



Maritime Business Resilience Toolkit

CITY OF NEW BEDFORD & TOWN OF FAIRHAVEN

A guide for the businesses of the New Bedford Harbor to build
resilience in the face of sea level rise and other climate hazards

JUNE 2020



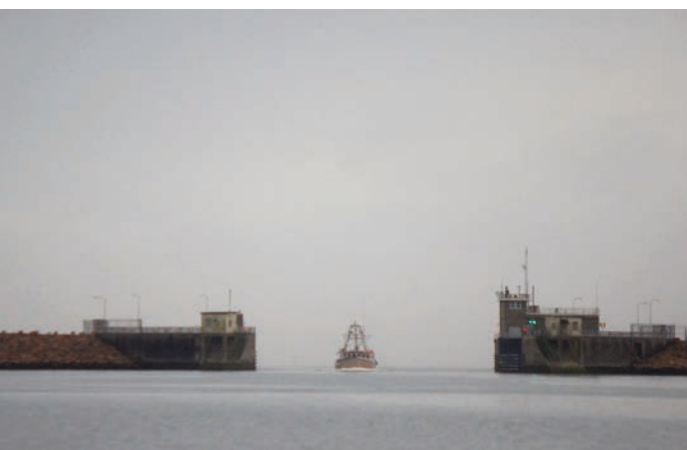
The background of the document is a photograph of a port scene. In the foreground, the red hull of a fishing boat is visible, featuring a yellow circle with a 'V' logo. In the background, several tall blue cranes are positioned along the pier, and other boats are docked. The water is calm, reflecting the sky and the structures of the port.

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Impacts of Climate Change on the Port of New Bedford

Climate change is bringing more intense storms, rising seas, and extreme heat to Massachusetts. Individuals, businesses, and municipalities are being forced to take steps to adapt to these changes in order to protect their operations or quality of life. Businesses will be uniquely affected by climate change as their bottom line depends on their ability to maintain their operations in a changing climate. For more information on the importance of the Port to the area and the projected climate hazards, skip to the [Port of New Bedford](#) and the [Climate Change and the Port](#) sections.



The Port of New Bedford is fortunate to be equipped with a hurricane barrier designed to protect it from large storms. The barrier stretches 150 feet across the water from the north end of the Clark's Point peninsula in New Bedford to the south end of Fairhaven and is operated and maintained by the United States Army Corps of Engineers (USACE). The barrier's construction was completed in 1966.

While the hurricane barrier helps make the New Bedford Harbor one of the safest on the east coast, it cannot entirely eliminate the impacts of sea level rise and storm surge.

Some residents and business owners located around the port are already noticing the impacts of sea level rise:

"In the last couple of years more and more storms are pushing water up over the sea wall."

"The time the dike was broken, our property was flooded."

"[Flooding] has killed approximately 8 feet of our 200-foot lawn."

"There was flooding with natural high tides when the barrier was under maintenance several years ago."

With extreme weather and sea levels on the rise in New Bedford and Fairhaven, there may be costly risks to businesses:

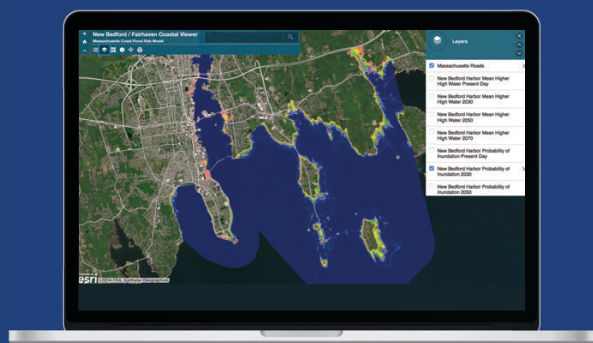
- Power outages and supply shortages;
- Inconsistencies in supply chain and procurement;
- Flooding of mechanical components and supply materials;
- Interruptions and closures of business operations; and higher costs for insurance, maintenance, and repairs.

Assessment of Risk and Vulnerability

This toolkit seeks to enhance the resilience of businesses to the threats of sea level rise, extreme storms, and storm surge. In order to fortify your business against the hazards posed by these conditions, it is essential to understand the risks and your business's associated vulnerabilities.

Massachusetts Coast Risk Model (MC-FRM)

Traditional Flood maps are backwards looking (e.g., FEMA FIRMs), meaning they are based on historic trends and do not take into account sea level rise predictions. Many maps that do take into consideration sea level rise tend to use a “bathtub” approach that does not reflect the dynamic nature of coastal flooding that occurs during storm events. Recognizing the limitations of traditional flood risk models, the Woods Hole Group—in collaboration with MassDOT and UMASS Boston—created the Massachusetts Coast Flood Risk Model (MC-FRM) which models the physics-based flow of water during coastal storms. It is a dynamic, probabilistic sea level and storm surge model that takes into account tropical and extra-tropical storms, sea level rise, landscape, elevations, and a changing climate. MC-FRM can predict flood probabilities, flood duration, inundation depths, winds, waves, flood pathways, flood volumes, and currents. It also provides accurate site-specific information, creating the ability to offer individualized project recommendations.



Access the MC-FRM data through the

[**New Bedford/Fairhaven Coastal Viewer**](#)

This interactive tool, provided by Woods Hole Group, allows you to explore the mean higher high water tidal benchmark, probability of inundation, and the 1% depth of inundation for present day, 2030, 2050, and 2070.

Using the Toolkit

This toolkit—developed as a component of a larger project to build the long-term resilience of the Port of New Bedford—is a resource for businesses in New Bedford and Fairhaven to bolster their own resilience to sea level rise and other climate changes.



The strategies in the toolkit are divided into short-term and long-term solutions. If you are looking for ways to streamline disaster recovery, improve emergency communications, or find immediate solutions to protect critical assets, check out the short-term solution checklist. If you are ready for a more major renovation or protective measure, consider the long-term guidance pulled from the Port of New Bedford's Resilient Design Guidelines.

Also included in the toolkit is an overview of the importance of the Port, localized climate projections, examples of local facilities' resiliency measures, and resources for frontline workers.

Long Term Solutions: Infrastructure Resilience

Another output of the effort to bolster the resilience of the Port of New Bedford is a set of Resilient Design Guidelines, which are specific to the projections and conditions of the Port. The guidelines are not part of the official building code, but instead serve as a resource for city and town planners, developers, businesses, and residence that are looking to take additional measures to protect their infrastructure from sea level rise. The guidelines provide detailed guidance on determining a safe base elevation, choosing a site to build, protecting that site from flooding, and protecting critical support infrastructure.

The following strategies are pulled from the Resilient Design Guidelines and have been identified as strategies that are particularly relevant for businesses seeking to protect existing infrastructure as they offer protection to structures or enable their recovery in the case of exposure to hazards. If you need more detail or are considering building a new structure, please consult the Resilient Design Guidelines.

Long Term Solutions: Infrastructure Resilience

Dry Floodproofing

Dry floodproofing makes a structure watertight to floods of a certain duration and depth. It reduces the potential for flood damage by reducing the chance of interior inundation. Dry floodproofing is most appropriate when relocating or elevating the structure is not cost-effective or technically feasible.¹ Consider the following strategies to dry floodproof your building.

- **Seal openings**

- Use flood-resistant doors
- Install watertight shields
- Permanently seal windows and other openings below the Design Flood Elevation
- Use aquarium glass or other specialized glazed storefront systems

- **Prevent water infiltration**

- Use of deployable (e.g., stop logs, flood doors/gates, inflatable barriers) or permanent floodwalls or a berm on the exterior of building or around the site's perimeter to prevent water infiltration
- Use waterproof membranes, permanent sealants or coatings to reduce seepage through walls, slabs and foundations

- **Seal electrical conduits and other utilities**

- **Reinforce structure**

- Reinforce walls to resist hydrodynamic loads caused by flooding
- Install pressure relief valves in floor system to avoid damage due to buoyancy forces

- **Install backup systems**

- Install pumps to prevent build-up of incidental leakage
- Install early warning devices to monitor water levels in dry floodproofed spaces
- Install devices to prevent surge intrusion through storm or sanitary sewers



Image credit: Sustainable Buildings Initiative

¹ "Dry Floodproofing Measures." FEMA. Retrieved from: https://www.fema.gov/media-library-data/06dabddadc3887f91906172d863749ab/P-936_sec3_508.pdf

Long Term Solutions: Infrastructure Resilience

Wet Floodproofing

Wet floodproofing provides resistance to flood damage while allowing floodwaters to enter the structure. These strategies are most appropriate for enclosures found under a building, such as a limited-use basement or parking structure.²

- **Use flood damage-resistant materials**

- Choose materials that are resistant to saltwater intrusion and corrosion

- **Prepare for flooding**

- Ensure only non-critical and non-vulnerable components are located below the DFE
- Install flood openings to equalize the hydrostatic pressure exerted by floodwaters to prevent structural damage to walls and floors
- Secure components and equipment (i.e., fuel tanks) to avoid buoyant movement during flooding
- Install pumps to gradually remove floodwater from basements and non-draining areas

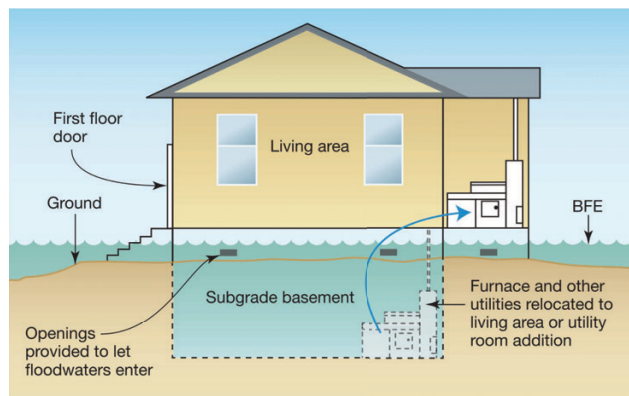


Image credit: Sustainable Buildings Initiative

Elevate Fueling and Mechanical Equipment

Regardless of whether you are going to dry or wet floodproof your building, a critical step in preparing a building for flooding is to elevate essential mechanical equipment. Take stock of essential equipment located below the Design Flood Elevation and consider relocating to a higher floor or elevating in place (i.e., placing on a concrete slab or water-resistant stand). Some equipment can be protected by dry floodproofing using flood barriers, but sump pumps are required to eliminate risk of seeping water damaging equipment. See FEMA's advice for [protecting building fuel systems from flood damage](https://www.fema.gov/protecting-building-fuel-systems-from-flood-damage).

Wind and Storm Resistance

In addition to sea level rise, climate change is bringing an increase in the frequency and intensity of storms. Consider incorporating the following materials and landscaping strategies to reduce the chance of storm damage to your building from wind, rain, or hail.

- Use high wind rated roofs and windows
- Use laminated glass or polycarbonate glazing systems to protect windows from windborne debris
- Use salt-resistant plantings to increase plant survival and decrease flood risk

² "Wet Floodproofing." FEMA. <https://www.fema.gov/wet-floodproofing>.

Long Term Solutions: Infrastructure Resilience

Flood Damage-Resistant Materials

Especially if a building has areas of regular flooding, choosing materials that are resistant to damage will increase the resilience of the building. Consult FEMA's [Coastal Building Materials](#) for recommended flood damage-resistant materials.

Outward Swinging Doors

Constructing or introducing outward swinging doors can provide additional protection in the case of a storm event. Materials used for weather stripping are generally located on the interior side of outward swinging doors, minimizing exposure to the elements. Furthermore, products are available to enhance the performance of outward-swinging doors that may not be available for inward-swinging doors.³

Vestibules

Vestibules can also offer added protection for entrances to buildings, providing a buffer from flooding. For example, vestibules could be designed to accommodate or capture water with water-resistant materials and drainage.⁴



Redundant Energy Systems

In case a building's power system is compromised from a flooding or extreme storm event, having a backup system can help avoid disruption to operations.

- Install a backup generator
- Configure electrical, mechanical, and telecommunication systems for easy isolation of system components below the Design Flood Elevation to facilitate repairs and to minimize disruption due to flood damage
- Install redundant electrical, mechanical, and telecommunication systems if primary systems may need to be temporarily shut down

³ FEMA. 2013. "Windows, Doors, and Opening Protection." <https://www.fema.gov/media-library-data/20130726-1707-25045-9020/chapter10.pdf>.

⁴ Ibid.

Short Term Solutions: Resilient Business Operations

Following the Resilient Design Guidelines will help ensure your business’s infrastructure is protected for decades to come, but much more goes into the success of your business than just infrastructure. The following checklist—originally developed as part of the *NB Resilient* planning process—will help you prepare your business operations for the impacts of climate change. With a proactive approach to protecting both your infrastructure and operations, your business will be more resilient to whatever shocks or stressors may come your way.

When creating communication materials based on this checklist, always consider your audience and find ways to make the materials accessible to everyone who needs or could benefit from the information.



Translate emergency response plans and other essential communications into multiple languages for non-English speakers



Hire a translator for essential trainings



Find ways to spread information that doesn’t require internet access




Make other accommodations for those with a hearing or visual impairment or any other disability.

Create Response and Recovery Plans

When an emergency strikes it is important to have a plan for how you and your employees should respond, and how to recover once the dust settles.

- ❑ Develop an [Emergency Response Plan](#)
- ❑ Create a [Disaster Recovery Plan](#)

Ready Business.

Emergency Response Plan

Company Name	
Address	
Telephone	
Contact Name	Title
Last Revision Date	

Figure 3. Introduction to an Emergency Response Plan

Short Term Solutions: Resilient Business Operations

Understand Your Flooding Risk

Do you know what your flood risk is? It's important to know how a flood might affect your business operations, supplies and equipment so you can plan accordingly to limit the impacts to your company.



- Check out this [interactive flood map](#) of New Bedford from Buzzards Bay National Estuary Program.
- Use this [toolkit](#) (also available in [Spanish](#)) to assess how flooding might affect your site, equipment, inventory, and operations. The toolkit is for inland flooding, but the recommendations are applicable to coastal flooding as well.

Figure 4. Interactive flood map from the Buzzards Bay National Estuary Program.

Prepare your Staff

Supporting employees is one of the most important parts of emergency planning. Keep them safe by educating them on their role during an emergency so everyone is prepared.

- Prepare and maintain an [Emergency Kit](#)
- [Train employees](#) on disaster preparedness including their roles and responsibilities

An emergency kit for businesses should include the following:

- Bottled water
- Non-perishable food
- Sanitation and hygiene supplies
- First aid kit
- Personal protection gear (e.g. gloves, masks, safety glasses)
- Emergency supplies (e.g. flashlights, batteries, whistle)
- Basic tools (e.g. swiss army knife, wrench, pliers, duct tape)
- Essential company documents
- Emergency contact lists

Short Term Solutions: Resilient Business Operations

Examine Information Technology

Minimize your losses during a storm by looking at your information systems and vital records. Are they protected? Can you recover them after an outage or disruption?

- ☐ [Prepare for a power outage](#)
- ☐ Protect data and vital records

\$80 Billion Annually

The cost of power outages and power quality disturbances to the U.S.

What does an outage cost you per hour?

$$\text{number of employees} \times \text{hourly wage} = \text{Outage Cost}$$

Assess Your Assets and Equipment

Once you understand your flood risks, create an inventory of your assets and move them to a safe place onsite to ensure your inventory and critical equipment is protected and away from potential water damage. Prepare a maintenance plan that keeps equipment in tip top shape, so it doesn't fail in an emergency.

- ☐ Create a [preventative maintenance plan](#) for the following:



Lighting



Exterior building components



Safety equipment



Interior building components



HVAC systems



Plumbing system

Short Term Solutions: Resilient Business Operations

Evaluate Material Storage Vulnerability

The Massachusetts Office of Technical Assistance provides free, confidential, onsite technical assistance to Massachusetts manufacturers, businesses, and institutions.

- ☐ [Request a no-risk evaluation of material storage and handling](#)
-

Know Your Utilities

Make a list of contact numbers for your utilities and reach out to them so they know how to contact you. Some of the important utilities In New Bedford and Fairhaven include:



- ☐ Electricity

EVERSOURCE

800-340-9822



- ☐ Cable

xfinity

800-266-2278



- ☐ Water/Sewer



508-979-1550



508-979-4030

Understand Your Insurance

Does your insurance policy include business interruption coverage and flood damage? Investigate your coverage and learn how to submit a claim so the recovery process is streamlined.

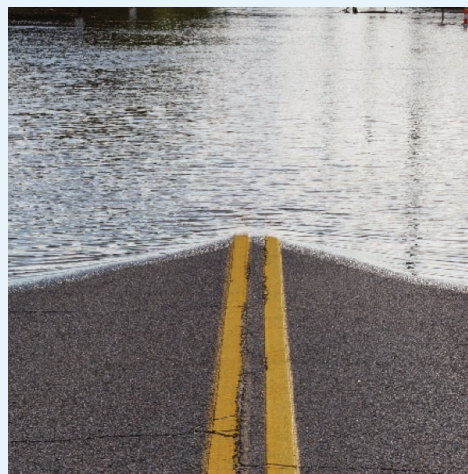
- ☐ [Assess your potential risk to natural disasters to access the correct coverage](#)
- ☐ [Know how to submit an insurance claim after an emergency](#)

Short Term Solutions: Resilient Business Operations

Develop a Business Continuity Plan

Business continuity refers to the processes and procedures that must be implemented to ensure that mission-critical functions can continue during and after a disaster. This is in addition to an emergency response and recovery plan, as it is more proactive.

- ❑ Understand the Business Continuity Planning process with FEMA's [free training](#), [Continuity Resource Toolkit](#), or [Continuity certificate program](#)
- ❑ Create a [Continuity and Recovery Plan](#)



Key components of a Continuity and Recovery Plan:

- ❑ Record basic information about your business
- ❑ Identify a continuity and recovery planning team
- ❑ Identify potential hazards
- ❑ List critical assets
- ❑ List critical operations
- ❑ Identify key suppliers and contractors
- ❑ Create a computer inventory
- ❑ Record information technology security information
- ❑ Identify a temporary/alternate business location
- ❑ Establish a staff notification system
- ❑ Record key contact information
- ❑ Create a continuity of management plan
- ❑ Record insurance information

Keep Communications Lines Open

In any situation, but particularly in an emergency, it is important to employ multiple communication methods to keep your customers in the know. Consider all the ways your customers communicate, including email and social media. Also, how can you communicate more widely? For example, a business association can send emails to a large group that can alert customers about their business members.



- ❑ Become a member of a [business association](#) for networking and recovery assistance
- ❑ Create a [Crisis Communication Plan](#)

The Port of New Bedford



To fully understand the need to take action against sea level rise, it is important to understand the importance of the Port itself. Positioned on the northwestern corner of Buzzard's Bay and flanked by the City of New Bedford and the Town of Fairhaven, the Port of New Bedford has been the top-valued fishing port in America for 19 years straight. More than 6,800 people are directly employed by New Bedford's commercial port industries, generating economic activity in excess of \$11 billion annually. Its importance reaches far beyond its immediate surroundings—the Port is the center of the commercial fishing industry on the east coast.

The port defines the resilient, hard-working identity of the surrounding communities. A diverse population makes up the workforce and keeps its daily operations running. From commercial fishing and fish processing and packing to cargo transport and offshore wind development, the port supports a unique blend of industrial, commercial, and recreational activities that contribute to the vibrant culture of New Bedford and Fairhaven.



Because the Port serves such a vital role in the economy and culture of the area, it is essential to plan for its continued ability to adapt and thrive. As climate change brings an increasing threat of sea level rise and intense storms, the City of New Bedford and the Town of Fairhaven have come together to develop an action and adaptation strategy for the Port. Using the state-of-the-art modeling and input from experts and information from frontline workers, the team created a set of design guidelines for future development.

Effective adaptation requires collaboration not only from developers, but also from businesses. This toolkit provides strategies and resources to help you better prepare your business for the impacts of sea level rise and storm surge. Together we can pave the way to a more resilient future for the Port of New Bedford.

Climate Change & The Port

The climate in Massachusetts and New Bedford is already changing. Burning fossil fuels to power our homes and vehicles and keep our economy running emits greenhouse gases. We have increased greenhouse gases in our atmosphere to a level that has led to disruptions to the Earth's climate. As a result, we are experiencing hotter days, more extreme storms, and rising seas bringing high tides further inland. These impacts are only projected to intensify in the future.

Of particular importance to the Port of New Bedford are the effects of sea level rise and storm surge on the resilience of infrastructure and business operations.

Sea Level Rise

Resilient MA—a State resource that compiles the latest climate data—has modeled sea level rise under four emission scenarios.



While the extent and rate of sea level rise depends on reducing greenhouse gas, The State recommends planning for sea level rise under a **high emission** scenario under which we would experience the following increases in sea level from a 2010 baseline:

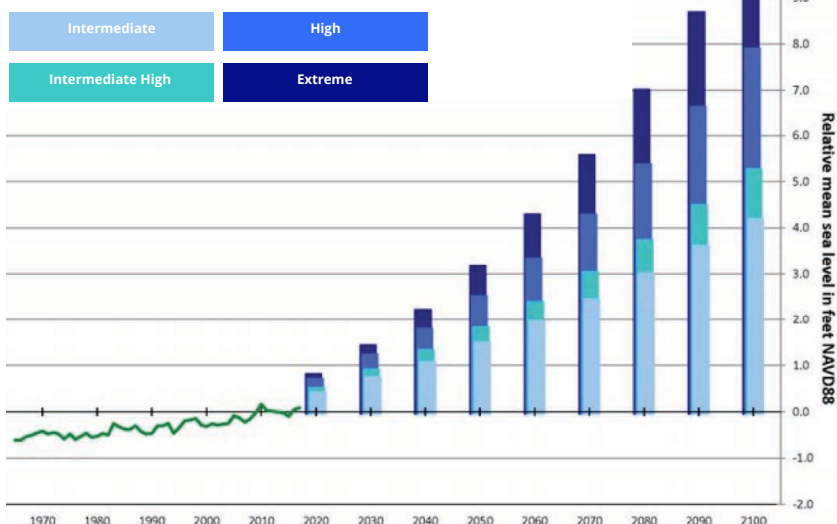
1.2 feet by 2030

2.5 feet by 2050

4.3 feet by 2070

7.8 feet by 2100

Relative Annual Mean Sea Level and Future Scenarios



Mean Higher High Water (Preliminary Projections)

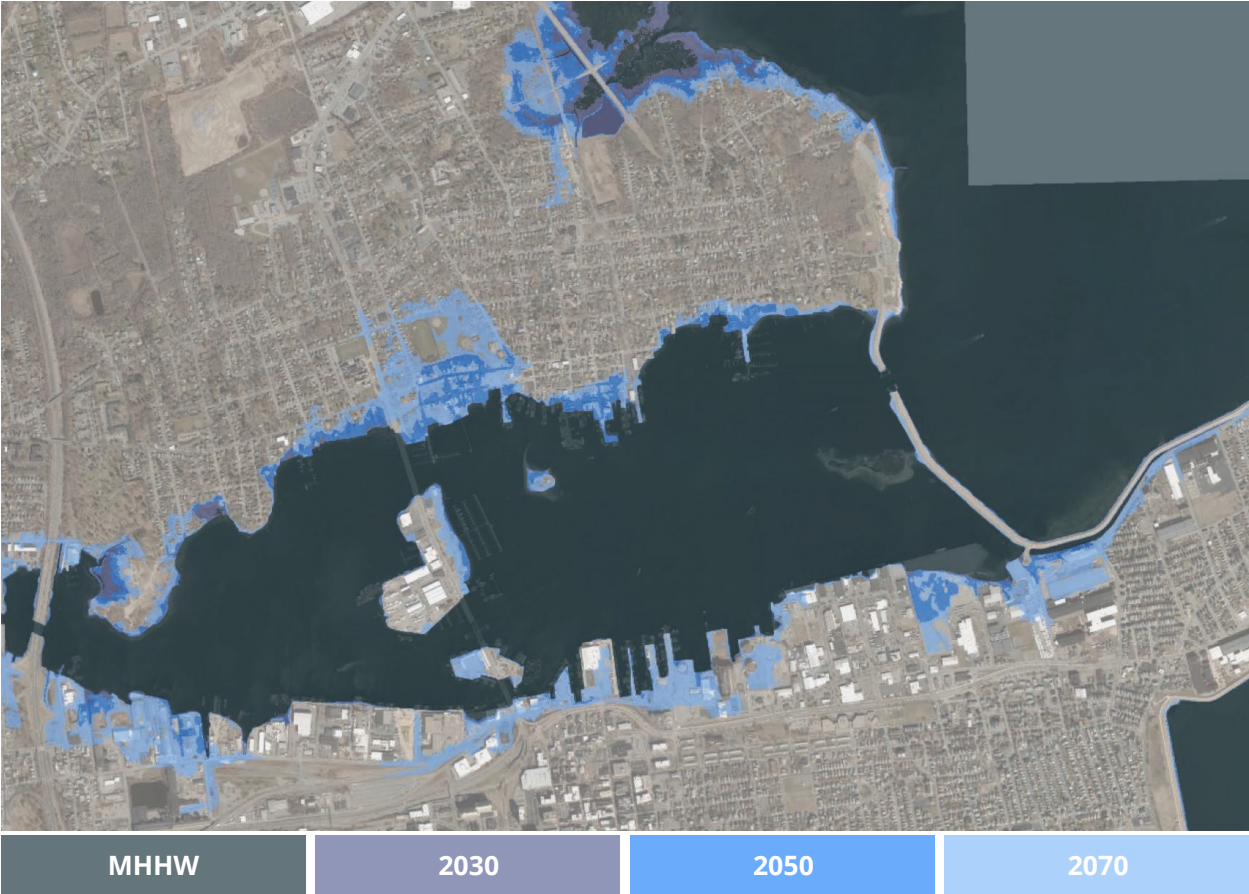


Figure 1. Created using the Massachusetts Coast Flood Risk Modeling (MC-FRM) tool, this map shows land area in the Port of New Bedford that will be underwater in a given year based on the mean higher high water (MHHW) level.

Flood risk modeling based on these projections indicate an increased risk of flooding along the shore of the New Bedford Harbor. While the Port of New Bedford is fortunate to be protected from routine storm surge by a hurricane barrier, SLR projections present a daily threat and make it essential to take steps to protect the harbor’s infrastructure. Of particular importance to the Port of New Bedford are the effects of sea level rise and storm surge on the resilience of infrastructure and business operations.

Storm Surge

While sea level rise projections are important for long-term planning for daily coastal inundation, sea level rise coupled with storm events, such as hurricanes and Nor'easters, create greater flooding risks and damage potential for coastal communities. With the frequency and intensity of storms rising, it is essential to plan for the impacts of storm surge. Even with the hurricane barrier, damage from storm surge is possible. The modeling used for this project incorporates data from thousands of storms to be able to model the effect of factors such as waves, wind, tides, and storm surges.

MC-FRM Coastal Flood Exceedance Probability

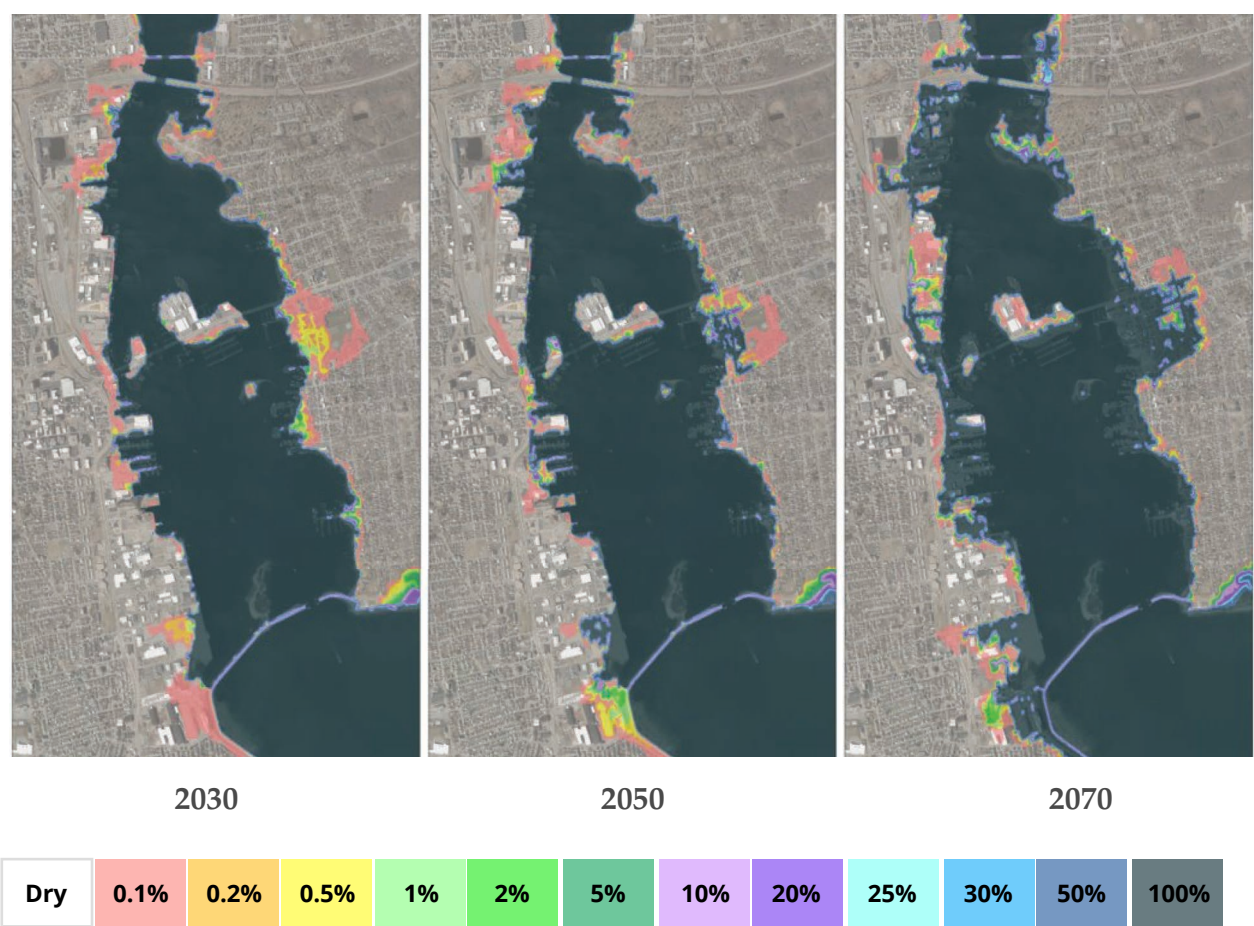


Figure 2. The probability of flooding in the years 2030, 2050, and 2070. 1% corresponds to a 100-year flood risk area, whereas 50% corresponds to a 2-year flood risk area. By 2070—and even 2050—there is significant land area that falls under the 1-year flood risk area.

Business Resilience in Action

Case Study: Spaulding Rehabilitation Hospital, Boston MA

Built on a previously contaminated brownfield in the Navy Yard of Charleston, the Spaulding Rehabilitation Hospital was built right at sea level. Recognizing their vulnerability, Partners HealthCare built for resilience. Upgrading infrastructure and protecting important mechanicals helped the hospital prepare for extreme weather events while also benefitting patients and reducing operating costs.

- The ground floor is raised 42" above the current 100-year flood elevation and 30" above the 500-year flood elevation.
- All patient and treatment rooms are located above the first floor.
- All mechanical assets—boilers, chillers, air ventilation — are installed on top floors and roof of the hospital for operation during flooding.
- High-voltage electrical service is run to a penthouse transformer and is encased in a concrete chase.
- Swales and granite earth beams deflect waves from hitting the building directly. A drainage network allows floodwaters to dissipate quickly during flooding.



Figure 5. Spaulding Rehabilitation Hospital in Charlestown, MA. Credit: Boston Planning & Development Agency

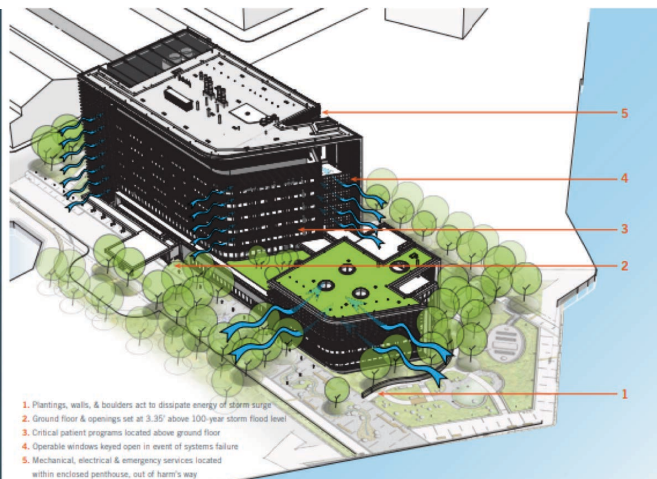


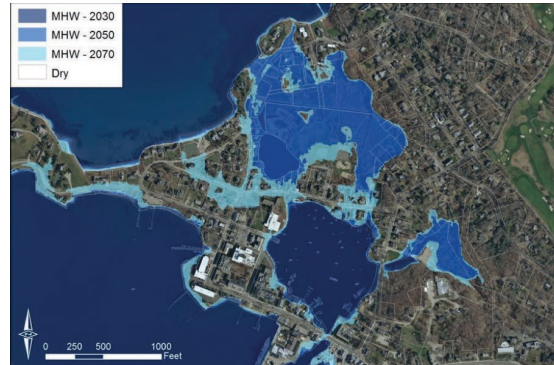
Figure 6. Credit: Boston Planning & Development Agency

Bottom Line Benefits

While \$1.5 million was invested into the project, half of the cost was covered by utility rebates and \$500,000 is recovered annually in operating costs, enhanced reputation, and reduced future losses.

Case Study: Woods Hole Oceanographic Institute Modular Dock Design

Facing episodic and chronic flooding and projections of continued sea level rise, the Woods Hole Oceanographic Institute pursued a modular dock design that could be gradually built up as sea levels rise. The design sought to balance the continued operations of the working waterfront with the service life of the dock. The design was customized to fit into the existing infrastructure.



Additional Resources

The following resources are intended both for businesses looking to increase their resilience to climate change and for frontline workers who may need access to essential services. Some of the organizations listed below may be helpful in providing resources for improving communications to immigrants or non-English speaking workers. Consider finding an organization to partner with to host a climate change educational workshop or a preparedness training.



Businesses Acting on Rising Seas: Prepared by the Climate Action Business Association, 2018.



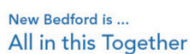
Centro Comunitario de Trabajadores: An organization supporting immigrant workers in the greater New Bedford area.



Community Economic Development Center: CEDC fosters economic justice in the local economy through people-centered development.



Fishing Partnership: An organization dedicated to the health of fishing industry workers and their families. Information available about health care and insurance, family services, safety and survival training, and more.



New Bedford Economic Development Council (NBEDC): Can provide financial assistance for small businesses looking to make resiliency improvements to their assets.



Massachusetts Division of Marine Fisheries: Manages the state's commercial and recreational saltwater fisheries and oversees other services that support the marine environment and fishing communities.



New Bedford Fishing Heritage Center: Educational center dedicated to the role of the fishing industry in the Port.



Northwest Atlantic Marine Alliance: A fishermen-led organization building a broad movement toward healthy fisheries and fishing communities.



Weathering the Storm: Building Business Resilience to Climate Change. Prepared by the Center for Climate and Energy Solutions, 2013.

Thank You



This Maritime Business Resilience Toolkit was designed by Kim Lundgren Associates, Inc. as part of the City of New Bedford and the Town of Fairhaven's effort to create a long-term resilience strategy for the Port. The project was funded by the Massachusetts Executive Office of Energy and Environmental Affairs, Municipal Vulnerability Preparedness Program. Many thanks to the entire project team for their guidance and support developing this toolkit.

