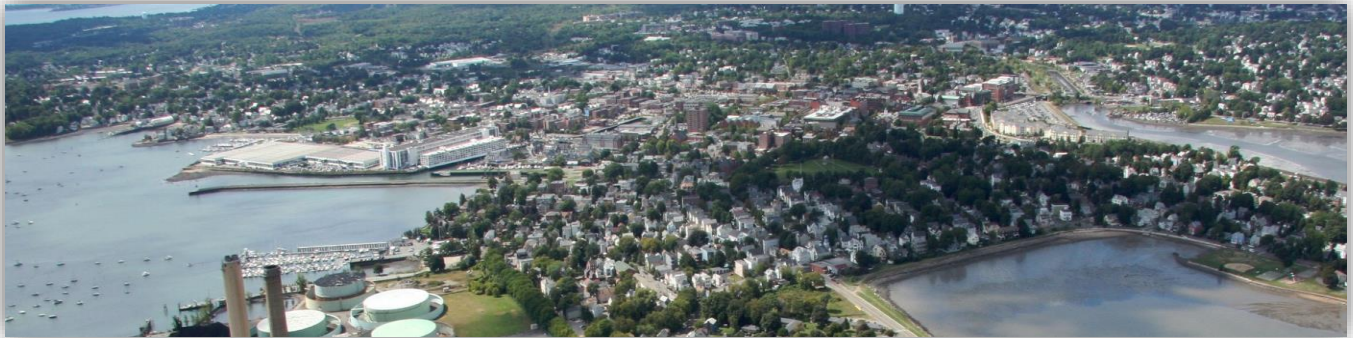


City of Salem



COMMUNITY RESILIENCE BUILDING WORKSHOP SUMMARY OF FINDINGS

March 18, 2020



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Salem Project #19305

City of Salem

Community Resilience Building Workshop

Summary of Findings

Overview

The City of Salem, founded in 1626, is one of the oldest settlements in the United States and, thus, has a rich history that its residents and visitors appreciate. Located in Essex County, approximately 16 miles northeast of Boston, and covering 8.1 square miles, Salem is the 28th largest city in Massachusetts with a population of 43,559 (2017). With 11.2 miles of coastal frontage and three tidal rivers — the North, Forest and South Rivers, much of which have been filled to accommodate development, the City recognizes the importance of preparing for climate change, as well the need for sustainability and the reduction of fossil fuel emissions.

In December 2014, the City produced its first Climate Change Vulnerability Assessment and Adaptation Plan (CDM Smith).¹ The Plan focused on six sectors - critical building infrastructure, water, energy, stormwater, transportation, and vulnerable populations, outlined 17 prioritized vulnerabilities and listed 46 general adaptation strategies. The City was designated a Municipal Vulnerability Preparedness (MVP) community because of this Adaptation Plan in 2017. Putting this designation to work², Salem received the following MVP grants:

- Salem Sanitary Sewer Trunk Line Relocation Assessment – FY18, design to relocate a hundred year old sewer trunk line suspended over Willow Ave Beach to avoid a rupture due to increasing storms and surge that would cause catastrophic damage to Salem Harbor, homes and businesses that rely on municipal sewage removal - \$ 345,000
- Green Infrastructure for Stormwater Management in City Projects – FY19, incorporates green infrastructure into existing City projects, including the renovations of Bertram Field and Gallows Hill Park and the filling of empty tree pits in downtown Salem with replacement street trees and pervious pavement - \$320,861

In 2019, Salem realized that there would be significant benefits gained from engaging in the MVP community resilience building (CRB) process. Its first CRB Workshop for city staff took place on June 6, 2019. For the majority of the staff, this was their first involvement in climate resiliency planning for the City.

The CRB Workshop's central objectives were the following:

- Introduce the participants to the four climate-related hazards of concern
- Identify existing and future strengths and vulnerabilities
- Develop prioritized actions for the City and its community
- Identify opportunities to collaboratively advance actions to increase resilience

¹ Salem's Climate Change Vulnerability Assessment and Adaptation Plan. 2014. Accessed at Salem.com

² The City of Salem has pursued many other resiliency related projects since 2014 that did not have MVP funding.

As part of this process, the City of Salem is committed to

- Understanding the potential impacts of climate change on the City's infrastructural, societal and environmental assets,
- Learning how its residents, businesses and city services may become more resilient, and
- Communicating its findings and plans with members of the Salem community

Salem's 2020 FEMA/MEMA Hazard Mitigation Plan reviews all the natural hazards that may affect the City, updates the City's existing mitigation measures and identifies new or revised measures that would benefit the City over the next five years. While there is overlap with the MVP Action Plan, the MVP community resilience building process includes long-term assessments and planning for changing climate hazards.

Community Resilience Building Workshop

Salem's Core Team (listed on page 21) spearheaded the climate adaptation update and reviewed goals, responsibilities, and timelines for this municipal CRB Workshop.

The June 6th morning workshop at the City Hall Annex was attended by 32 participants representing the following Departments: Police, Fire, Engineering (including Water & Sewer & recycling/solid waste), Planning, Housing (& Housing Authority), IT, Public Services, Health, School, Traffic and Parking, and Park and Recreation. Representatives from City committees included Sustainability, Energy, Resilience Committee (SERC), Design Review Board, Board of Health, and Recycling Committee. A staffer from Senator Lovely's office participated along with a representative from each of the following: National Grid, South Essex Sewerage District (SESD), Mass in Motion, and the National Park Service.

Barbara Warren, Salem Sound Coastwatch's Executive Director and MassBays Regional Service Provider, facilitated the CRB Workshop as the certified MVP Provider. Salem Sound Coastwatch staff and volunteers from Northeastern University helped facilitate and scribe for the breakout sessions.

The following Summary of Findings provides an overview of the top hazards, current concerns, challenges, strengths, and actions to improve the City of Salem's resilience in the light of climate-related hazards today and for the future.

Summary of Findings

During the June 2019 CRB Workshop, participants were presented with the latest climate projections developed for Massachusetts by the Northeast Climate Science Center at UMass-Amherst (resilientma.org) for the top four natural hazards that were identified in Salem's Climate Change Vulnerability Assessment and Adaptation Plan. The City of Salem's assets map was used to set priority facilities and properties.

Top Hazards

1. Extreme Heat Events
2. Extreme Precipitation Events
3. Storm Surge - Coastal Flooding
4. Sea Level Rise - Coastal Flooding

1. Extreme Heat Events

Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined. Since 1979, more than 9,000 Americans have died from heat-related ailments.³ Extreme heat events are defined as days in which the daily maximum temperature is equal to or above 90° F. The baseline average from 1971-2000 was 11 days of extreme heat. By 2050, the number of days per year with 90° F or higher could increase to 31 days. By the end of century, we could be experiencing 68 days of extreme heat.⁴

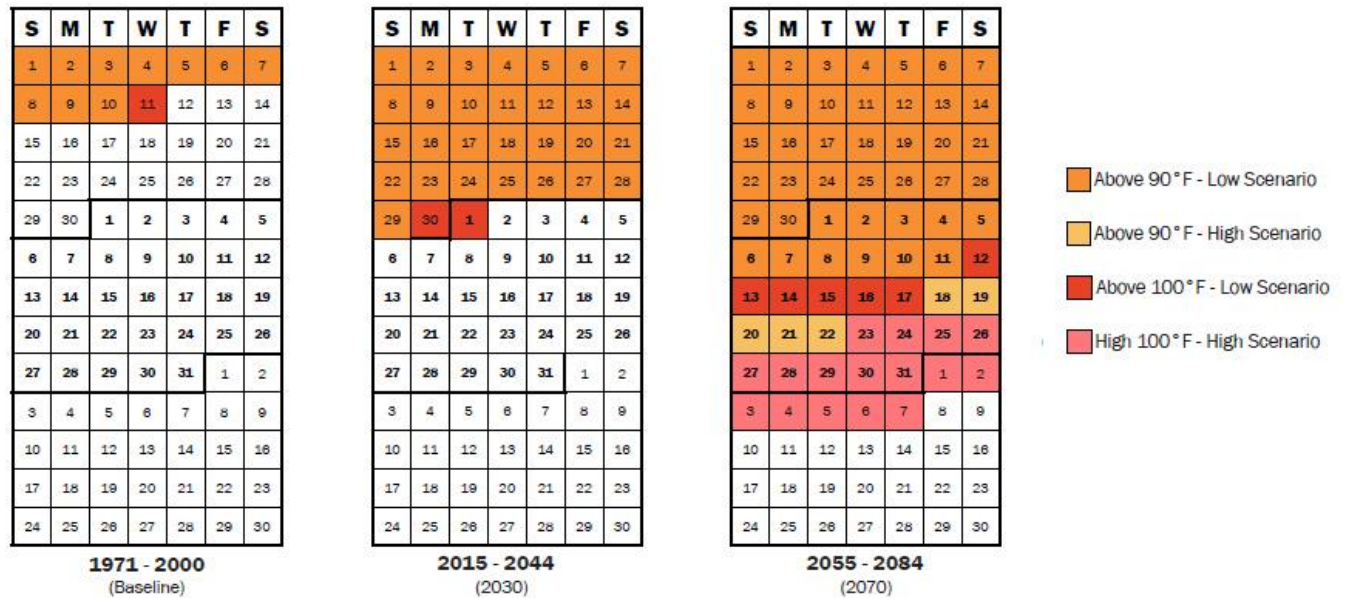


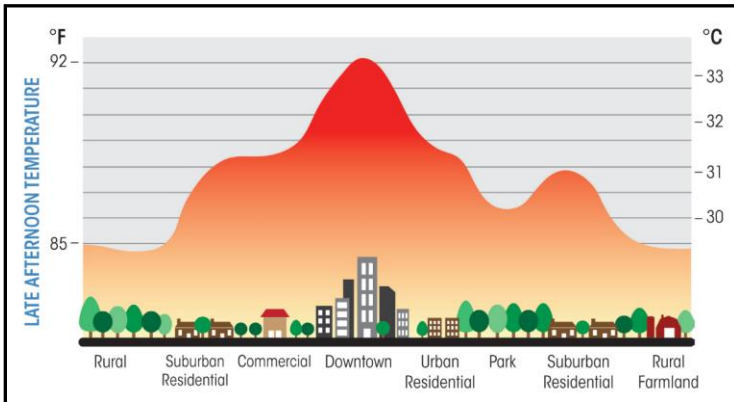
Figure 1. Relative increase in possible projected days above 90°F and 100°F over a 3-month period
(Source: Kleinfelder based on ATMOS research, November 2015)

³ Climate Change Indicators: Health and Society. EPA. <https://www.epa.gov/climate-indicators/health-society>

⁴ City of Cambridge Climate Change Vulnerability Assessment 2015. Lead consultants, Kleinfelder.

<http://www.cambridgema.gov/climateprep>.

Extreme heat is a major concern in Salem because over 48% of the City is impervious or hardscaped. This can lead to the creation of heat islands, which can increase and exacerbate air temperatures during extreme heat events. When dark surfaces, such as roofs and pavement, absorb the daytime heat, a heat island forms,



which is an area hotter than the surrounding temperature in parks, under trees and on the water. A heat island is defined as an area where temperature ranges more than 1.8-5.4° F greater during the daytime or up to 22° F greater in the evening than the surrounding areas.⁵ Figure 2 shows how areas that have more trees or have more rural characteristics remain cooler in the late afternoon.

Figure 2. Heat Island Diagram Illustrating the Urban Heat Effect

Many of Salem’s most vulnerable populations live within heat islands (Figure 3) and may be negatively impacted by prolonged high heat and humidity. Massachusetts Executive Office of Energy and Environmental Affairs (EEA) categorizes Salem as an Environmental Justice (EJ) Community. EEA defines EJ communities as those communities with median and household income that is at or below 65% of the statewide median income, 25% or more of the residents are minority, 25% or more of the residents are foreign born, and 25% or more of residents are lacking English language proficiency. When Salem’s heat island map is compared to its EJ neighborhoods, the overlaps become clear. In particular, the Point Neighborhood is the densest neighborhood in the City, with approximately 33 people per acre, while the average Salem density is eight people per acre.⁶ Heat events have other implications, such as degraded air quality (increased ozone), a higher demand on the electricity utilities, power outages, and increased health concerns for the people of Salem.

⁵ Learn About Heat Islands. <https://www.epa.gov/heat-islands/learn-about-heat-islands>. 12/26/2019.

⁶ [2015 Open Space & Recreation Plan Update](#). Section 3. Page 14. Accessed at Salem.com. 12/26/2019.

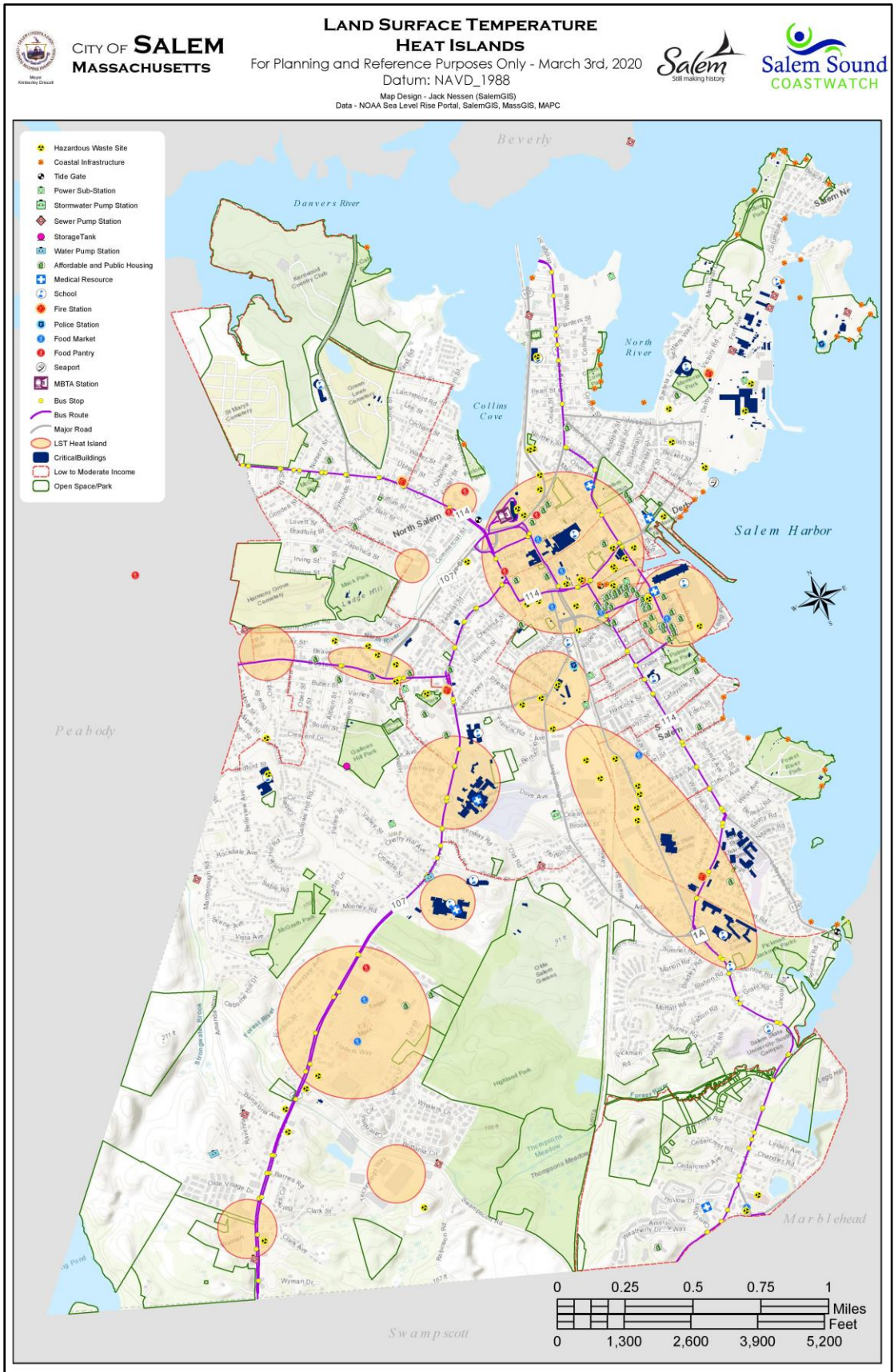


Figure 3. Land Surface Temperature – Salem Heat Islands

2. Extreme Precipitation Events

3. Storm Surge - Coastal Flooding

4. Sea Level Rise – Coastal Flooding

Two of the four hazards, extreme precipitation and storm surge, are driven by severe storms, which may take the form of nor'easters, blizzards, hurricanes, thunderstorms and tornadoes. Climate change projections indicate that with a warming world comes an increase in the frequency and intensity of storms and precipitation since “with every 1C° of warming, the air can hold 7% more moisture.”⁷ “The 2018 nor'easters caused some of the highest sea levels Boston has experienced since 1825. Records, which are some of the oldest chronicles of Boston Harbor tides, show that the temporal closeness of the 2018 storms was rare.”⁸ Table 1 documents historic flooding events and shows an increase in frequency of storms.

CRB Workshop participants were more aware of the impacts of climate change after experiencing the freezing temperatures and four nor'easters during the 2018 winter, which left businesses and roadways flooded, seawalls in shambles, trees uprooted, power outages, and homes destroyed across the North Shore. Participants were shown the following three maps during the CRB Workshop presentation. The FEMA Flood Map, although revised in 2014, is based on historical data (Figure 4). The Storm Surge Map shows the hurricane surge inundation zones (Figure 5), which is also for current conditions based on history. The NOAA Sea Level Rise map (Figure 6) illustrates climate predictions. Workshop participants discussed affected areas identified on these maps.

During the CRB workshop, the NOAA Sea Level Rise Map with increases of one to five feet conveyed to participants the severity of impacts to Salem from increases in sea level. The Woods Hole Group is currently finishing statewide probabilistic coastal flood modeling, which measure, model and forecast flooding due to storms, sea level rise, climate change influences, and combined effects for coastal communities across Massachusetts. This mapping covers the present and predicts future scenarios for 2030, 2050 and 2070. Having this data will be very beneficial in planning for Salem's future. Salem already experiences coastal flooding from storms and king tides. Storm surge on top of increase in sea level has even more potential to cause extensive damage.

A coastal community with aging stormwater and sewer systems, Salem has experienced flooding from precipitation events, which worsens at high tides. The likelihood of more extreme rain and storms, sea level rise, and extreme heat events will lead to even greater damages being sustained by the community and strain the City's capacity to respond. CRB Workshop participants understood that whatever has been experienced to date would continue to worsen unless actions are taken (Figure 1 and Table 1).

⁷ Carey, John. Global Warming and the Science of Extreme Weather, Scientific American, June 29, 2011. Quoting Peter Stott, U.K. Met Office's Hadley Center for Climate Change. <https://www.scientificamerican.com/article/global-warming-and-the-science-of-extreme-weather/>

⁸ Lauren Hinke. Boston's High Waters. 5/3/2018. MIT Department of Earth, Atmospheric and Planetary Sciences (EAPS). EPS News. Accessed at <https://eapsweb.mit.edu/news/2018/bostons-high-waters>

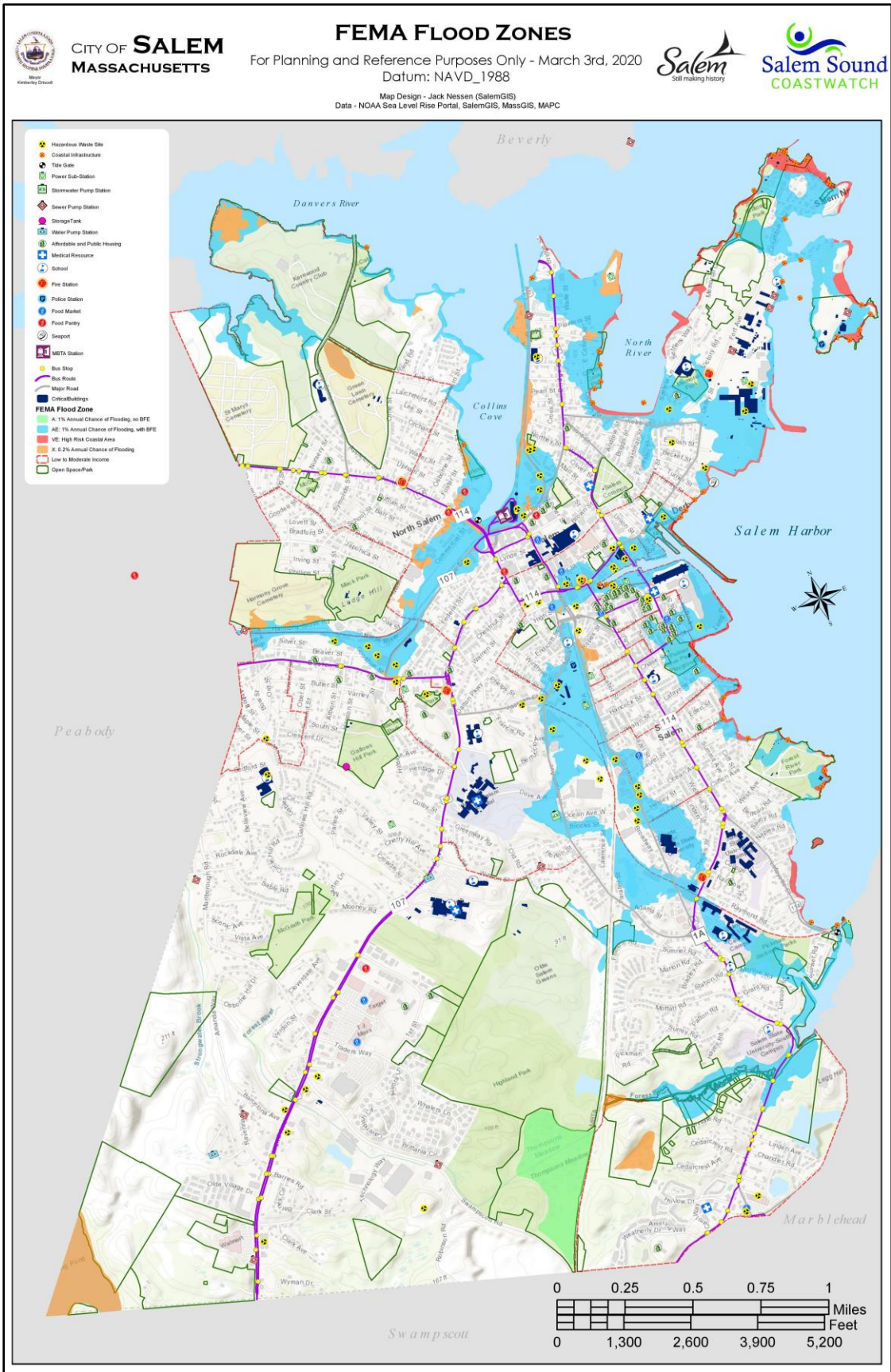


Figure 4. FEMA Flood Zone Map shows current floodplains and velocity zones

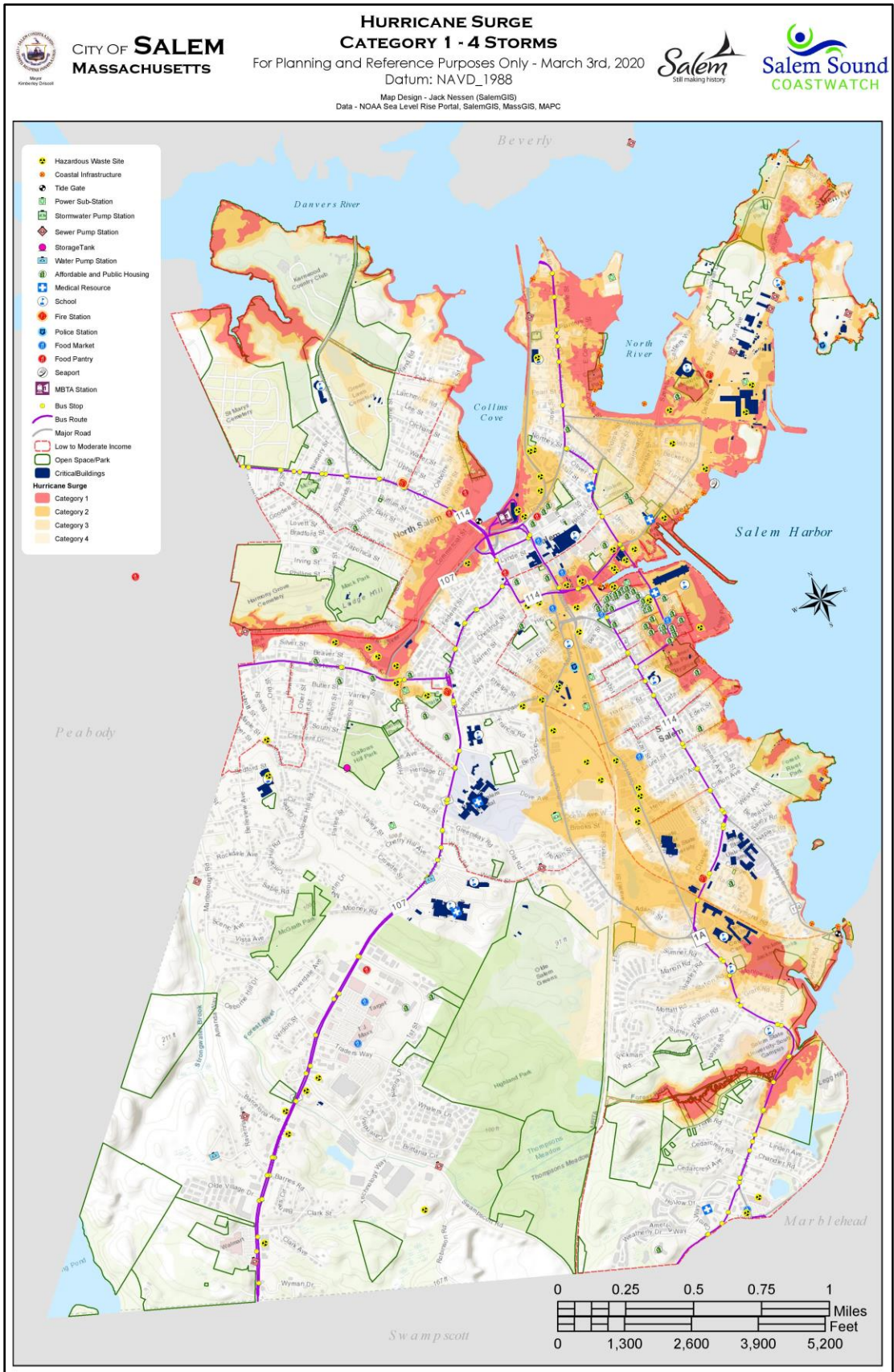


Figure 5. Storm Surge Map of the Current Areas at Risk from Hurricanes Surge

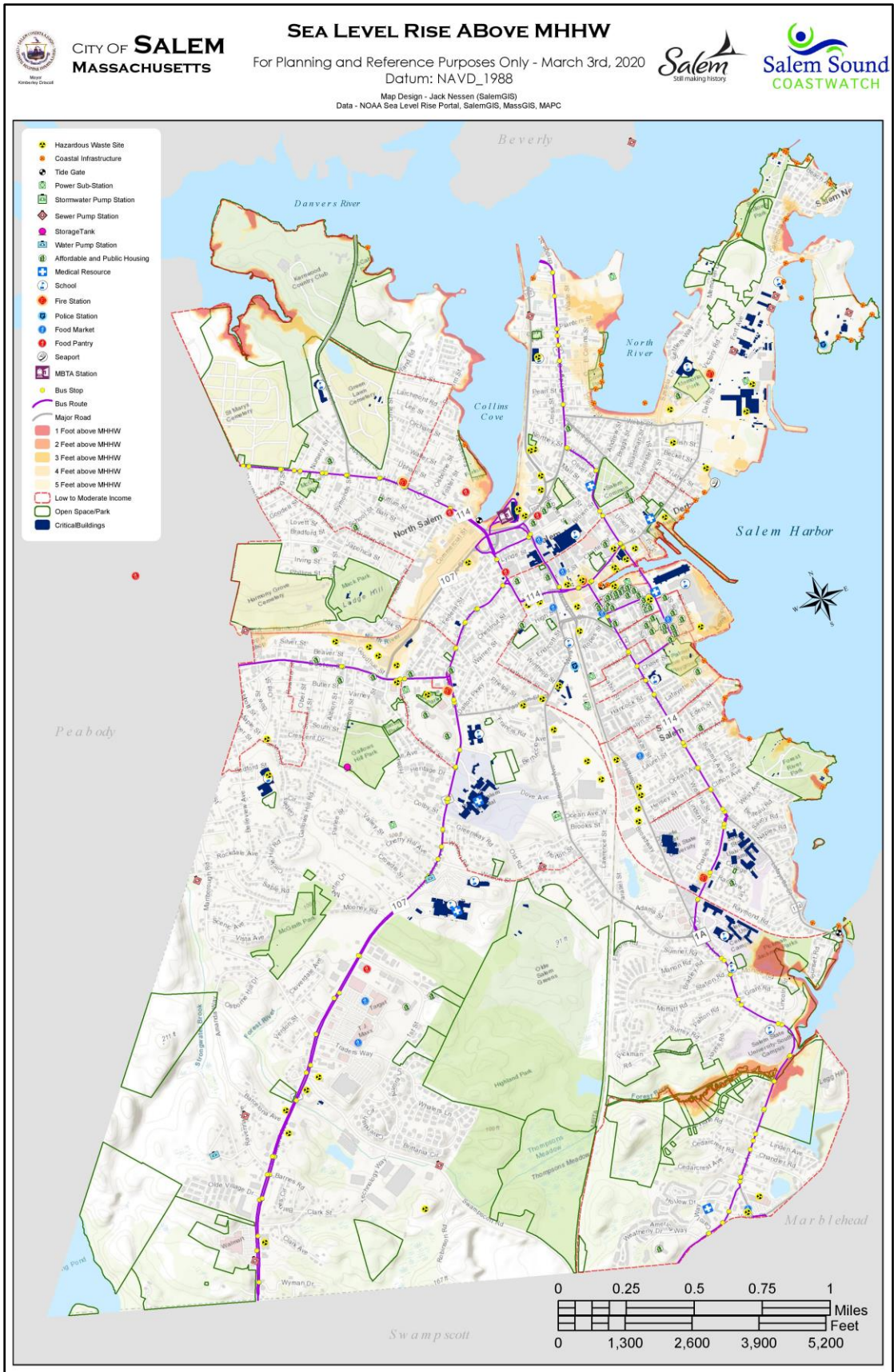


Figure 6. Projected Sea Level Rise Map from NOAA Sea Level Rise Portal

Table 1. Historic Flooding Events - Massachusetts

Date	Type of Event	Local Impacts
September 21, 1938	The Great New England Hurricane - Cat 3	10-17" of rainfall and up to 20-foot storm surge.
September 15, 1944	The Great Atlantic Hurricane - Cat 1	11" of rain and up to 70-foot waves reported.
August 31, 1954	Hurricane Carol - Cat 2, followed by Edna	2 hurricanes struck within 12 days with 7 inches of rain causes stream flooding and streets washed out.
September 12, 1960	Hurricane Donna - Cat 2	10-20" of rain and 5-10-foot storm surge; wettest tropical cyclone to hit New England.
March 1972	Severe Storms and Flooding	No information available.
February 1978	The Blizzard of '78	Nor'easter set all-time high water mark of 15.1 feet above Mean Higher High Water (MHHW) in Boston Harbor, 30" snowfall.
September 27, 1985	Hurricane Gloria - Cat 3	Arrival at low tide resulted in moderate storm surge.
March 31-April 7, 1987	Severe Storms and Flooding	Spring storms added 7" to already high river conditions to produce major flooding.
August 19-21, 1991	Hurricane Bob - Cat 3	4-7 inches of rain and storm surge impacts.
October 15-18, 1991	"The No-Name Storm" or "Perfect Storm" Nor'easter	25-foot waves on top of 4-foot high tide washed out many coastal roads.
December 11-13, 1992	Nor'easter	Highest water levels 1-foot below record of 1978 (25 ft. dunes wiped out in Ipswich) and 6 inches of rain.
October 20-21, 1996	Severe storms and flooding	13" of rainfall in Essex County (7.89" in Boston).
June 13-18, 1998	Heavy rain and flooding	Flash flooding from June 12-14, over 8" in 12 hours.
March 21-22, 2001	Nor'easter	High tides 2-3 feet above normal along east facing shore.
February 2003	Presidents Day Storm	Astronomical high tide coincided with 15-foot seas to cause flooding along most of eastern Massachusetts coastline. 27.5" of snow recorded at Logan Airport.
March 31-April 2, 2004	Flooding	6-inches over several days, flooding closed many roads.
May 9-16, 2006	"Mother's Day Flood"	Extreme rainfall >12 inches.
April 15-20, 2007	"Patriot's Day Storm" Nor'easter	Worst coastal flooding coincided with evening high tide on April 17 (3.6" recorded at Logan Airport).
December 11-12, 2008	Severe winter storm	8-12" of snow fell accompanied by 30-40 mph winds resulting in coastal flooding and structural damage.
March 12-16, 2010	Nor'easter	Record-breaking rainfall (7.06" Logan), 70 mph winds.
January 11-12, 2011	Nor'easter	Snow, high winds, and coastal flooding
October 29-30, 2012	Nor'easter	Rare October snow storm, icing, high winds
February 8-10, 2013	Winter Storm - Nemo - Nor'easter	24.9" of snow in Boston, hurricane-force winds, and 4.2 feet of storm surge.
January 26-28, 2015	Winter Storm - Juno	24" of snow in Boston with 4-foot storm surge, high winds.
January 4, 2018	Winter Storm - Grayson	15.16' high water level, with storm surge topping 4.88' MHHW, +12" of snow.
March 1-3, 6-8, 12- 14 2018	3 - Nor'easters - Riley, Quinn, Skyla	Unusually high tides and storm surges, hurricane-force winds, downed trees, heavy snow, severe coastal flooding.
October 17, 2019	Bomb Cyclone	Central pressure plummeted 30 millibars in only 15 hours, 4" of rain and 90 mph winds.

Areas of Concern – Vulnerable Areas

Neighborhoods: Locations abutting the coast and the three tidal rivers will be impacted first: North River, Northfields, Bridge Street Neck, Collins Cove, Salem Willows, Historic Derby Street, Point, Palmer Cove, Salem State University Central Campus and South River- Downtown, Jefferson Avenue and Rosie’s Pond

Transportation: Commercial Street, Bridge Street, Webb Street, Szetela Lane, Essex Street, Forrester Street, Columbus Avenue, Derby and New Derby Streets, Jefferson Avenue, Lafayette Street at New Derby (South River) and Loring Ave and the bridge at Leggs Hill Road (Forest River)

Ecosystems: Salem parks, including Salem Woods, Forest River estuary shoreline (which includes beaches, fringing salt marsh), Salem Harbor and intertidal marine resources – eelgrass and shellfish

Infrastructure: Assets built around Salem Harbor, Collins Cove and in the floodplains of the North, South and Forest Rivers, Historic and Business Districts, tide gates, the police station, DPS building, fire stations and stormwater, siphon and sewer infrastructure

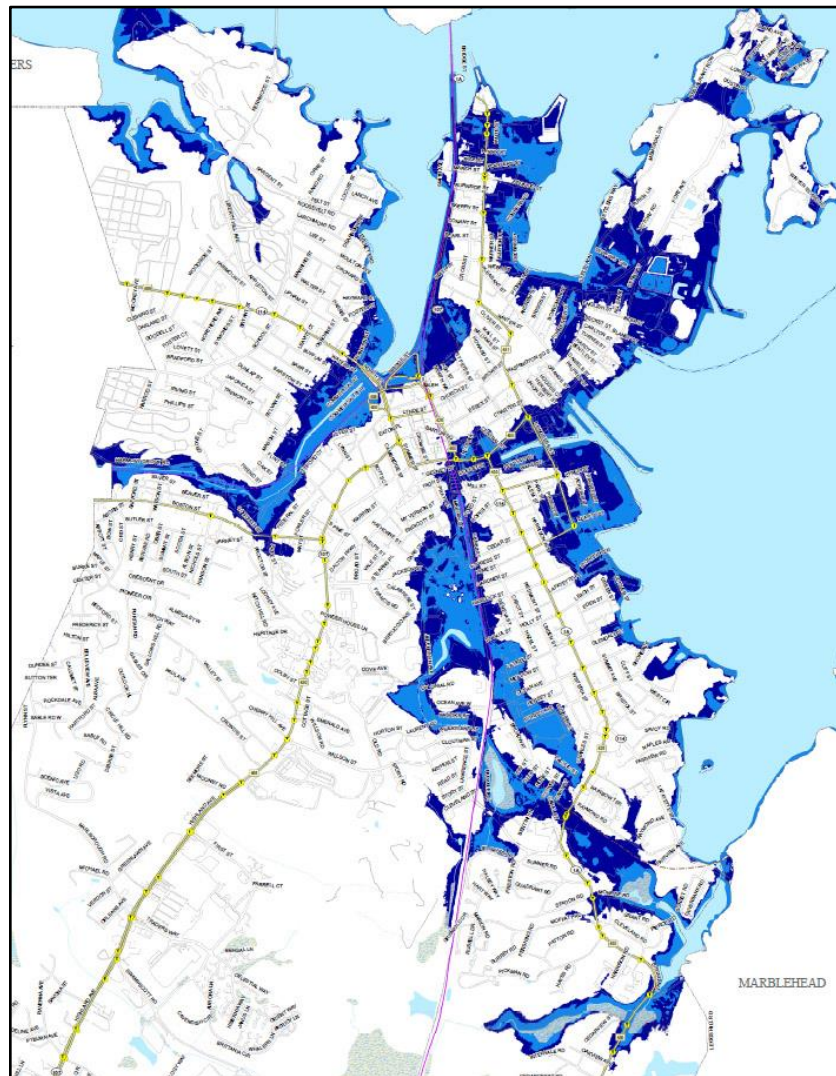


Figure 7. Storm Surge Transportation Map - Climate Change Vulnerability Assessment and Adaptation Plan 2014

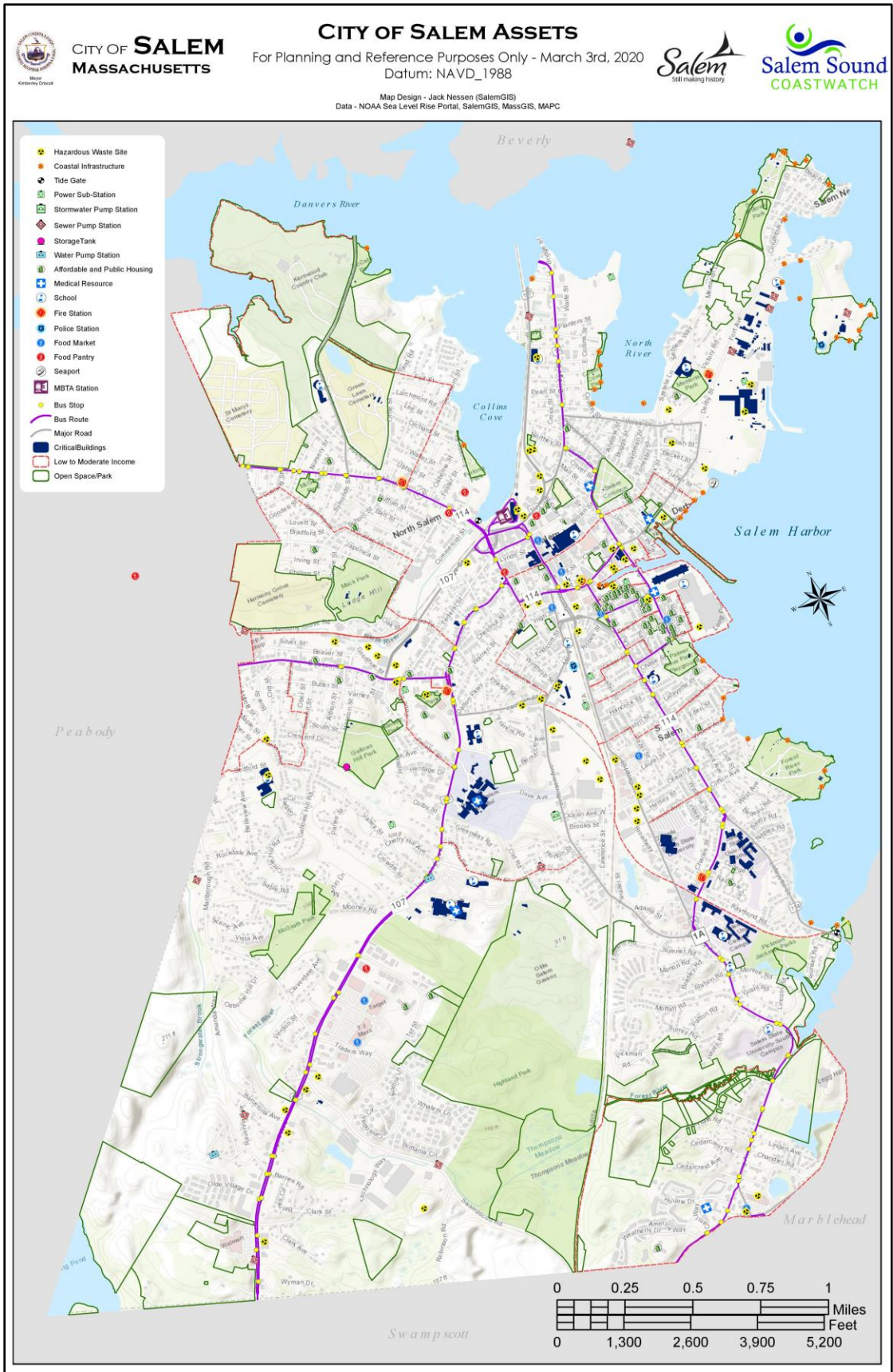


Figure 8. Salem Asset Map Used During the Workshop

Current Concerns and Challenges Presented by Hazards

No one living on the coast of Massachusetts' North Shore is a stranger to the fierceness of the ocean, destructive storms and coastal erosion from nor'easters, blizzards or hurricanes (Table 1). However, there is a growing awareness that climate change will be the driver of a new future and that the time to plan and begin implementing adaptation measures for climate change resiliency is now. While there are many actions that are in progress or are ongoing, CRB Workshop participants understood the significance of reexamining actions with longer-term climate resilience criteria for 2030, 2050 and 2070 scenarios, beginning with coastal and riverine areas that are already flood-prone.

While almost half of Salem's coastal frontage is publicly owned when the islands of Salem Sound are included, much of the downtown shoreline abutting the harbor is occupied by private residential or industrial development, such as Shetland Park, Salem Harbor Station, National Grid, and South Essex Sewer District (SESD). Therefore, it will be important for the City to engage private enterprises in its adaptation planning and implementation to maintain the following:

- Integrity of Salem's neighborhoods and economy
- Historical and cultural significance of Salem
- Thriving tourism – historical, recreational and commercial

Specific Categories of Concerns and Challenges

Department of Public Services (DPS) is responsible for, among other duties, the maintenance of roadways, drinking water distribution, sewer and drainage collection, as well as seawalls/revetments and tide gates. DPS also provides emergency response associated with failures of these assets as well as engineering infrastructure improvements. Well-functioning **Police and Fire Departments** are critical for the City and must be able to respond regardless of hazard. Understanding the vulnerabilities of these assets to the identified hazards and providing protection against those vulnerabilities are necessary to build resilience throughout the City. The **Planning Department** is responsible for guiding long-term resiliency planning efforts and recommending regulatory changes to mitigate the impacts of climate change. Staff from the following departments: Housing (& Housing Authority), IT, Health, School, Traffic and Parking, and Park and Recreation provided their input at the CRB workshop as did representatives from City committees including Sustainability, Energy, Resilience Committee (SERC), Design Review Board, Board of Health, and the Recycling Committee.

Critical Infrastructure Limitations

The assets along the coast, such as the seawalls and tide gates, are the City's first defense and are also most susceptible to sea level rise and storm surge. The low-lying areas of the City are by design the location of sewer and stormwater pump stations and thus are vulnerable to runoff and flooding associated with extreme precipitation. Inland flooding particularly when extreme precipitation events coincide with high tides affects Salem. Coastal and inland flooding is exacerbated by inadequate stormwater infrastructure. A better understanding of the future interplay of inland and coastal flooding is necessary to understand where to build resilience. The following are few of the priority actions identified in the CRB workshop:

- Complete an in-depth watershed analysis for the inland and coastal hydrology

- Evaluate flooding risk and recommend resilient design, adaptations or relocation for assets such as the Police Station, DPS building, Fire Department Headquarters, and the Bentley Academy Charter School, the Community Life Center, and Salem Harbor Parking garage
- Complete an inventory of the stormwater infrastructure, in particular the ocean stormwater outfalls that experience backflow at current high tides
- Reduce vulnerabilities at the stormwater pump station located at Ocean Avenue West along the South River that does not have a backup generator and needs increased capacity
- Maintain and evaluate for future water level scenarios Salem’s two tide gate systems – on the South River at the North Shore Bank and on the Forest River at Lafayette Street near the Salem-Marblehead boundary.

Vulnerability of Road Network and Public Transportation



Figure 9. Bridge Street (left) and Commercial Street (right) flood at extreme high tides.

Access to the Salem MBTA parking garage, MBTA Commuter Rail Newburyport/Rockport Line and MBTA bus routes are critical for Salem’s economy. In addition, as a major tourist center on the North Shore, Salem draws more than one million visitors annually, bringing \$100 million in tourism to the city.⁹ While many of Salem’s main streets are inland from the ocean, there are still portions of Highland Avenue and areas around Vinnin Square that experience inland flooding. When extreme precipitation events are combined with extreme high tides and storm surge, many important roads are flooded: Commercial Street, Bridge Street, Canal Street, Webb Street, Szetela Lane, Essex Street, Forrester Street, Columbus Avenue, Derby and New Derby Streets, Jefferson Avenue, Lafayette Street (Rt. 114), Fort Avenue, and Loring Ave at Leggs Hill Road. The bridge over the Forest River at Leggs Hill Road is also vulnerable. Roadways contain electric, gas, water, sewer and stormwater infrastructure that may be impacted from flooding, particularly the older brick or concrete sewer mains that may be subject to groundwater infiltration or experience saltwater intrusion. Additionally, Salem has several areas that are dependent on sewer and storm drain siphons (Forest River at Leggs Hill Rd., the downtown underground commuter rail tunnel, South River under the Police Station). A downstream storm surge could affect the proper functioning of these siphons.

⁹ [2015 Open Space & Recreation Plan Update](#). Section 3. Page 16. Accessed at Salem.com. 12/26/2019.



Figure 10. Nor'easter 3/3/18: Intersection of Congress St-Hawthorne Blvd at Derby St, on right Szetela Lane, Collins Cove

Coastal Storm Damage and Coastal Reinforcements

There are many vulnerable neighborhoods in Salem with approximately 1,311 structures in the FEMA flood zone, which reflects current flood risk, not projected flood risks. One issue that participants recognized is the need for prioritization, i.e., “Where does resiliency building begin and what is the appropriate response?” One area, for example, is Collins Cove. Assets around Collins Cove that are at risk from flooding or being isolated by high water are Salem Housing Authority’s Lee Fort Terrace, Bentley Academy Charter School, Bridge Street Neck neighborhood, and Webb Street, which is the main route for SESD and Salem Harbor Station. When the City has the probabilistic coastal flood modeling, under sea level conditions for the present, 2030, 2050 and 2070, it will be able to visualize how the lack of protection at Collins Cove will affect other neighborhoods. Another example of the complex impacts from a changing climate is the Derby St. and Point Area neighborhoods. These contain significant housing, commercial, historic, tourist, and other resources that are highly vulnerable.

While the City owns and is responsible for nine (9) revetments and twenty-seven (27) bulkheads or seawalls, there are many private coastal reinforcements in the City. Coastal infrastructure design standards need to be developed to be able to work with private and public property owners to make the entire City more resilient. Many questions will need to be addressed such as the nature of government regulations, the interaction of public safety, property protection, and property rights. Accommodating and adapting to the risks of climate change may require local and state policy changes and greater flexibility. The interconnectedness of coastal reinforcements requires an inclusive study of private and public property along the water's edge to develop a resilient, cohesive response that will work at private, city, state and federal levels. In some instances, retreat and actions to protect and improve existing open space and natural resources along the coast will need to be considered.

Emergency Management

For most people, emergency preparedness is “out of sight, out of mind” until the emergency is a reality. When emergencies are imminent, people need to know how to safely protect and, if necessary, evacuate their homes. Evacuation routes need to be identified with signage, and local shelters need to be available for those who cannot or choose not to leave Salem. Staffing responsibilities need to be clearly defined. People need to be better prepared for hazardous conditions, including extreme heat precautions and alternative routes when roads are flooded. For Salem, this includes its senior population, of which more than one-third

live alone and 19% speak a language other than English at home, as well as its homeless population and the million tourists that visit the City every year.

By maintaining and improving emergency preparedness and telecommunications, the community's resilience will be strengthened. Salem has a comprehensive hazard mitigation plan and emergency response. CRB Workshop participants understood the importance of continued public education on the dangers inherent in these hazards and the need to seek new and nontraditional ways to provide the public with this essential information. The CRB participants also determined that making emergency response more public and accessible is a priority; opportunities include having emergency toolkits for residents, providing more education on City plans and procedures and marking emergency evacuation routes.

Current Strengths and Assets:

Salem is a diverse city with over 43,000 people, with many important partners, such as Salem State University, the National Park Service's Salem Maritime National Historic Site, Peabody Essex Museum, Footprint Power Station, and the North Shore Medical Center Salem Hospital, to name just a few.

Infrastructural Asset Strengths

Salem has significant infrastructural strengths. While some roads may become impassable from flooding or fallen trees, Salem generally has alternative routes for emergency. While Salem has a functioning communication and emergency response system, technology has changed significantly, and the population has shifted with significant development occurring on Highland Avenue, which calls for an expanded and updated action plan. Salem is working on studying this. NSMC Salem Hospital, the second largest community hospital system in Massachusetts, is located on higher ground allowing access during disasters, has stand-alone power generation and water backup. Salem houses the South Essex Sewerage District Wastewater Treatment facility. Salem's sewage is gravity fed to SESD, and there are no combined sewer overflows. Salem's City Hall and much of the downtown district are out of the flood zone, although they are susceptible to heat island and may be cut off from transportation routes. All the schools are on higher ground except for the elementary schools, Bentley Academy Charter School and Carlton Innovation School. Three reservoirs provide Salem's drinking water, with three gravity fed main trunk lines. The drinking water distribution system also includes two pumps, one at the treatment plant and the other a booster station on Highland Avenue. The evaluation of drinking water supply and the ability to withstand drought conditions were positive. However, the line under the Beverly-Salem Bridge (Rt. 1A) needs repairing before being reactivated. In addition, the City of Salem invests annually in repairing and replacing water and sewer lines. This investment will need to continue, in particular, for stormwater drainage infrastructure to manage increases in runoff as intense precipitation is expected.

Societal Asset Strengths

The City has over 16 active neighborhood associations, 20 churches, YMCA, Boys and Girls Club, and many "Friends of" groups that work to share communications and build a stronger community. In addition, Salem has several official committees that work toward sustainability: Sustainability, Energy, and Resiliency Committee (SERC), Bicycle Advisory Committee, Recycling Committee, and the Tree Commission. Many environmental non-profits are critical to education, including but not limited to, SAFE and Salem Sound Coastwatch. The new Mayor Jean A. Levesque Community Life Center provides diverse services and

welcomes the initiative “Salem for all ages.” Collins Middle School and Salem High School are designated as shelters during emergencies. These facilities are on higher ground and are close to NSMC Salem Hospital. The high school has a self-sustaining kitchen and power.

Many organizations and agencies, such as the North Shore Community Development Corporation, Salem Housing Authority, and Lifebridge, provide housing and services to the most vulnerable.

Salem abounds in cultural heritage and historic resources: Historic Derby Street, Salem Common, McIntire Historic District, the House of the Seven Gables, Salem Maritime NPS, Salem Common, Pioneer Village, Peabody Essex Museum (PEM). PEM ranks in the top 10 North American art museums in terms of gallery square footage, operating budget and endowment. In addition, it owns 24 historic structures and gardens. The Salem Maritime National Historic Site operated by the National Park Service, is 9.2 acres comprised of several buildings, including the original Custom House, as well as several wharves and homes.

Salem’s diversity is a strength. Salem has been a place that attracts immigrants while also retaining a strong population of existing residents. This creates the opportunity for new ideas, the transfer of knowledge from other countries, and local expertise.

Environmental Asset Strengths

Salem’s Open Space and Recreation Plan Update in 2015 has a wealth of knowledge about environmental assets. During deglaciation 12,000 years ago, the sea rose covering much of Salem and deposited marine clay and sand, which underlies most of downtown Salem and the lower South, North and Danvers river valleys. While much of Salem’s coastal wetlands and rivers have been lost to filling, there is still approximately 171 acres of relatively natural wetland and wooded upland. The Forest River Conservation Area contains 126 acres of wetlands, dense forests, an estuary, and tidal coves, which perform essential ecological roles for fisheries and wildlife, while providing a sense of natural open space close to the densely built city center.¹⁰

Salem is one of the ten deep-water ports in Massachusetts, which, CRB Workshop participants saw as a strength for the City.¹¹ The city boundary stretches approximately seven miles into the Salem Sound and contains 10 square miles of aquatic environment in both Salem Harbor and Salem Sound. Approximately 37 acres of salt marshes, including the Forest River estuary and small areas surrounding Peter’s Point in the Danvers River, provide valuable functions today.

Salem has received four grants from the Massachusetts Office of Coastal Zone Management FY2016 - FY2019 to identify vulnerable city-owned coastal sites and evaluate their potential for living shorelines and coastal resiliency enhancements, which led to the design, permitting and restoration of a salt marsh within filled tidelands along the Collins Cove bike path.

Salem has a long history of preserving space for public use since the public parks movement in the late 1880’s which resulted in over 350 acres of public parks: Salem Willows (1883), Liberty Hill Park (1883, now the Bates

¹⁰ 2015 Open Space & Recreation Plan Update. Section 4. Environmental Analysis. Pages 2- 7 accessed at Salem.com. 12/26/2019.

¹¹ State policy seeks to preserve and enhance the capacity of the DPAs to accommodate water-dependent industrial uses and prevent significant impairment by non-industrial or non-water-dependent types of development, which have a far greater range of siting options. <https://www.mass.gov/service-details/czm-port-and-harbor-planning-program-designated-port-areas>

School), Ledge Hill/Mack Park (1886), Highland Park (1906), Forest River Park (1907), and Gallows Hill Park (1912). The Salem Great Pastures was purchased by the City to build the high school, and the remaining land became Highland Park (now Salem Woods and the Salem Green – the municipal golf course). The City continued in the 1940's to expand its parks and playgrounds with five neighborhood parks (Pickman, McGlew, Splaine, Juniper Point, and McGrath). Kernwood Marina opened in 1961, followed by Winter Island Park in 1970's. Cabot Farm playground, Gonyea Park, Leslie's Retreat, Peabody Street Park, and Charlotte Forten Park were added in the last twenty years.¹² These parks along with conservation areas provide not only significant recreational, tourist, and economic value but also are fundamental to mitigation, resilience, and adaptation by providing:

1. Natural stormwater retention by absorbing rain and stormwater; impervious surfaces not only cost money to install, but artificial drainage systems must be installed, maintained, and replaced.
2. Significant benefits to reduce the heat island effect; open green space decreases overall heat and provides areas for people to escape from the heat
3. Buffers for flooding; passive recreational areas, in general, are easier to repair after an event and slow the flooding that comes from upland areas.

Designated a Tree City USA, Salem recently reconfirmed the value of trees by passing a tree ordinance, establishing a tree committee, hiring a full-time arborist, and maintaining a City tree inventory. For various reasons, the City has experienced a net loss of trees and, therefore, is committed to improving tree maintenance and planting more trees than are removed to compensate for past tree losses and the length of time required for a tree to achieve maturity. The City also has set as a priority the development of policies to assure better tree survivability. Policies include considering climate change when tree species and locations are chosen, supporting green infrastructure practices that allow water to infiltrate from parking areas to trees and protecting tree roots in high use areas with pervious surfaces. Mayor Driscoll and the Salem Tree Commission have established the Century Tree Program. This new initiative is tied to Salem 400, Salem's quadrennial celebration in 2026, and aims to plant the next generation of heritage trees at suitable locations throughout Salem for future residents to enjoy for decades to come. "Salem is committed to our public trees as a critical part of our climate change mitigation strategy, our beautification efforts, and our historic legacy as a green city," said Mayor Driscoll, in announcing the Century Tree Program.

¹² [2015 Open Space & Recreation Plan Update](#). Section 3. Community Setting. Pages 2-14 accessed at Salem.com. 12/26/2019.



Top Recommendations to Improve Resilience:

The Municipal Vulnerability Preparedness CRB process seeks to demonstrate the need for more resilient, cohesive responses to protect Salem’s assets, while addressing some very real and immediate threats from the four climate hazards. A resilient community responds to adverse hazards by changing its essential basic structures and functions to be able to respond, withstand and recover from adverse situations. The June 2019 Community Resilience Workshop identified over 130 specific actions for future planning and implementation. Appendix 1 groups all the actions by infrastructural, societal and environmental assets, while actions are itemized in Appendix 2. The following are examples that highlight some of the priority issues:

1. Emergency Planning and Response

- Update and communicate a city-wide coordinated emergency plan that includes climate resiliency actions to strengthen the City's response to increased flooding and heat events
- Provide necessary services and utilities at shelters and critical emergency facilities for continuity during emergencies, including upgrading systems (backup generators), and providing more signage and communication

2. Long-term Climate Resiliency

- Evaluate current and future flood pathways on the watershed level and possible resilience actions for the City, residents and community partners
- Conduct immediate flood proofing at critical city-owned infrastructure, which may mean moving important items (i.e. documents, generators, etc.) to higher ground and/or actual flood proofing buildings
- Relocate assets as needed
- Explore and implement opportunities to restore and protect natural systems, in particular, within existing parks or near seawalls

- Study the vulnerability and adaptation potential for private and City properties built in flood prone areas

3. Roadway Continuity

- Identify key road networks to develop safe evacuation routes
- Install evacuation route signage and educate the public about these routes
- Evaluate street flooding, using projected future storms modelling, develop a remediation plan and begin implementation

4. Green Infrastructure and Low Impact Development (LID)¹³

- Encourage more trees around parking lots, bus stops, businesses and new housing to reduce stormwater and the heat island effect
- Plant trees in ways that allow water to infiltrate to the tree roots
- Update city ordinances to require or incentivize new development and redevelopment to offset stormwater through LID, green infrastructure construction (green roofs/bioswales, etc.)
- Use green infrastructure and canopy solar to reduce heat islands and create clean, renewable energy when repairing or replacing existing parking lots and bus shelters

5. Community Outreach and Communication

- Develop and deliver consistent educational messages about climate change, hazards, risks, and actions
- Conduct outreach on the dangers of extreme heat and how to stay cool
- Provide multiple opportunities for residents, businesses and NGOs to learn how to mitigate their property risks
- Coordinate efforts around seawalls and coastal resilience among residents, property owners and the City
- Meet with historic building managers and staff to discuss climate change and resiliency
- Encourage the development of business risk continuity plans through partnerships with businesses, the Salem Chamber of Commerce and others
- Educate the public about the importance of water conservation especially during times of drought.

¹³ Green infrastructure and LID are cost-effective, distributed practices that restore the natural hydrologic processes of infiltration, percolation, and evapotranspiration to reduce the adverse effects of stormwater runoff on receiving waterbodies.

Next Steps

The MVP Summary of Findings and the list of actions set the direction for building a more climate resilient Salem. The City will continue ongoing collaboration and support amongst leadership, staff and the community to advance comprehensive, cost-effective approaches to resilience as identified in this Summary of Findings. Understanding the urgency and necessity, the City will increase educational efforts on climate change, sustainability, hazard mitigation, and adaptation. The City seeks to engage its residents, businesses, NGOs, and industry to increase understanding, planning and implementation of the actions identified in its climate vulnerability and adaptation reports.



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CRB Workshop Project Team: Organization, Name, Role

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Appendix 1. Community Resilience Building Risk Matrix

Community Resilience Building Risk Matrix SALEM 2019				 Municipal Vulnerability Preparedness (MVP) www.CommunityResilienceBuilding.org				
H-M-L priority for action over the Short or V = Vulnerability S = Strength				Top Priority Hazards				
				Extreme Heat Events	Extreme Precipitation Events	Sea Level Rise	Storm Surge	Priority H - M - L
Assets - Features	Location	Ownership	V / S					
Infrastructural								
Police Station	Jefferson Street	City	V/S	Conduct immediate flood proofing: elevate important items (i.e. documents vaccines, etc.) or flood proof; Maintain drains and siphons outside; Replace 25-year old generator with a new one that is flood proofed; Develop police station evacuation plan that includes a backup site, mobile communications and command center, dispatch, hazardous waste, vehicles, etc.; Evaluate hydrology, drainage, elevation for a long-term plan to prevent flooding or relocate.			H	S/O/L
Fire Department	Lafayette Street	City	V/S	Evaluate the condition, functions, flood protection, vulnerabilities of Fire Headquarters #1; Consider location of fire stations for best coverage based on flooding, drought, city growth and wooded open space.			M	S/L
Roads (in and out of city, roads to hospital and roads that separate one section of the city from the rest)	multiple locations	State and City	V	Assess and identify critical roads for emergency vehicles; Identify key road networks and develop safe evacuation routes; Install evacuation route signage; Study ways to reduce flooding around 114/Bridge St/North River, Highland St near Walmart, and Loring Ave., Lafayette St. at the Forest River .			H	S/O
Neighborhood Flooding	multiple locations	City and Private	V	Evaluate flood pathways and possible resilience actions for the City and residents; Conduct workshops on floodproofing and elevating homes; Prepare City grant application to FEMA for private floodplain management; Participate in the National Flood Insurance Program's Community Rating System so property owners may receive flood insurance discounts; Strengthen City ordinances and regulations to increase resilience, adaptations and sustainability.			H	S/O
MBTA (commuter rail and buses)	multiple locations	State	S/V	Provide shade at bus stops by planting trees; Coordinate with state and region to improve flood emergency plans; Build a second commuter rail stop (outside of a flood zone).			H	S/O
Emergency services and vehicles (fire stations, police, hospital)	multiple locations	State, City, Private	S/V	Assess emergency equipment locations and move equipment if needed; Identify current communication systems and move or build redundancy as needed, includes police, fire and public safety communications; Develop a plan for staging vehicles in emergency situations with refueling capability; Evaluate high-water vehicle need and purchase; Use FirstNet system for public safety communications; Purchase mobile high capacity trash pump.			H/M	L/O
Emergency Coordination	multiple locations	State, City, Private	S/V	Facilitate coordination between Salem Hospital, Salem Harbor Power Plant, SESD, Salem State, schools, businesses and the City; Conduct an Emergency Planning Forum and workshops.			H/M	S/O/L
Communication Systems	multiple locations	State, City, Private	S/V	Evaluate communications systems to determine what needs to be updated and where communications systems are needed; Consider new locations (Highland Ave near Walmart).			H	S/O/L
Sewer and Stormwater Siphons	Forest R. Legg's Hill Rd, commuter rail tunnel, South R. Police Station, Flint St.	City	V	Evaluate resiliency of siphons (downstream storm surge could disturb the pressure causing the siphons to fail, creating backups upstream).			M	O
Sewer Trunk Lines		City	V	Remove suspended sewer main from Willow Ave Beach; Evaluate flooding impact from saltwater intrusion and sump pumps; Plan for aging sewer system upgrades; Remove stormwater sources and sump pumps.			H	S/L/O
Stormwater Pump Stations	multiple locations	City	V	Assess which pump stations can handle flooding - examine backup power and need for flood barriers; Ocean St. West South River stormwater pump station extremely vulnerable / has no generator.			H/M	L/O

Infrastructural Assets - Features	Location	Ownership	V / S		H - M - L	Short Long Ongoing
Forest River Pool	Forest River Park	City	S	Use new pool during extreme heat events.	M	O
Schools Vulnerable to Flooding	Bentley, Carlton, Saltonstall	City	V	Evaluate risk and effective short-term solutions including preventive maintenance; Plan for evacuation and possible relocation.	M	S/L
Schools as Shelters	Salem High School, Collins Middle School	City	S	Ensure schools have resources to act as shelters (generator with capacity, fuel storage, facilities to make food, bedding, HVAC, restrooms); Identify staffing needs.	L	L
Public Cooling Stations	Community Life Center, Salem schools	City, Private	S	Update emergency plan to include cooling centers (Community Life Center, Salem High School and Collins Middle); Ensure adequate staffing and resources; Encourage programs that warn people of the dangers of extreme heat and the importance of staying cool; Protect utilities at cool centers for service continuity during heat emergencies; Look into microgrids for critical infrastructure.	H	S/O
Drinking Water Infrastructure and Supply	Wenham Lake, Beverly and Wenham	City, Beverly-Salem Water District	V/S	Maintain water lines and encourage water conservation through educational campaigns, building regulations (stormwater retention and rainwater harvesting for non-potable uses) and water rates; Evaluate with Beverly long-term needs.	L	O/L
Seawalls - Inadequate seawalls that generally are protecting property on filled tidelands	multiple locations	City and Private	V	Go beyond as built replacement if insufficient to handle projected sea level rise and storm surge; Review CZM seawall mapping and inventory with condition assessment; Update codes for seawalls being rebuilt to take future flooding into account (Palmer/Point, Juniper Cove, Collins and others); Hold a forum on coastal resilience and protection for staff, residents and others.	H	S
Tide Gates	Lead Mills-Forest River; South River; Rt 114-North River culvert	City and MassDOT	V/S	Evaluate current conditions and future risk scenario needs; Implement needed improvement initiatives; Work regionally with Peabody and MassDOT to plan North River tide gate & pump; Work regionally with Marblehead and MassDOT to maintain and improve Forest River tide gate and reduce flooding on Loring Ave.	M	S/L/O
Highland Ave flooding near Walmart	Highland Ave	City and MassDOT	V	Evaluate the cause of flooding that closes an evacuation route and access to the hospital from Lynn; Implement remediation plan.	H	S
DPS Building	Jefferson Street	City	V	Evaluate flooding risk and develop resiliency adaptation or relocation; Look into microgrids for critical infrastructure.	M	S/L/O
Heat Islands	multiple locations	City and Private	V	Evaluate daytime vs nighttime population density in the heat island areas and update Salem heat island map; Incentivize white or green roofs and LID in parking areas; Encourage tree planting; Complete the Forest River Municipal Pool; Examine use of microgrids.	H/M	S/O
Flood Prone Areas	multiple locations	City, private, NPS	V	Study the vulnerability and adaptation of private and City properties in flood prone areas; Initiate a development policy for neighborhoods at risk; Evaluate a buyback plan; Begin conversation regarding an eventual managed retreat in high-risk areas.	M	L
Utilities	multiple locations	City	V	Evaluate critical utility infrastructure; Maintain utilities at shelters and critical emergency facilities for service continuity during emergencies.	H	S/L/O
Development	multiple locations	City and Private	V/S	Promote LID; Update subdivision regulation with LID; Write City ordinances that requires or apply building incentives for new buildings to offset more stormwater through LID, green infrastructure/construction (green roofs, bio swales, etc.); Develop zoning requirements for sustainability in new or renovated buildings; Create overlay zones to protect vulnerable areas making a permit necessary to build in the overlay zone, which mandates building according to resiliency guidelines.	M	S/L/O
SESD - South Essex Sewerage District	Fort Avenue	Regional	V/S	Coordinate with SESD and the municipal members to understand its vulnerabilities - what is the back up power at plant and pump stations; Evaluate its risk though 2100 scenarios.	M	S/L/O
Impervious surfaces, such as parking lots	multiple locations	City and Private	V/S	Reduce parking demands with regulations and policy solutions; When repairing or replacing existing parking lots and bus shelters, use green infrastructure and canopy solar (in large parking lots) to reduce heat islands and create clean, renewable energy.	H	O

Societal Assets - Features	Location	Ownership	V / S		H - M - L	Short Long Ongoing
Communication and Outreach		City, Public and Private	S	City-wide cooperation to develop and deliver consistent messages that educate about climate change, hazards, risks, and actions; Help residents and businesses learn how to mitigate risks on their property; Build partnerships with businesses and Chamber to encourage the development of business risk continuity plans; Work with National Park and neighborhood associations as well as others; Increase emergency planning communication within the Salem Housing Authority's different property management groups.	H	S/L/O
Elderly / disabled people and Environmental Justice (low income, ESL, minorities)	multiple locations	City and Private	V	Develop database with locations of vulnerable individuals (especially people who are not mobile or require electronic medical devices) to facilitate rescue in case of an emergency; Have evacuation plans for vulnerable people; Have services available for people who may not be able to leave and will need access to food, medicine, heating or cooling and other resources; Prioritize placement of vulnerable populations (resiliency zoning) to reduce number of vulnerable people in at risk locations.	H	L/O
Community Life Center	Bridge Street	City	V/S	Evaluate needs and building/staff capabilities under each hazard to develop a plan for how the Center may be used.	M	S
Historic Resources: districts and museums (Derby St., House of Seven Gables, Salem Maritime NPS, Salem Common, Pioneer Village, PEM assets) and cultural heritage	multiple locations	City and Private	V/S	Conduct risk study; Hold meetings with historic building managers and staff to discuss resiliency; Conduct education to the historical community on climate risks and encourage relocation of assets within buildings.	H	S/O
Parks/ open space including the Common, Collins Cove, Willows, Palmer, Winter Island, Forest River	multiple locations	City	S	Reduce heat island effect for City; Provide gathering spaces for community.	L	O
Environmental						
Parks/ open space including the Common, Collins Cove, Willows, Palmer, Winter Island, Furlong, Forest River	multiple locations	City	S/V	Expand green infrastructure; Maintain parks, living shorelines, salt marshes; Reduce imperviousness; Increase and maintain tree canopy; Where possible, increase stormwater storage capacity.	H	L/O
Street Trees and City Green Spaces	multiple locations	City and Private	V	Encourage more trees around parking lots to reduce heat Island effects and improve stormwater management at parking lots, large paved areas, streets and bus stops, businesses and new housing; Revise policy to integrate green infrastructure & low-impact development; Continue the City's Street tree inventory and tree programs.	H	S/O/L
Rivers (South, North, and Forest)	multiple locations	City, Marblehead, Peabody, MassDOT	S/V	Develop a regional plan for extreme events, that may include tide gates and pumps; Develop watershed plan to combat flooding - North River Plan with Peabody and Forest River with Marblehead; Renaturalize rivers and revegetate shoreline.	M	O/L
Shoreline	multiple locations	City and Private	S/V	Assess where gray infrastructure is necessary; Revegetate shorelines and seek out living shoreline options for better resilience; Relocate sewer line from Willow Ave beach (pipe beach).	M/H	O
Salem Harbor	Salem Harbor	City	S/V	Maintain access to recreational boats and commercial docks and piers by adapting to increasing sea level rise and potential storm surge.	L	L/O
Conservation Land (wetlands and woods)	multiple locations	City	S/V	Enforce protection and maintenance; Evaluate fire response plans	L	O
Upland development (higher elevation)	multiple locations	City	S/V	Encourage development in higher elevation areas where there is greater climate resiliency, i.e. away from flood zones, floodplains and near wetlands.	L	O
Coastal Access	multiple locations	City and Private	S/V	Evaluate coastal access and its vulnerability to sea level rise; Develop adaptation plans for vulnerable sites to protect access.	M	S/L/O
Dunes	Dead Horse Beach, Juniper Cove, Collins Cove at Connors St.	City	S/V	Encourage formation of dunes wherever naturally possible.	L	S/L