action geared toward remaining tasks.
3	Consider installing an emergency egress between Laurel Crest Drive and Miner Lane.	Remove	No progress. Not a priority, due to the very low residential population along this road.
4	In lieu of installing an emergency egress between Laurel Crest Drive and Miner Lane, determine other options for emergency evacuation and egress from southern Miner Lane.	Remove	No progress. Not a priority, due to the very low residential population along this road.
5	Ensure relevant personnel know where the EOP is kept and are able to access it.	Complete	Document is available in several locations.
6	Consider potential need for a gradual phasing in of new policies related to SLR	Carry Forward	Funding to implement floodproofing in private homes has been a challenge, and the substantial improvement lookback was recently changed downward to two years which will not drive flood mitigation. A 2-ft freeboard has not been put into place. The Town would like an aspirational statement for this action.
7	Incorporate the results of the Coastal Resilience project into the next HMP update	Carry Forward with Revisions	This current HMP update will help make progress with this action. However, Town attendees explained that board and commission support is reportedly not strong for incorporating many recommendations from the coastal resilience planning effort. The Planning Commission is concerned that some of the strategies in the plan will make it harder for property owners to maintain their properties. The revision to this action could rephrase this

			action to “evaluate” coastal resiliency recommendations or include actions that are achievable. A recommendation that may come from the POCD is to include this responsibility under another board or commission.
8	Pursue enrollment in the Community Rating System	Remove	Remove - The town decided not to pursue this due to lack of capacity relative to minimal community benefits.
9	Ensure that sewer pumping stations have a method for connecting emergency power and are adequately floodproofed	Carry Forward with Revisions	The responsible department for this action is Utilities, not Public Works. The challenge is that the sewer pumping stations are located in low points. Some of the facilities have been floodproofed, and some of the electric systems inside have been elevated. There is more work to do. The Mago and Bolles facilities are reportedly the next on the list; check the SCCOG wastewater management plan and the Wright-Pierce resilience study for details.
10	Include structures within the 1% annual chance floodplain and storm surge areas within the Reverse 9-1-1 contact database	Complete	The town now uses Everbridge. Every listed landline (business and private) is in the system, and the town makes it clear on social media how people can sign up other devices.
11	Pursue the acquisition and demolition of floodprone properties with conversion to open space, prioritizing repetitive loss properties	Carry Forward with Revisions	The town typically does not acquire RL properties. There are no future specific acquisitions in mind, but if there was another future storm event that resulted in the town wanting to acquire a property then the town would want the option. Revise the action to focus on acquiring damaged properties.
12	Upgrade stormwater collection and discharge systems to keep up with rising sea level	Carry Forward with Revisions	The Ridgewood system along Alewife Cove is a concern but upgrades probably will not occur in the near future. The town does not want to lose sight of this goal.
13	Replace culverts along Gardiners Wood Road and elevate sections of the road	Remove	This is a variation of the previous Gardiner Wood action (#2).
14	Replace culvert and/or elevate a section of Braman Road	Carry Forward with Revisions	This was resurfaced (added a few inches) and the pipe was cleaned although not replaced and additional improvements are still desired/necessary. The Great Neck area can be cut off if this road floods.
15	Replace culverts and/or elevate sections of Niles Hill Road at Fenger Brook	Carry Forward	No progress.
16	Raise and improve hydraulics of the secondary access to Millstone Station	Carry Forward with Revisions	Revise to be more achievable - This issue was also identified in the coastal resiliency plan. There has been talk about restoring the pond that the culvert serves and restoring some tidal flow. DEEP has been interested in possibly constructing a fishway. The main obstacle here is the private (and unclear) ownership of the road, which is further complicated by Dominion’s involvement.

17	Send out an annual flood-hazard mailer to homeowners.	Carry Forward with Revisions	Mailers have not been sent out. The town suggests incorporating an <i>online option for all</i> town residents and then a <i>targeted</i> mailing for residents in 500 year+ flood zones. It would be helpful to put out a notice before hurricane season. Keep this action but revise to be more specific. FEMA has brochures that towns can use.
18	Determine if any at-risk structures that are not yet eligible for historic designation will be eligible in the future. This may take the form of a historic resources survey.	Carry Forward with Revisions	No progress. There are a number of historic structures identified by SHPO in Waterford. One new historic district (Oil Mill) was designated a few months ago. Individual new historic structures have not been designated. The Town has concerns about wind loading at O’Neill Theatre.
19	Consider drafting a written plan for inspecting and prioritizing the removal of snow from Town-owned structures	Complete	Complete and capability.
20	Prioritize snow removal from municipal buildings.	Complete	Complete and capability.
21	Include dam failure inundation areas in the Reverse 9-1-1 contact database	Complete	Complete - If the Miller Pond dam failed, many houses would be underwater. This area can be identified in the Everbridge system for targeted communications by delineating a polygon for the notification area. The dam EAP and Town LEOP are currently being administered with these targeted procedures.
22	Work with CT DEEP to ensure that the owners of high hazard dams have current EOPs and keep local copies	Complete	Complete. EAPs are on file.

During the planning process, CIRCA and consultant staff facilitated a discussion with the Town staff to identify the greatest climate change concerns and challenges. The previous actions were re-evaluated in this context. Elements of 12 prior actions have been carried forward into the new hazard mitigation and climate adaptation actions.

8.2. Prioritization of Specific Actions

The proposed actions for the Town of Waterford to undertake from 2023 through 2028 are listed in Table 8-1 on the next page. The full list of actions for the region with buildups for the PERSISTS and STAPLEE scores are available in the multi-jurisdiction document.

The actions with the highest PERSISTS score and the highest STAPLEE score are different, which is consistent with the intent of the two scores. PERSISTS scores tend to be higher for actions that maximize public safety while advancing climate science and being transferable to other communities, whereas STAPLEE scores tend to be higher for actions that are highly cost effective and technically feasible for reducing losses from hazards. The actions with the highest combined scores are:

- o Establish a process for the phasing-in of new policies related to sea level rise (freeboard, infrastructure retrofits, road elevations, etc.). The process could include incorporation of additional goal statements into the POCD (2023) and capital improvement plans.

The Town intends to focus on the above actions, along with the sole action about cooling centers:

- Ensure that the cooling center (Community Center) has appropriate standby power to operate AC and is accessible using transit or alternate transportation options.
- Identify at least one secondary cooling center in a more accessible, centrally located position; ensure that it has appropriate standby power to operate AC and is accessible using transit or alternate transportation options.

This is consistent with the State’s emphasis on cooling center resilience.

Table 8-1 Town of Waterford Actions and STAPLEE and PERSISTS Scores

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERSISTS Score	STAPLEE Score	PERSISTS x STAPLEE =
WF1	Ensure that the cooling center (Community Center) has appropriate standby power to operate AC and is accessible using transit or alternate transportation options.	Ensure that critical facilities are resilient, with special attention to shelters and cooling centers.	Preparedness & Emergency Response	Office of the Chief Elected Official	\$100,000 - \$500,000	FEMA HMA; Other preparedness grants; STEAP	7/2023 - 6/2025	High	16	6	96
WF2	Identify at least one secondary cooling center in a more accessible, centrally located position; ensure that it has appropriate standby power to operate AC and is accessible using transit or alternate transportation options.	Ensure that critical facilities are resilient, with special attention to shelters and cooling centers.	Preparedness & Emergency Response	Office of the Chief Elected Official	\$100,000 - \$500,000	FEMA HMA; Other preparedness grants; STEAP	7/2023 - 6/2025	High	16	6	96
WF3	Maintain at least one school as a backup local shelter for situations when the regional shelter in East Lyme cannot be accessed.	Ensure that critical facilities are resilient, with special attention to shelters and cooling centers.	Preparedness & Emergency Response	Office of the Chief Elected Official	\$100,000 - \$500,000	FEMA HMA; Other preparedness grants; STEAP	7/2023 - 6/2025	Medium	16	6	96
WF4	Ensure that goals and objectives related to resilience are consistently structured between the Climate Change Risk Assessment and Adaptation Study (2017), the POCD (2023), and this HMCAP.	More than one goal	More than one category	Planning	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 6/2024	High	15	5	75
WF5	Establish a process for the phasing-in of new policies related to sea level rise (freeboard, infrastructure retrofits, road elevations, etc.). The process could include incorporation of additional goal statements into the POCD (2023) and capital improvement plans.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Prevention	Planning	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 6/2024	High	17	10	170

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERSISTS Score	STAPLEE Score	PERSISTS x STAPLEE =
WF6	Implement and construct roadway resilience design along Gardiners Wood Road including road elevation, resurfacing, and culvert/pipe installations to mitigate flood risks along this single egress route.	Invest in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.	Structural Projects	Public Works	>\$1M	LOTICIP; STEAP; DEEP Climate Resilience Fund	7/2023 - 6/2024	Medium	19	6	114
WF7	Acquire and install evacuation signs in coastal flood hazard areas.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Preparedness & Emergency Response	Emergency Management	\$10,000 - \$25,000	Municipal CIP Budget	7/2023 - 6/2025	Medium	13	7	91
WF8	Ensure that sewer pumping stations have a method for connecting emergency power and are adequately floodproofed with specific focus on those particularly vulnerable, such as Mago and Bolles, as identified in the SCCOG Wastewater Management Plan and the Coastal Resilience Plan.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Water & Wastewater Utility Projects	Water & Sewer	\$100,000 - \$500,000	CWSRF; FEMA HMA	7/2024 - 6/2027	High	17	8	136
WF9	Pursue the acquisition and demolition of flood damaged properties with conversion to open space, prioritizing repetitive loss properties that have been severely damaged.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Natural Resources Protection	Floodplain Manager	>\$1M	FEMA HMA	7/2023 - 6/2028	Medium	15	6	90
WF10	Upgrade stormwater collection and discharge systems to keep up with rising sea level, with particular focus on areas of concern including the Ridgewood system in Alewife Cove.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Structural Projects	Public Works	\$500,000 - \$1M	Municipal CIP Budget; Stormwater Utility Fees (if implemented)	7/2024 - 6/2027	Medium	18	6	108

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERSISTS Score	STAPLEE Score	PERSISTS x STAPLEE =
WF11	Identify needs and funding sources for roadway and infrastructural improvements needed to reduce isolation risk in certain areas including Quaker Hill, West Neck, Great Neck, and Gardiners Wood. This action should result in a written report or statement prior to the update of this HMCAP in 2027-2028.	Invest in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.	Structural Projects	Public Works	\$10,000 - \$25,000	LOTICIP; STEAP; DEEP Climate Resilience Fund	7/2024 - 6/2027	Medium	19	7	133
WF12	Increase capacity and implement additional improvements along Braman Road to reduce the risk of the road being cut off by flooding and eliminating egress for the Great Neck area.	Invest in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.	Structural Projects	Public Works	\$500,000 - \$1M	LOTICIP; STEAP; DEEP Climate Resilience Fund	7/2024 - 6/2026	Medium	15	5	75
WF13	Replace culverts and/or elevate sections of Niles Hill Road at Fenger Brook.	Invest in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.	Structural Projects	Public Works	\$500,000 - \$1M	LOTICIP; STEAP; DEEP Climate Resilience Fund	7/2024 - 6/2026	Medium	15	6	90
WF14	Partner with CT DEEP and Dominion to identify a solution to improve secondary access to Millstone Station with possible solutions including pond restoration to improve tidal flow, construction of a fishway, and road elevation.	Invest in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.	Structural Projects	Office of the Chief Elected Official	\$25,000 - \$50,000	Dominion Funds; NOAA/NFWF; LISFF	7/2025 - 6/2028	Medium	19	4	76
WF15	Partner with CIRCA and CT DEEP to identify solutions for areas experiencing high erosion rates along the shore and Niantic River.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases	Structural Projects	Office of the Chief Elected Official	\$25,000 - \$50,000	CIRCA Resources	7/2025 - 6/2028	Medium	18	5	90

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERSISTS Score	STAPLEE Score	PERSISTS x STAPLEE =
		frequency and severity of floods.									
WF16	Send out flood and storm related information to all town residents via email/electronically, and a similar message via mail to residents in flood zones, including the 0.2% annual chance flood hazard area. An annual frequency is ideal.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Education & Awareness	Emergency Management	\$0 - \$10,000	Municipal Operating Budget	1/2024 and annually during this month	Medium	14	5	70
WF17	Develop locally-adopted recommendations resulting from the stormwater authority and utility feasibility study conducted by CDM Smith for SCCOG in 2022 using CIRCA's municipal resilience grant.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	More than one category	Office of the Chief Elected Official	\$0 - \$10,000	SCCOG Special Projects; DEEP Climate Resilience Fund; CIRCA Resilient Connecticut	7/2023 - 6/2025	High	18	8	144
WF18	Determine if any structures at risk (to flooding and severe storms) that are not yet eligible for historic designation will be eligible in the future. This may take the form of a historic resources survey.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Property Protection	Planning	\$10,000 - \$25,000	SHPO	7/2024 - 6/2026	Low	15	5	75
WF19	Work with CT DEEP to update the list of repetitive loss properties and ensure that errors and updates are incorporated by FEMA.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Property Protection	Floodplain Manager	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 12/2023	High	12	6	72
WF20	Conduct direct outreach to property owners in repetitive loss areas with information about how to mitigation flood losses.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Property Protection	Floodplain Manager	\$0 - \$10,000	Municipal Operating Budget	1/2024 and annually during this month	High	13	4	52

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERSISTS Score	STAPLEE Score	PERSISTS x STAPLEE =
WF21	Require floodplain manager and land use staff to take free training at https://portal.ct.gov/DEEP/P2/Chemical-Management-and-Climate-Resilience/Chemical-Management-and-Climate-Resilience to reduce risks of spills from businesses during floods.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Education & Awareness	Planning	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 12/2023	Low	14	6	84