City of Brockton

Community Resilience Building Workshop
Summary of Findings

January, 2019

FUSS & O'NEILL

Project No. 20170390.J10

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Overview

Extreme weather and natural and climate-related hazards are an increasing concern for the communities of Massachusetts, and there is a clear need to involve municipalities, corporations, organizations, and the State in increasing resilience at all levels. Recent storm events affecting the region have highlighted many of the vulnerabilities that towns and cities face. Hurricane Irene and Superstorm Sandy brought intense flooding to many municipalities and threatened (or destroyed) infrastructure across the state. Extreme temperatures at both ends of the spectrum have pushed the limits of communities' preparedness to protect both infrastructure and people. In coastal communities, the impacts of sea level rise are felt daily and further exacerbate the impacts of other extreme events. Current climate modeling indicates that all of these hazards are expected to increase in frequency and scale over the coming decades. The Municipal Vulnerability Preparedness (MVP) program provides support and a prescribed process for cities and towns in Massachusetts to plan proactively for resiliency and implement key climate change adaptation actions.

In 2018, the City of Brockton was awarded a $47,000 MVP grant to fund the planning stage of this process. The City partnered with Fuss & O'Neill, a state certified MVP Provider, to complete a comprehensive, baseline climate change and natural hazard vulnerability assessment and develop a list of priority actions for the City. This process involved a project kickoff meeting on October 24, 2018 attended by most of the members who would later develop into the MVP Core Team, which met on November 7, 2018 to determine initial concerns and worked to identify stakeholders within the municipality and set goals for the process. Those stakeholders were then invited to participate in a Community Resilience Building (CRB) workshop on December 5, 2018, engaging in a day-long, tried and tested process developed by The Nature Conservancy. The CRB methodology is an "anywhere at any scale" format that draws on stakeholders' wealth of information and experience to foster dialogue about the strengths and vulnerabilities within the City. Workshop participants interacted at both large and small group levels, using an iterative process to gather input, synthesize ideas across groups, and ultimately develop a set of priority resilience and adaptation actions.

The CRB workshop's central objectives were to:

- Define top local natural and climate-related hazards of concern;
- Identify existing and future strengths and vulnerabilities;
- Develop prioritized actions for Brockton;
- Identify immediate opportunities to collaboratively advance actions to increase resilience.

Following the completion of the prescribed MVP planning process, Brockton began to move forward with resiliency-building actions identified through the CRB Workshop. Building on existing and ongoing efforts to improve the resiliency of the many dams in the City, Brockton utilized planning grant funds to develop a

design and permitting for an automated gate at the spillway of Ellis Brett Pond Dam to improve flood response during hazard events. The automated gate will give DPW personnel the ability to operate the gate remotely based upon remotely-monitored water surface elevations in the pond and to remotely close the gates to store floodwaters until they can be released in a controlled manner after the storm. The gate will further protect downstream neighborhoods and commercial areas from flood impacts associated with increasing precipitation.

Top Hazards and Vulnerable Areas

During the Community Resilience Building workshop, participants were asked to reflect on the potential impacts of the top four natural hazards of concern for the City of Brockton. Discussion of the top hazards built on earlier conversations that took place at the MVP Core Team Meeting, as well as the City's existing Hazard Mitigation Plan. Flooding and the collective impacts of heavy precipitation and stormwater were identified as one of the City's top hazards. Severe storms bringing high winds and heavy, sometimes mixed precipitation, were identified as a second hazard. Extreme cold and hot temperatures, especially the increase in days over 90 degrees fahrenheit, was seen as a third major hazard. Finally, drought was identified as a fourth hazard. These four hazards have already had demonstrated impacts on the City, and as climate change progresses, these hazards are expected to have ever greater consequences for infrastructure and environment, as well as for various societal elements. Specific areas of concern are identified below.

Top Hazards

- Flooding
- Severe Storms
- Extreme Temperatures
- Drought

Areas of Concern

While many impacts are expected to be felt City-wide, certain elements, locations, or community groups present particular concerns.

Neighborhoods/Communities
Downtown, Ward 2, Belmont Avenue, Caffrey Towers Apartments, Campello Neighborhood

Buildings and Facilities
Kmart Plaza, Westgate Shopping Mall, Massasoit Community College, Brockton High School, North Middle School, Brockton Housing Authority properties, D.W. Field Park

Ecosystems
Searle's Brook, Malfardar Brook, Westgate River, Salisbury Brook, Salisbury Plain River, Ellis Brett Pond, Silver Lake (southeast of the City), , Trout Pond, Hunt's Pond, Gerry's Farm, Brockton Reservoir (north of the City, in Avon), D.W. Field Park

Infrastructure
Electric infrastructure, natural gas lines, Campello rail line, Wastewater Treatment Plant, water supply transmission lines, the "T" Commuter rail line

Dams
Brockton Reservoir Dam, Trout Pond Dam, Hunt's Pond Dam, dams in D.W. Fields Park

Current Concerns and Challenges Presented by Hazards

Flooding is a severe hazard that frequently affects Brockton. The City has been experiencing an increasing regularity of storms, with the so-called ten and one hundred year storms now happening on an annual or near-annual basis. Intense storms occurring throughout the year are producing very high volumes of rain, causing rivers and streams to overflow their banks, putting significant pressure on dams, culverts, and other drainage infrastructure, and overwhelming the stormwater infrastructure system. Flooding frequently has City-wide impacts, including road closures at susceptible locations, such as Crescent Street and the Kmart Plaza on Main Street. Because of a high degree of impervious surfaces in the City, even moderate volumes of stormwater in Brockton can result in stormwater runoff that floods buildings and infrastructure. In recent memory, rescuers have had to pull residents out of flooded homes from a boat, and certain neighborhoods are susceptible to flooding and related power outages. Four homes in one neighborhood have even been removed after suffering repetitive losses from flooding, including damage from sewage that would accumulate to a depth of six feet inside the buildings.

In addition to concerns about heavy precipitation, Brockton residents face the potential impacts of more major storms, such as hurricanes and Nor'easters. Notable historic events include impacts from the Great Hurricane of 1938, and although recent hurricanes have not had a direct impact on Brockton, residents are concerned that such storms will become more impactful on the community. The City was in the path of Tropical Storm Barry in 2007, but fortunately, the storm lost most of its power before reaching Brockton. Indirect or diminished rainfall from hurricanes and tropical storms can be devastating, as a result of the City's vulnerability.

Unlike hurricanes and tropical storms which occur with medium frequency, mainly during spring and fall, and have thus far largely spared Brockton, winter storms are a high frequency hazard for the City. Brockton receives an average 38 to 48 inches of snowfall annually. High winds and accumulating precipitation threaten public safety, restrict economic activity, and disrupt transportation as streets become impassable. The weight of ice and snow can pull down trees and powerlines and over-burden flat roofed buildings with excessive snow loads, causing them to collapse. Further, climate change is bringing new types of winter storms, where ice, snow, and rain may arrive in a single event, complicating the already challenging task of maintaining roads and keeping residents safe. In extreme cases, residents may be unable to leave their homes or receive assistance for many days at a time.

In recent years, Brockton residents have also observed extreme temperature changes during each change in season. Summer, for instance, brings its own challenges, as the City is increasingly dealing with extreme heat conditions. In 2018, cooling centers were opened, and City pools made the decision to extend their hours and the season by 7 days in order to provide essential cooling services to local residents.

Although recent history has shown that Brockton has experienced a recorded tornado event occurring downtown (July 10, 1989), tornadoes are virtually unheard of, and are still considered to be a low-frequency hazard. Nonetheless, the City experienced two tornado warnings in 2018 which negatively impacted activities at Massasoit Community College and other events in the City, with increasing concern about the link between climate change and more extreme weather events.

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Specific Categories of Concerns and Challenges

Infrastructural

Culverts and Bridges

Culverts and bridges are a concern City-wide, particularly as Brockton's developed areas are in close proximity to the Salisbury Plain River and several vulnerable brooks and wetlands. Existing culverts and bridges were designed to accommodate historic patterns of precipitation and runoff, but are rapidly becoming inadequate as a result of climate change. Brockton's Belmont Avenue Bridge, built in 1910, is undersized to the point that, rather than serve as a conveyance, as intended, it is instead acting as a flood control structure by limiting flows. While design standards have changed, the City's infrastructure largely predates such changes. As precipitation events become more intense and less predictable, undersized culverts are expected to pose a greater threat of failure and flooding. Brockton is implementing a bridge replacement program designed to provide adequate hydraulic capacity, lift bridges and roadways out of the floodplain, and relocate suspended utilities to provide greater resiliency. Seven replacements have taken place to date and have greatly reduced flooding in the Belmont Road area. However, removal of upstream constrictions, by allowing water to move through Brockton more quickly, has transferred the problem downstream and is leading to increased flooding in West Bridgewater. There is not currently a systematic, detailed inventory that catalogs the size and condition of culverts and bridges City-wide.

Dams

There are eleven dams in the City of Brockton. Six of these are part of a contiguous system of dams that run through the length of D.W. Field Park and are managed by the Parks Department. Though not originally designed for flood control, the park dams provide upstream flood storage and protect heavily populated, downstream areas where development along the Salisbury Brook and Salisbury Plain River would be threatened by floodwaters from a dam failure. Tim Carpenter, the City's Superintendent of Parks, noted that the dams do not have much additional flood storage capacity in their current state, based upon the preliminary results of a dam safety investigation being undertaken by Fuss & O'Neill through a grant from the Dam & Seawall Grant program. The current study is specifically focused on design of required improvements to the Ellis Brett Dam but also includes evaluating potential improvements to the seven City-owned dams in the Salisbury Brook Watershed that could potentially reduce flooding in downstream flood prone areas of the City. Workshop participants recognized the critical importance of the upstream dams to the City and the need to have them assessed for safety and infrastructure improvements. During the workshop, it was noted that the dams primarily impound water flowing from upstream and water that falls within the parks themselves, whereas much of the City's stormwater enters the system further south. There was also concern about the dams that are outside the City limits, such as the Brockton Reservoir Dam which supports one of the City's water supply sources and is the seventh dam after the six park dams. More information is needed to better understand how the City's dams work together, how they could best be managed for flood control, and where modifications could be made to help mitigate flooding impacts to downstream areas.

Roads

Roads in Brockton are vulnerable to flooding, in addition to the impacts of snow and ice. In general, shifting weather patterns due to climate change make it increasingly difficult to maintain and clear existing roadways. Potholes and sinkholes are becoming more problematic due to new patterns of freezing and thawing that occur repeatedly throughout the winter season. Roadways in the City are also susceptible to blockages from trees and power lines brought down by wind storms. These impacts in turn compromise the City's ability to provide emergency services. As climate change increases the frequency of weather-related risks, more focus on the prevention of hazard conditions is necessary to increase the resiliency of the City's roads. The layout of Brockton's street system is an interconnected urban grid, which is beneficial

for circumventing around road closings and escaping hazard areas. However, certain intersections are considered dangerous or susceptible to extreme traffic delays, such as the intersection of North Main Street and Oak Street. As identified in the CRB Workshop, having plans for safely managing traffic, providing alternative routes, and effectively evacuating residents from these areas is a priority. Additional consideration was given to regional evacuation routes for the homeless and elderly.

Water Supply and Water Infrastructure

Water Supply for the City of Brockton comes primarily from Silver Lake, 15 miles southeast of the City, and is supplemented with water from Brockton Reservoir, making both waterbodies areas of concern as aquatic ecosystems and vital municipal resources. The City also purchases water from the Aquaria Water Treatment Plant in Dighton, MA, which processes water from the Taunton River through the Taunton River Desalination Facility. The City of Brockton is concerned about the resilience of its water resources, in particular, having enough water to sustain the City during extended drought. Extreme temperatures and drought conditions are known to exacerbate problems with harmful algal blooms, which are already a concern for the waterbodies around Silver Lake. The desalination plant is also vulnerable to drought-induced salt intrusion, which has the potential to raise salinity levels beyond the plant's operating range constraints. In addition to the impact of drought on regular water supply, extended drought makes surrounding landscapes susceptible to wildfires, putting additional strain on the City supply. The water supply transmission lines that carry water to the City from Silver Lake and Dighton are also a concern, as they are aging and vulnerable to hazards such as flooding and extreme temperatures. The "new" supply line from Silver Lake was installed around 1920. Finally, workshop participants expressed concern about the possibility of private wells running dry as a result of drought and the need to consider expanding the public water supply to provide a more resilient supply source for residents served by private wells.

Stormwater Basins and Conveyances

Detention basins and other stormwater infrastructure are recognized as a potential concern City-wide. Similarly to culverts conveying natural streams, there is a general recognition that much of the stormwater drainage system was designed to accommodate historic patterns of precipitation and runoff, and may be undersized as climate and weather patterns continue to shift. The City's aging stormwater infrastructure and lack of maintenance funds exacerbates flooding potential during heavy rains. Further, development in Brockton has added to the amount of impervious area in the City, and in some cases decreased flood storage, which in turn has increased runoff and flooding potential. Drainage-driven flooding is a problem town-wide, but particular areas of concern include the area around the Westgate Shopping Mall, the Kmart plaza (on Main Street), and Route 28.

Communications Infrastructure

Brockton's communications infrastructure is vital to providing emergency services, but is vulnerable to a variety of climate-related hazards, including wind, but also flooding, snow, and ice. Ted Medeiros, a Network Administrator for the City, explained that extreme heat and humidity are also taking a toll on City-owned communication infrastructure. In addition to municipal infrastructure, the City is served by a privately-owned, Crown Castle high-capacity fiber line which would break down communications capabilities within the City if damaged by a hazard, potentially compromising residents' ability to receive emergency messages or communicate with emergency responders.

Emergency Operations Center

Brockton's Emergency Operations Center (EOC) and the Brockton Emergency Management Agency are housed in the War Memorial Building. The EOC provides a place to run operations in case of an emergency and is equipped with backup power via a portable generator that is stationed at the EOC all winter.

Underground Storage Tanks

Underground storage tanks exist on public and private land, City-wide, though the location and condition of each one is not known. The tanks are vulnerable to flooding and considered to be an area of concern for the City.

Buildings and Facilities

City Hall, the War Memorial Building, and the Council on Aging typically maintain power because of their locations and electrical infrastructure, which enables these critical facilities to maintain function during a hazard-induced power outage and, in the case of the War Memorial and Council on Aging, to operate as warming and cooling centers. There are various other public buildings where generators are needed to protect the buildings and related infrastructure, for example, from the threat of frozen pipes during extreme cold. The major facilities operated by the Housing Authority have back-up generators to maintain heating and cooling capabilities and keep elevators running for a temporary period but cannot operate on a prolonged, multi-day, 24 hour basis. Fire personnel have had to carry senior residents down stairs during hazard events when generator power operating building elevators ran out. A portable generator is currently shared among sites, but is recognized as insufficient.

Utilities Infrastructure

The City's utility infrastructure is susceptible to a range of hazards. Power lines can be knocked out by snow and ice in addition to wind events, causing extensive impacts to the City. Workshop participants recognized that impacts to the downtown power network that resulted in power outages would hinder economic activities and access to goods and services, critically important to the City and its residents. The City's partnership with National Grid is important in making power lines more resilient, and Brockton benefits from National Grid's tree trimming program, which was recently modified to put the City on a four-year maintenance cycle instead of a five-year cycle. In addition to risks to the power lines, the City has a power transmission substation located in a floodplain, which is vulnerable to flooding. Extreme heat also stresses the electrical system, as increased use of air conditioning leads to a risk of brownouts and outages, particularly if heat impacts are region-wide. Though the impacts were less-widely discussed, the City's gas infrastructure may also be vulnerable to the impacts of flooding; further information is needed to fully identify the associated risks.

Wastewater Infrastructure

Severe storms bringing heavy precipitation can overwhelm the sewer system by inundating pipes and pump stations, and causing Inflow and infiltration in various areas of the City. The City has an ongoing infiltration and inflow program, and recently purchased a camera truck for CCTV to be used in tandem with smoke testing to trace problems. A minimum of $3 million is expected to be needed for additional work. Wastewater infrastructure is also vulnerable to power outages, which may result in backups and sewer overflows if pump stations are shut down. Maintenance and upgrades to Brockton's wastewater infrastructure are ongoing, but further safeguards are needed at pump stations located in low areas across the City and at the wastewater treatment plant in order to ensure back-up power, flow control, and protection from flooding.

Environmental

Wetlands

Encroachment and unpermitted filling of Brockton's wetlands has occurred historically and in more recent years. The City currently lacks a local wetlands or stormwater ordinance to provide additional protections to these sensitive environmental areas that play a crucial role in resiliency to climate impacts, particularly the effects of flooding. The City's Conservation Agent, Megan Shave, expressed a need to explore further

regulatory mechanisms and increased enforcement of existing regulations to mitigate damage caused by filling and encroachment and increase resiliency.

Environmental Contaminants

Workshop participants raised questions about the location and extent of environmental contaminants that remain as legacy pollution from the City's industrial past, the potential negative impacts these contaminants could have on the City's water quality, and how human communities, ecosystems, and wildlife could be affected. This is particularly pertinent as climate change threatens to mobilize latent contamination through increased heat or flooding risks. Specific concerns were raised with regard to contamination at the waste transfer stations in Campello and Montello.

Trees and Forests

Forests provide critical ecosystem services that help buffer the effects of climate change, from sequestering carbon, to increasing groundwater recharge, to modulating local temperature. Street trees within urban spaces are likewise critical for infiltration of rainwater and provision of shade. However, trees and forests are also threatened by climate change, and loss of trees was identified as an issue in the City. Wind and storms cause blowdowns, drought can contribute to die-offs, new invasive pests (e.g. Emerald Ash Borer, Asian Longhorned Beetle) are eliminating certain tree species, and others are in decline due to shifting temperature and precipitation regimes that favor more southerly species. Participants expressed interest in stewarding the City's trees and forests, recognizing them as a form of valuable "environmental infrastructure."

Open Space

Open space provides many of the same resilience benefits and faces many of the same threats described above for forests. Brockton's open space includes an extensive network of parks, playgrounds and other open space that provides many social, environmental, and economic benefits to the City, but some of the City's open space is threatened by problems such as high salt levels from stormwater runoff (especially noticeable at the D.W. Field Golf Course). Open space is critical in floodplains for providing a buffer and increased flood storage, near public water supplies to maintain high water quality and promote recharge, and to maintain overall habitat connectivity that will be vital to allowing ecosystems and individual species to adapt to a changing climate. Open space also provides important recreational opportunities and relief from stress. Brockton's most recent Open Space and Recreation Plan was completed in 2013.

Flood Storage

The City is threatened by the loss of flood storage capacity caused by historic and ongoing development and filling of wetlands and floodplains. Brockton has extensive development and critical infrastructure in highly vulnerable, low-lying areas. There is a need for strategies to increase flood water storage capacity in the City and implement green infrastructure approaches to increase resiliency. Ellis Brett Pond offers a success story within the City. The pond, which used to be used for swimming, became polluted with runoff and salt from the shopping mall and surrounding parking lots. The City eventually emptied the pond and instead created a wetland to help mitigate stormwater issues and flooding downstream.

Invasive Species

Invasive plants and animals are a source of concern throughout the Commonwealth. Forest and upland ecosystems are threatened by a variety of invasive plants, including plants such as oriental bittersweet, multiflora rose, two types of swallowwort, and several non-native honeysuckles. Riparian and aquatic habitats are severely threatened by common reed, Japanese knotweed, invasive water chestnut, hydrilla, purple loosestrife, and Eurasian milfoil. Critical invasive insect pests already in the area include the Asian Longhorned Beetle, Hemlock Wooly Adelgid, and Emerald Ash Borer, all of which have the potential to do serious damage (both environmental and economic) to Massachusetts' forests and trees. These and other

species already pose a significant challenge and have serious consequences for ecosystem health and resilience, and these impacts are likely to increase in response to climate change. Warming temperatures will also bring new invasives to the area, and these will have an easier time gaining a foothold if the City's natural ecosystems are simultaneously weakened due to changes in climatic conditions.

Water Quality

Many of the waterbodies surrounding Silver Lake are already experiencing harmful algal blooms, which poses a major concern for the quality of the City's primary water source. Rising average water temperatures resulting from climate change and decreased water levels due to drought both contribute to conditions that are increasingly favorable for the presence of harmful algal blooms and bacteria. These negative impacts, as well as nutrient pollution, which is driven in part by changes in land use, can result in fish kills, and impacts to recreation and public health. The City recently received funding for a $200K water quality monitoring program for Silver Lake.

Stormwater Runoff

Patterns of urban growth and development in Brockton have resulted in extensive imperious surfaces, which prohibit stormwater infiltration and lead to issues with runoff. Participants at the workshop reported that stormwater volumes become so high during significant rain events that they can pop off manhole covers. Stormwater runoff is recognized as an area of concern affecting both public and private properties City-wide, but the problem is particularly relevant at the Westgate Shopping Mall. Workshop participants recognize the value of the MA MS4 permit in addressing stormwater runoff issues and mitigating polluted discharges affecting waterways and water quality. Participants also noted that all new development, since 1985, has had to abide with provisions that provide for no-net increase in stormwater runoff. This provision would be in effect for any future development, including Calvary Cemetery on Cary Street, Lower Ames Street, and any other sites where flooding is already an issue, and continued stormwater runoff may be a concern. The City is also exploring a stormwater utility which would help to generate the necessary funding to implement strategies like green infrastructure retrofits.

Environmental Regulations

Participants noted the importance of governance and regulations for discouraging development within the City's flood zones, ensuring that new development and building construction meets improved permitting standards, and proactively addressing stormwater and flooding issues. However, Brockton does not currently have a stormwater or local wetlands ordinance.

Societal

Public Transportation

Brockton has strong public transportation assets, which are critical to mobility during hazard events. The Brockton Area Transit Authority (BAT) currently provides on the order of 9,000 trips per day, and the majority of its users (which are estimated to include approximately 20% of the City's population) are transit-dependent. Maintaining public transportation options during emergencies and extreme weather helps to ensure that residents who do not drive or own a car can evacuate hazard areas, obtain necessary provisions, or access critical services and medical care. In addition to those critical, short term objectives, the City also depends on its public transportation system to achieve long term objectives, such as allowing people to get to work and keeping businesses open whenever possible, despite hazardous weather. Workshop participants also recognized that encouraging the use of public transportation is necessitous to decreasing greenhouse gas emissions from personal vehicles, and a necessary step toward meeting the Commonwealth's goals for emissions reductions and helping to curb the effects of climate change.

Massasoit Community College

There are currently two entrances to Massasoit Community College, one of which, located on Crescent Street, is prone to flooding. In addition to the obvious need for staff and students to get in and out of the college facilities in the event of a hazard, the college is a FEMA-designated, area-wide staging area for emergencies affecting the City or greater region. The college is also one of two helicopter landing sites utilized by the hospital. Adequate emergency access is therefore imperative. Elsewhere on campus, buildings are subject to flooding due to a high water table, a situation which is already resulting in the need to consistently run sump pumps to remove water from the buildings and is expected to worsen with climate change impacts.

Gerry's Farm

Workshop participants noted that New England as a whole has a three to five day supply of food if the existing supply chain were to break down due to a hazard event. Gerry's Farm, the last remaining farm in Brockton, was identified as an important local agriculture resource that could support a food resilience plan for the City.

Language Barriers

Brockton is home to diverse populations, including its predominant Haitian and Cape Verdean communities. Addressing potential language barriers as part of the City's emergency preparedness planning and response efforts was an area of social concern. The City recognizes that hazard warnings and emergency updates should be accessible to, and easily understood by, all residents, including those who speak English as a second language.

GIS Maps

Brockton's assessors' maps are 60 years old, and therefore lack critical, up-to-date information on lot locations and sizes, proximity to critical infrastructure and flooding areas, and other data that is especially relevant to flooding hazards. Funding for updates has been repeatedly delayed.

Residential Property

Certain neighborhoods within Brockton, such as Ward 2, Campello, and the Belmont Avenue area, are especially prone to flooding and have been experiencing problematic events for decades. Stormwater runoff from extended rainfall like that associated with recent precipitation events can cause local waterbodies to surge with large volumes of water moving at high velocity, increasing the threats to private property. Four repetitive loss properties on Belmont Avenue have already been removed using a FEMA grant. Properties near Malfardar Brook have experienced erosion from stormwater that is undercutting stream banks, eroding ten to twelve feet into residential properties, undermining and toppling trees, and posing a risk to the surrounding single-family homes, which are owned largely by low-income residents and/or seniors. Flooding of yards and basements on both residential and commercial properties continues to be a problem City-wide.

Environmental Justice Communities and Vulnerable Populations

Workshop participants expressed concern about the impacts of climate hazards on a variety of environmental justice communities and vulnerable populations in Brockton, including low-income residents, seniors, the homeless, and individuals with respiratory issues. Identifying and reaching vulnerable populations can be a challenge, especially those who may no longer have a land-line telephone, homeless individuals without an address, or those who may not self-identify as vulnerable. Certain populations, such as seniors and people with health or income constraints, are known to be at higher risk during hazard events and may require support beyond emergency notifications. Workshop participants expressed concerns about these populations' ability to obtain food and medical supplies during hazard events, the risks from diseases that may be exacerbated by certain climate change impacts such as extreme heat, as well as the challenges involved in getting individuals (especially seniors) to leave their

homes (and sometimes their pets) in order to seek shelter elsewhere. Participants also noted that Brockton has a high rate of homelessness, with up to 70% of the homeless population coming to Brockton from surrounding communities, placing extra demands on the City's services and emergency response capacity. These numbers may further increase if additional individuals from the surrounding community migrate to Brockton after being displaced by climate change. Better understanding Brockton's vulnerable populations and their distinct needs is essential to the City's emergency preparedness and planning efforts and to successful coordination with local civic organizations that support these populations.

Communications Systems

The City deploys a Code RED/Reverse 911alert system during emergency situations, which sends emergency alert messages to anyone with a home phone or a smart phone registered with the system. All citizens and businesses are encouraged to register to receive alerts. Question remains whether critical communications services like this can reach everyone with consistent and reliable information, especially homeless populations, residents without a cell phone or landline, and residents who speak English as a second language. Existing social organizations in the City complement and bolster the formal communications system by coordinating on-the-ground information gathering and sharing strategies to reach more citizens. Insufficient communication between these entities and the public as well as internal communication break-downs within City departments is recognized as an issue that may be hindering the effectiveness of the City's communication systems.

Provisions, Fuel, and Medical Care

Maintaining access to essential supplies like groceries, fuel and medicines, as well as social services like mental health care, drug treatment, and fuel (for vehicles, home heating, and generators) was a concern for workshop participants. It was acknowledged that power outages or road closures, which affect access to these services, could have extensive impacts on residents throughout the City. These issues are exacerbated for vulnerable populations, including individuals depending on oxygen, refrigerated medicine, or energized devices for maintaining their health.

Stress on Emergency Services

Brockton's Fire, Police, and Public Works departments bear much of the burden of responding to the increased human threats that result from climate-induced hazards. An ever larger percentage of the departments' time and resources are being devoted to handling things like traffic accidents, clearing roads to maintain access and traffic flows, activities to protect property, such as pumping out residents' flooded basements, and aiding overall recovery efforts. The Fire Department knows the City's flood-prone areas and responds effectively. Coordinated emergency response between the Police department and ambulance service was also described as strong. However, staffing and equipment needs exist among the departments. It was also acknowledged at the workshop that the practice of neighboring communities sending displaced and homeless populations to Brockton for services and resources places additional strain on emergency services, and that climate impacts may disproportionately impact low-income neighborhoods or homeless populations, with the potential to overwhelm support services.

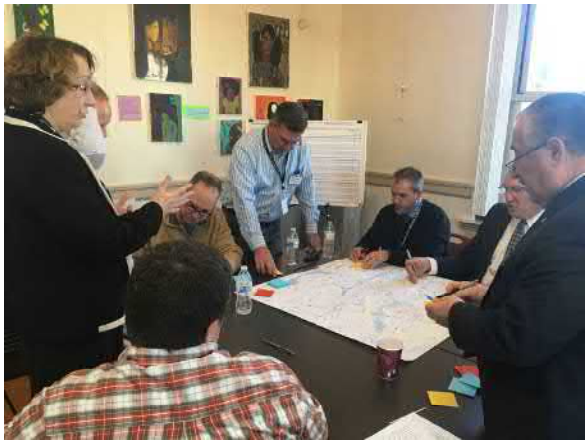
Schools

Brockton's schools and student population are affected by a variety of hazard types. While the City has four newer schools, built in the early 2000's, many of the City's occupied school buildings are over 100 years old, making them difficult to maintain. Some of the City's schools are located in floodplains and are susceptible to flooding, including the Raymond School, which required remediation and drainage work after its gym was flooded 10-15 years ago. Schools are increasingly forced to cancel classes due to snow and ice events or extreme cold that make it impossible to safely get the City's 17,000 students to and from school. This, in turn, extends the school year further into the summer, which exacerbates the risks that school will be in session during extreme heat events. As days above 90 degrees increase, heat stroke is a

concern for the student population at the six out of 20 schools that are not air conditioned, and for student athletes practicing outdoors. Of the schools that lack air conditioning, many need their electrical systems upgraded before they can support A/C systems. Nonetheless, the City is working on these upgrades and plans to have all schools air conditioned by July, 2019. This would not only benefit students in class during the summer, it would potentially allow the City to offer more cooling centers for residents during heat waves.

Pests and Disease Control

Climate change is affecting pests and disease vectors both through changing precipitation conditions and changing temperature conditions. Warmer, wetter conditions lead to increased mosquito populations, while the absence of sufficient periods of cold means that pest populations that would historically have been killed off or reduced are able to survive the winter and emerge in greater numbers the following season. Further, as the Massachusetts climate begins to look more like that of the mid-Atlantic and southern states, we are seeing new types of diseases show up in existing pests (e.g. mosquitoes carrying West Nile Virus, Eastern Equine Encephalitis, or Zika and ticks carrying Rocky Mountain Spotted Fever). 2018 marked the Commonwealth's highest ever incidence of West Nile Virus diagnosis. These changes present a major public and animal health challenge in terms of education, prevention, and treatment. The City feels there is a need to educate its residents about precautions against contracting vector borne illnesses and to explore environmental strategies, like protecting undeveloped areas and providing more landscape buffers, in order to reduce human exposure to pests.



Current Strengths and Assets

While the City recognized a number of vulnerabilities, workshop participants identified key strengths as well. Brockton has a number of systems in place to facilitate emergency communications and help ensure that emergency services can be provided in a wide range of conditions. The City also benefits from the support provided by Old Colony Regional Planning Council.

- Brockton's Schools have many resilient features, including a strong IT communications network, situational awareness practice, and outreach programs to parents during emergencies.
- The City is in the process of installing air conditioning in City schools, and systems operate on timing controls for maximum efficiency and energy savings.
- City Hall has a back-up generator to ensure that power to the City's IT and 911 hubs housed there is uninterrupted during power outages.
- The Mayor's Quality of Life Taskforce meets weekly to discuss matters of importance to the City and its residents.
- Brockton has six Fire Stations that are well-positioned to respond during hazard events, and coordination between the Police and ambulance services is strong.
- The City has a portable generator that can be deployed at one of multiple buildings during emergencies, including warming and cooling centers.
- The City operates a Code RED Emergency Alert system that can be used to share information relevant to short-term hazards or expected long-term hazards.

- The War Memorial is home to a brand new Emergency Operations Center, where a portable generator is stationed during the winter.
- Brockton is already completing bridge repairs and replacements to provide adequate hydraulic capacity at these structures.
- The City has multiple water sources, including Silver Lake and the desalination plant in Dighton.
- The City has robust public transportation resources through Brockton Area Transit.
- The state-owned commuter rail, with stops in Campello, Brockton, and Montello, improves mobility for the City's many residents, which is important for emergency management.
- Brockton's schools practice sustainability measures such as using green cleaning products.
- The City's Housing Authority has back-up generators to power emergency lighting and elevators, and a community room with A/C.
- Massasoit Community College is a vital resource for training students and community members about sustainability through both curricular activities and by demonstrating practices such as rain gardens and a solar power project in its parking lot. The college has also implemented energy and water conservation measures that will save $2 million over the next 20 years.
- Brockton's wastewater treatment plant is operating under capacity. The facility has a capacity of 36mgd, but is currently only permitted for 18mgd because of the capacity of receiving waters.
- All City lights have been converted to LED, including parking lots and street lights, resulting in cost savings and lower energy use.
- Two of Brockton's fire stations have been converted to natural gas to increase efficiency and resiliency.
- Massasoit Community College also serves as an area-wide FEMA emergency site.
- There are two designated emergency helicopter sites on opposite sides of the City; one at Massasoit Community College and one at Brockton High School.
- The City of Brockton is a certified Green Community.
- Several emergency shelters are available during hazard events, including the Arnone School.
- Brockton's hospitals are serviced by dual electric feeds which increase resiliency to power outages.
- A remediation project at the Raymond School repaired damage from past flooding.
- Brockton Emergency Management Agency (BEMA) is a dedicated department focused on emergency management.

- The City has established new parks, transforming former industrial and commercial sites into valuable open space.
- Brockton's partnership with National Grid includes tree work to increase the resiliency of utility lines.
- Brockton is included in a 2015 regional Hazard Mitigation Plan developed by the Old Colony Planning Council.
- Brockton is part of a regional Local Emergency Planning Committee (LEPC) and has mutual aid agreements in place to assist during emergencies.
- Brockton has resources available in multiple languages, including a multi-lingual City website, radio offerings in several languages, and translation skills available in the Mayor's office.

Top Recommendations to Improve Resilience in Brockton

Participants at the CRB workshop identified a number of recommendations to address vulnerabilities and increase resiliency in three main topic areas: infrastructure, environment, and society. Management of water, from stormwater runoff from impervious surfaces, to flood storage capacity, to the quantity and quality of public drinking water, was an overarching concern that emerged in both the small and large group discussions. Improving undersized or deteriorating infrastructure systems was a second major theme. Finally, much attention centered on providing services to the City's residents during hazard events, with particular focus on vulnerable populations.

Highest Priority

- Develop an integrated all-waters approach to increase flood resiliency City-wide. Assess the viability of using nature-based solutions such as restoration of wetlands and river channels or implementation of green infrastructure to develop a list of specific priority projects where reduction of stormwater runoff and increased flood storage capacity could mitigate flooding risk. Building on the ongoing dam study by Fuss & O'Neill, conduct a thorough study of the City's dams to understand how they work together, where they are effectively contributing to flood storage capacity, or where dam removals may be a more effective means of encouraging resiliency. Additionally, evaluate areas where additional stormwater infrastructure (including green or grey infrastructure) may be necessary or where stormwater structures may require enlargement in order to accommodate high volume or high velocity stormwater runoff. Assess feasibility and cost, rank priority projects in terms of climate resilience potential, and develop concept designs for key projects. Review City regulations and update as necessary to support green infrastructure and low-impact development approaches. Explore multi-community and public-private partnerships to address interrelated flooding issues that cross over community and jurisdictional boundaries.

- Conduct a field inventory of culverts and bridges that builds upon the City's existing bridge replacement program to rank and prioritize projects for increased flooding resiliency and storm-hardening, followed by design and implementation of priority re-sizing or replacement projects. Green infrastructure, Low-Impact Design, and other nature-based solutions will be integrated with hard-infrastructure improvements to establish approaches that will be robust in the face of natural hazards and climate-change scenarios.

- Conduct engineering and hydrology studies on the City's dams to identify and prioritize repair needs. Pursue design and permitting for projects that will improve flood resiliency, such as the installation of an automated gate at the spillway of Ellis Brett Pond Dam.

- Conduct a comprehensive assessment of water quality, supply, and infrastructure, including assessment of aging infrastructure, such as the transmission lines from the desalination plant in Dighton and from Silver Lake; options for an additional back-up water supply; potential for incorporating homes with private wells into the City water supply system and means of mitigating climate-driven impacts on public water supply sources, such as harmful algal blooms, drought, or salt intrusion. Assessments should build on already ongoing work with increased coordination to facilitate progress toward actionable projects and improvements.

- Perform a risk assessment of the wastewater treatment plant and pump stations and establish priority actions for reducing potential flooding impacts, including consideration of nature-based solutions or green infrastructure approaches, as well as the possibility of constructing levees to protect the Campello wastewater treatment plant. Establish emergency back-up plans for the plant and pump stations.

- Increase maintenance of catch basins, conveyances and detention ponds. Review and improve maintenance schedule and budgets, keep up with regular maintenance of publicly-owned structures, and increase frequency of street sweeping and catch basin cleaning.

- Review and update City regulations to improve stormwater management and mitigate flooding risk. Develop and adopt a wetlands ordinance and stormwater ordinance and ensure that the City's regulatory mechanisms are in compliance with and work in tandem with the MA MS4 Permit to promote infrastructure improvements and increase infiltration of stormwater. Increase capacity for oversight and enforcement relative to existing wetlands, and incorporate new standards such as requirements for green space and tree preservation and/or planting in development projects. Develop methods to disincentivize development within the City's flood zones, and ensure new development and building construction meets improved permitting standards.

- Assess needs and vulnerabilities in the City's emergency communication systems. Determine where communication breakdowns are occurring or may occur during a hazard event. Develop a plan to overcome internal communication barriers within City departments and between the City and community partners or residents. Improve outreach and education efforts to ensure City residents, especially vulnerable populations and residents for whom English is not a first language, can access accurate and up-to-date emergency information, shelters, heating and cooling centers, evacuation routes, provisions and services during emergencies.

- Develop an urban agriculture initiative centered around Gerry's Farm in order to foster urban agriculture and local food resiliency.

- Pursue funding to update assessors (GIS) maps. Make maps available online for property owners, banks, and appraisers. Map locations of lots and delineate land sizes and flooding areas to provide data that is especially relevant to flooding hazards.

- Establish a gated emergency entrance at Massasoit Community College that connects the college to the Shaw's Plaza on Crescent Street and ensures access to the college and associated area-wide FEMA staging site during hazard events, particularly in the event that the college's existing entrance is blocked by flooding.

- Develop a City-wide Business Improvement and Economic Development Plan to support local businesses and make the business community more resilient. Identify business development areas where impacts from climate hazards can be easily avoided or mitigated (e.g., by avoiding floodplains or areas of known drainage-related flooding) and targeted improvements, such as a microgrid, could be employed to provide extra resilience to community businesses. Simultaneously identify areas from which businesses would be encouraged to divest in order to avoid hazards and minimize the potential for economic losses or additional stress on emergency services. The plan's goals should also include a focused plan for attracting climate-friendly businesses to the City that will invigorate the City's economy, improve the tax base and reduce the tax burden to all residents, business owners, and land owners while simultaneously generating funds that will enable the City to continue building toward a resilient future.

- Plan and post neighborhood and regional evacuation routes, with particular attention to the needs of homeless and elderly populations.

- Evaluate opportunities to provide emergency backup power to critical facilities, including feasibility of green power and battery storage. City-wide, there are a number of buildings and facilities (including substations, schools, Brockton Housing Authority properties, etc.) in need of backup power systems to protect public buildings and infrastructure from freezing and improve services for residents who may lose power during emergencies or hazard events.

- Assess additional mosquito/pest control options, including establishment of buffers between developed and undeveloped areas, determination of future risks due to increase in type and quantity of pests/disease vectors due to climate change, and development of an education and outreach program.

- Partner with electric and gas utility providers to identify and address vulnerabilities in utility infrastructure and enhance communication and cooperation between the City and private utilities.

Moderate Priority

- Assess levels and sources of stream contaminants in tandem with the requirements of the MS4 Permit and develop and enforce measures to detect and eliminate illicit discharges where they are contributing to water quality problems. Utilize the MS4 requirments and TMDLs to promote stormwater management and green infrastructure improvements.

- Continue to support coordinated efforts to provide emergency shelters that effectively serve Brockton's population during hazard events, including cooling and warming centers.

- Upgrade all traffic lights with Opticom transmitters to give priority access to emergency vehicles at busy intersections and aid in emergency response during hazards.

- Conduct an assessment of communications vulnerabilities related to predicted climate hazards. Crown Castle's high-capacity fiber line is of particular concern, as it is key to ensuring that residents remain connected during hazard events and can access emergency information and the City's Reverse 911 system.

- Assess redundant power options for the downtown area, including studying the feasibility of various options, such as establishing a dual-feed connection or microgrid system to ensure that services continue if the primary power supply is disrupted by a hazard event.

- Develop a Greenhouse Gas (GHG) Reduction Plan, which includes public transportation systems to foster improved air quality and health for residents suffering from respiratory issues, especially seniors and vulnerable populations.

- Inventory and assess school buildings, in particular the Middle School and High School, for necessary repairs or upgrades to educational buildings and infrastructure.

- Implement plans to install air conditioning in all Brockton schools, including necessary upgrades to the electrical infrastructure to allow for the additional capacity required to run air conditioning systems.

- Coordinate emergency response plans with the bus transit network and commuter rail line in Campello, Brockton, and Montello. Build upon emergency plans already in place to improve mobility and increase emergency response efficacy.

- Develop a regional approach to stormwater management so that actions taken in Brockton consider impacts downstream. Brockton is near the top of the Taunton River watershed, and as noted above, improvements that enable water to move through and past Brockton more quickly may result in negative impacts downstream. Collaboration with downstream communities, including Bridgewater, is therefore crucial to any successful resilience strategy. Build on recent activities by watershed communities to look for future planning synergies.

- Conduct a traffic study to address areas in the City where extreme traffic delays could exacerbate hazard impacts, hinder evacuation, or delay emergency services. Particular focus should be placed on the intersection of Oak Street and N. Main Street, where an alternate route may be necessary to efficiently evacuate the area or reach the northern part of the City during hazard events.

Lower Priority

- Assess drainage and management improvement options for the Campello rail line where it stretches through a floodplain in order to prevent potential damage from flooding or other climate change-induced hazards.

- Investigate potential contamination from waste transfer stations in Campello and Montello and assess vulnerability to flooding and other hazards.

- Develop a comprehensive tree and forests management program to identify, remove, and replace problem trees, preserve intact forests and street tree cover, provide guidance and resources for gradually moving toward more climate-resilient trees and forest communities (e.g. species that will tolerate warmer temperatures) and develop guidelines to manage conversion of forest land and require shade tree plantings in new developments to promote erosion control and improved infiltration.

- Increase the availability of electric vehicle charging stations to encourage use of electric vehicles and decrease greenhouse gas emissions.

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CRB Workshop Participants

All workshop invitees are listed below; attendees are indicated with an asterisk.

Name	Position/Organization
Benjamin Denny*	Firefighter/ Fire
Bill Mitchell*	Massasoit Community College
Bill Santos*	IT Director/ IT
Chavonne Baldwin	Columbia Gas
Chike Ondukwe*	City Engineer
Chris Cooney	Metro South Chamber of Commerce
Chris Pike*	Assessor's Office
Claudia Sousa	Brockton Neighborhood Health Center
Conor Michauld	Community Stewardship Program Coordinator/ Wildlands Trust
Dave Farrell	Veterans Services
Deniz Leuenberger	Bridgewater State University (PHD)
Gena Glickman	President/ Massasoit Community College (PHD)
Howard Newton*	Engineering
Jaime DiMestico*	Facilities Manager/ BPS
Jim Casieri*	Buildings Superintendent
Joanne Zygmunt*	Environmental Sustainability Consultant/ Fountain Collaborative
Joe Cardinal*	National Grid
John Crowley*	Chief of Police
John O'Donnell	Assessors Office
Ken Thompson	Facilities Director
Kevin Borges	Board of Health
Kim Hollon	President/ Signature Health Care
Koren Cappiello	Director of Social Services
Kurt Calderwood*	Assistant Superintendent/ Parks
Larry Rowley	DPW Commissioner
Laurie Muncy*	Principal Comprehensive Planner
Lisa Sullivan*	Senior Planner
Megan Shave*	Conservation Agent
Michael McKenna*	Lieutenant/ Fire
Michael Williams	Fire Chief
Michael Lambert*	Deputy Administrator/ Brockton Area Transit
Mike Thomas	Deputy Superintendent
Pat Hill*	DPW
Pat Ciaramella*	Executive Director/ Old Colony Planning Council
Paul Umano*	Grants Coordinator/ Mayor's Office, City Hall
Paulo Gomez	Good Samaritan/ Medical Center
Ray Ledoux	Brockton Area Transit
Rob May*	Director/ Planning and Economic Development
Sandra Wright	Plymouth County Commissioners
Steve Hooke	Director/ Brockton Emergency Management Agency
Stephanie Danielson*	Director/ Planning and Economic Development, Easton
Sue Joss	Brockton Neighborhood Health Center
Taunton Watershed	Director
Ted Medeiros*	Network Administrator/ IT

Tim Carpenter*	Superintendent of Parks
Tom Thibeault	Brockton Housing Authority
Tom Plouffe*	Brockton Housing Authority

* indicates attendees

Citation

Fuss & O'Neill (2018). Community Resilience Building Workshop Summary of Findings. City of Brockton, Fuss & O'Neill, Inc. Springfield, Massachusetts.

CRB Workshop Project Team

Name	Organization	Role
Paul Umano	Mayor's Office	Project Coordinator/ Core Team Member
Karen Coppiello	Social Services	Core Team Member
Lisa Sullivan	OCPC	Core Team Member
Laurie Muncy	OCPC	Core Team Member
Pat Ciaramella	OCPC	Core Team Member
Ken Thompson	Facilities, Brockton Public Schools	Core Team Member
Jim Casieri	Buildings Superintendent	Core Team Member
Larry Rowley	DPW	Core Team Member
John Crowley	Police	Core Team Member
Michael Williams	Fire Department	Core Team Member
Tom Plouffe	BHA	Core Team Member
Megan Shave	Planning	Core Team Member
Ray Ledoux	BAT	Core Team Member
Michael Lambert	BAT	Core Team Member
Steve Hooke	Emergency Management	Core Team Member
Chike Ondukwe	City Engineer	Core Team Member
Pat Hill	DPW	Core Team Member
Mike Thomas	Schools	Core Team Member
Mary Monahan	Fuss & O'Neill	MVP Lead Facilitator
Julianne Busa	Fuss & O'Neill	MVP Facilitator/Scribe
Phil Moreschi	Fuss & O'Neill	Technical Input/Scribe
Jessica Montagna	Fuss & O'Neill	Scribe

Acknowledgements

Many thanks to the MVP Core Team members, CRB workshop participants, and to Paul Umano who acted as the local Project Coordinator. Thanks to the City of Brockton and the Brockton Public Library for providing a meeting space for the Core Team Meeting and CRB Workshop.

Funding for the CRB Workshop was provided through a Massachusetts MVP grant.

Appendix A

Final Risk Matrix

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

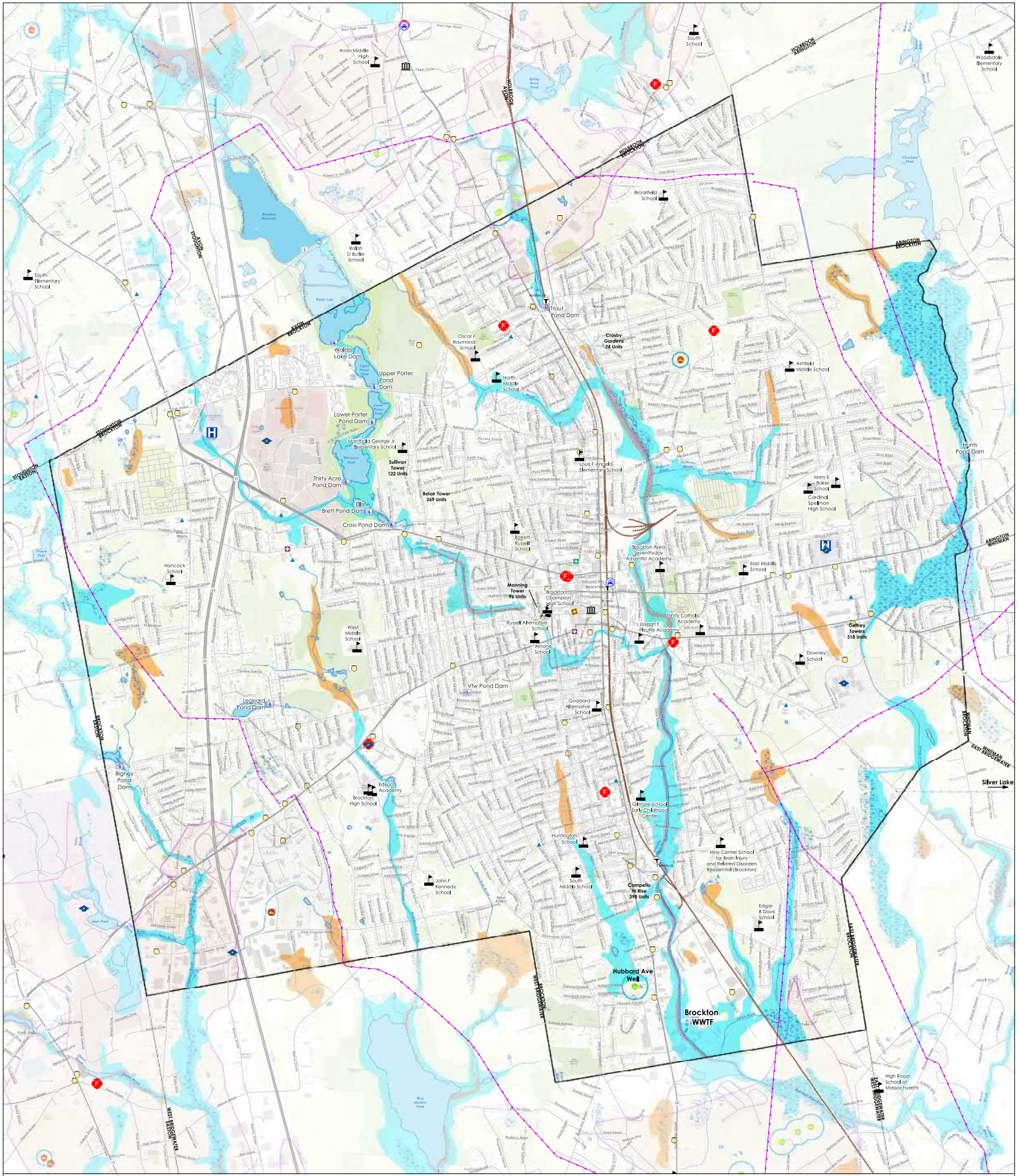
H-M-L priority for action over
V = Vulnerability S = Strength

Features	Location	Ownership	V or S	Flooding	Severe Storms	Extreme Temperatures	Drought	Priority H - M - L	Time Short Long
Infrastructural									
Culverts and Bridges	City-Wide	City	S	Brockton is already completing bridge repairs and replacements to improve flooding resilience.				N/A	O
			V	Conduct a field inventory of culverts and bridges; rank and prioritize projects; assess green infrastructure opportunities; design and implement priority re-sizing or replacement projects.				H	S
Dams	City-Wide	City/Private	V	Conduct engineering and hydrology studies on the City's dams to identify and prioritize repair needs.				H	S
			V	Develop an integrated all-waters approach to increase flood resiliency City-wide. Incorporate nature-based solutions, identify projects to reduce stormwater runoff and increase flood storage capacity. Build on the current Fuss & O'Neill dam study to evaluate necessary dam improvements and potential for dam removals. Assess feasibility and cost and develop concept designs. Review and update City regulations as needed. Explore multi-community and public-private partnerships to address interrelated flooding issues.				H	S
Roads	City-Wide, Oak Street and N. Main	City/State	V	Conduct a traffic study in areas where extreme traffic delays could exacerbate hazard impacts or delay emergency services. Identify alternate routes to efficiently evacuate congested areas.				M	S
Water Supply and Water Infrastructure	City-Wide	City	S	Brockton has access to multiple water sources, including Silver Lake and the desalination plant in Dighton.				N/A	O
			V	Conduct a comprehensive assessment of water quality, supply, and infrastructure, including options for an additional back-up water supply; potential for incorporating homes with private wells into the City water supply system and means of mitigating climate-driven impacts on public water supply sources (e.g., HABs, drought, or salt intrusion).				H	S
Stormwater Basins and Conveyances	City-Wide	City/Private	V	Increase maintenance of catch basins, conveyances and detention ponds.				H	O
Communications Infrastructure	City-Wide	City/Private	V	Conduct an assessment of communications vulnerabilities, especially related to Crown Castle's high-capacity fiber line.				M	S
Emergency Operations Center	156 W. Elm Street	City	S	The War Memorial houses the Emergency Operations Center and a portable generator.				N/A	O
Underground Storage Tanks	City-Wide	City/Private	V	No specific priority action identified.				N/A	N/A
Buildings and Facilities	City-Wide	City	S	The City's IT and 911 hubs have back-up generators; the City has a portable generator that can be deployed as needed. All City lights have been converted to LED and two fire stations were converted to natural gas. Brockton is a certified Green Community.				N/A	O
			S	The City's Housing Authority has back-up generators to power emergency lighting and elevators, and a community room with A/C.				N/A	O
			V	Evaluate opportunities to provide emergency backup power to critical building and facilities, including feasibility of green power and battery storage.				H	S
			V	Inventory and assess school buildings for necessary repairs or upgrades.				M	S
Utilities Infrastructure	City-Wide	Private	S	Brockton's partnership with National Grid includes tree work to increase the resiliency of utility lines.				N/A	O
			V	Partner with electric and gas utility providers to identify and address vulnerabilities and enhance communication and cooperation.				H	O
			V	Assess redundant power options for the downtown area, including the feasibility of a dual-feed connection or micro grid system.				M	L
Wastewater Infrastructure	City-Wide	City	S	Brockton's wastewater treatment plant is operating below total capacity.				N/A	O
			V	Perform a risk assessment of the wastewater treatment plant and pump stations and establish priority actions, including feasibility of nature-based solutions, green infrastructure, and levees. Establish emergency back-up plans for the plant and pump stations.				H	S
Societal									
Public Transportation	City-Wide	Brockton Area Transit/State	S	Brockton has robust public transportation resources through Brockton Area Transit and the state-owned commuter rail.				N/A	O
			V	Develop a Greenhouse Gas (GHG) Reduction Plan, which includes public transportation systems.				M	L
			V	Coordinate emergency response plans with the bus transit network and commuter rail line.				M	S
			V	Assess drainage and management improvement options for the Campello rail line where it stretches through a floodplain.				L	S
			V	Increase the availability of electric vehicle charging stations.				L	L

Massasoit Community College	MCC	State	S	The college is a resource for sustainability training and demonstration practices, has energy and water conservation measures in place, and serves as an area-wide FEMA emergency site.			N/A	O
			V	Establish a gated emergency entrance that connects the college to Shaw's Plaza on Crescent Street.			H	S
Gerry's Farm	810 Pleasant Street	Private	V	Develop an urban agriculture initiative centered around Gerry's Farm to foster local food resiliency.			H	L
Language Barriers	City-Wide	Public	S	Brockton has public information resources available in multiple languages and translation skills available in the Mayor's office.			N/A	O
GIS Maps	City-Wide	Public	V	Pursue funding to update assessors (GIS) maps.			H	S
Residential Property	City-Wide	Private	V	No specific priority action identified.			N/A	N/A
Environmental Justice Communities and Vulnerable Populations	City-Wide	N/A	S	The Mayor has instituted a Quality of Life Taskforce. Several emergency shelters are available during hazard events.			N/A	O
			V	Plan and post neighborhood and regional evacuation routes.			H	S
			V	Continue to support coordinated efforts to provide emergency shelters, including cooling and warming centers.			M	O
Communications Systems	City-Wide	Public/Private	S	The City operates a Code RED Emergency Alert system.			N/A	O
			V	Assess needs and vulnerabilities in the City's emergency communication systems.			H	S
Provisions, Fuel and Medical Care	City-Wide	Private	S		Brockton's hospitals are serviced by dual electric feeds which increase resiliency to power outages.		N/A	O
Stress on Emergency Services	City-Wide	City	S	The City has six Fire Stations and two designated emergency helicopter sites. Coordination between Police and ambulance services is strong. Brockton has a dedicated Emergency Management Agency (BEMA), a regional Hazard Mitigation Plan, and Local Emergency Planning Committee (LEPC) and has mutual aid agreements in place.			N/A	O
			V	Upgrade all traffic lights with Opticom transmitters to aid emergency vehicles at busy intersections.			M	S
Schools	City-Wide	City	S	Brockton's Schools have a strong IT network, situational awareness practice, and outreach programs to parents. The schools practice sustainability measures such as using green cleaning products.			N/A	O
			S	A remediation project at the Raymond School repaired damage from past flooding.			N/A	N/A
			V/S			Implement plans to install air conditioning in all schools.	M	O
Pests and Disease Control	City-Wide	City/Private	V	Assess additional mosquito/pest control options, including establishment of buffers, determination of future risks, and development of an education and outreach program.			H	L
Environmental								
Wetlands	City-Wide	City/Private	V	Develop and adopt a wetlands ordinance and stormwater ordinance.			H	S
Environmental Contaminants	City-Wide	City/Private	V	Assess levels and sources of stream contaminants; develop and enforce measures to detect and eliminate illicit discharges.			M	O
			V	Investigate potential contamination from waste transfer stations and assess vulnerability to flooding and other hazards.			L	L
Trees and Forests	City-Wide	City/Private	V	Develop a comprehensive tree and forests management program.			L	L
Open Space	City-Wide	City	S	City has established new parks, transforming former industrial and commercial sites into valuable open space.			N/A	O
Flood Storage	City-Wide	City/Private	V	Develop an integrated all-waters approach to increase flood resiliency City-wide. Incorporate nature-based solutions, identify projects to reduce stormwater runoff and increase flood storage capacity. Build on the current Fuss & O'Neill dam study to evaluate necessary dam improvements and potential for dam removals. Assess feasibility and cost and develop concept designs. Review and update City regulations as needed. Explore multi-community and public-private partnerships to address interrelated flooding issues.			H	S
Invasive Species	City-Wide	City/Private	V	No specific priority action identified.			N/A	N/A
Water Quality	City-Wide	City	V	Conduct a comprehensive assessment of water quality, supply, and infrastructure (see above).			H	S
Stormwater Runoff	City-Wide	City/Private	V	Develop a City-wide Business Improvement and Economic Development Plan to support local businesses and increase resiliency. Identify areas where climate hazards can be avoided/mitigated and targeted improvements, such as a microgrid, could be employed. Simultaneously identify areas from which businesses would be encouraged to divest to avoid hazards. Include a plan for attracting climate-friendly businesses.			H	L
			V	Develop a regional approach to stormwater management that accounts for Brockton's position in the larger watershed.			M	L
Environmental Regulations	City-Wide	City	V	Review and update City regulations to improve stormwater management and mitigate flooding risk. Work in tandem with the MA MS4 Permit to promote infrastructure improvements and increase infiltration of stormwater.			H	S

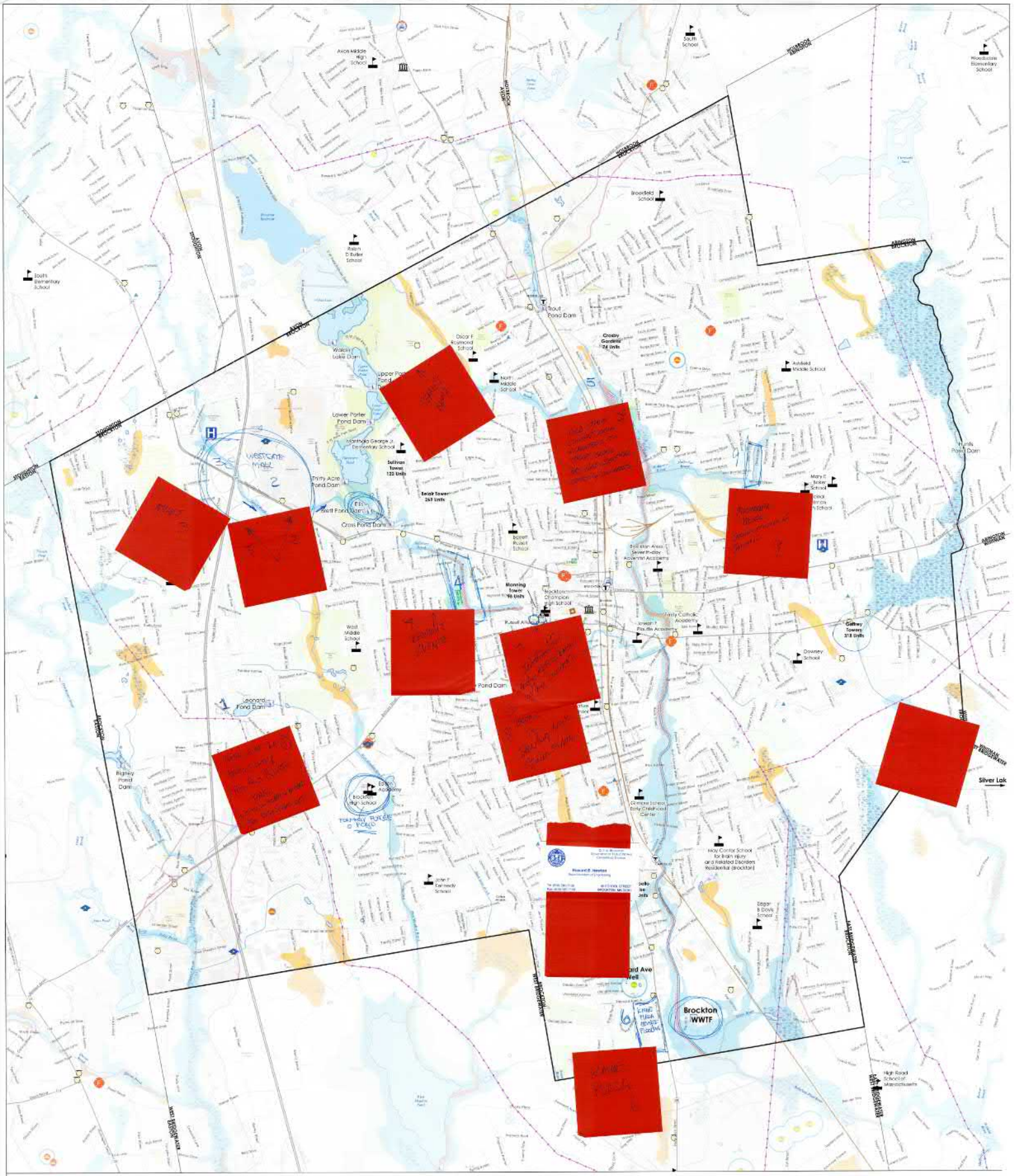
Appendix B

CRB Workshop Base Map


Avon Middle High School
South School
Woodsdale Elementary School
Brockfield School
Ralph D Butler School
South Elementary School
Trout Pond Dam
Crosby Gardens 76 Units
Oscar F Raymond School
Ashfield Middle School
North Middle School
Welde Lake Dam
Upper Porter Pond Dam
Lower Porter Pond Dam
Hunts Pond Dam
Manthala George Jr Elementary School
Sullivan Tower 122 Units
Louis F Angelo Elementary School
Thirty Acre Pond Dam
Belair Tower 269 Units
Mary E Baker School
Cardinal Spellman High School
Ellis Brett Pond Dam
Cross Pond Dam
Barrett Russell School
Brockton Area Seventh-day Adventist Academy
Hancock School
Manning Tower 96 Units
East Middle School
Brockton Champion High School
Trinity Catholic Academy
Joseph F Woulte Academy
Gaffney Towers 318 Units
West Middle School
Russell Alternative School
Arnone School
Downey School
Vfw Pond Dam
Leonard Pond Dam
Goddard Alternative School
Bigney Pond Dam
Edison Academy
Brockton High School
Gilmore School Early Childhood Center
Huntington School
May Center School for Brain Injury and Related Disorders Residential (Brockton)
John F Kennedy School
South Middle School
Campello Hi Rise 398 Units
Edgar B Davis School
Hubbard Ave Well
Brockton WWTF
High Road School of Massachusetts
Silver Lake
Town Hall
Police Station
Fire Station
Hospital
School
Colleges and Universities
Main Health Center
Satellite Health Center
Homeless Shelter
Long Term Care Residences
Community Groundwater Source
Surface Water Intake
Non-Community Groundwater Source
Underground Storage Tanks
Dams
Railroads - Active Service
MBTA Commuter Rail Station
Powerline
Landing Strip/Airport
Perennial or Intermittent Stream
Shoreline
Ditch/Canal
Aqueduct
Pond, Lake, Ocean
Reservoir
Wetland
Wellhead Protection Zone I
Wellhead Protection Zone II
Flood Zone Designations
1% Annual Chance of Flooding
Regulatory Floodway
0.2% Annual Chance of Flooding
Area Not Included
N
W
E
S
0
0.5
1
Miles
Data sources:
MassGIS - Infrastructure, Hydrology, and Administrative Data
ESRI - World Topographic Map - Base Map
BROCKTON, MA
MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM
FUSS & O'NEILL

Appendix C

CRB Workshop Outputs:
Participatory Mapping Exercise & Risk Matrices



- Town Hall
- Police Station
- Fire Station
- Hospital
- School
- Colleges and Universities
- Main Health Center
- Satellite Health Center
- Homeless Shelter
- Long Term Care Residences
- Community Groundwater Source
- Surface Water Intake
- Non-Community Groundwater Source
- Underground Storage Tanks
- Dams
- Railroads - Active Service
- MBTA Commuter Rail Station
- Powerline
- Landing Strip/Airport
- Perennial or Intermittent Stream
- Shoreline
- Ditch/Canal
- Aqueduct
- Pond, Lake, Ocean
- Reservoir
- Wetland
- Wellhead Protection Zone I
- Wellhead Protection Zone II

Flood Zone Designations

- 1% Annual Chance of Flooding
- Regulatory Floodway
- 0.2% Annual Chance of Flooding
- Area Not Included

N W E S

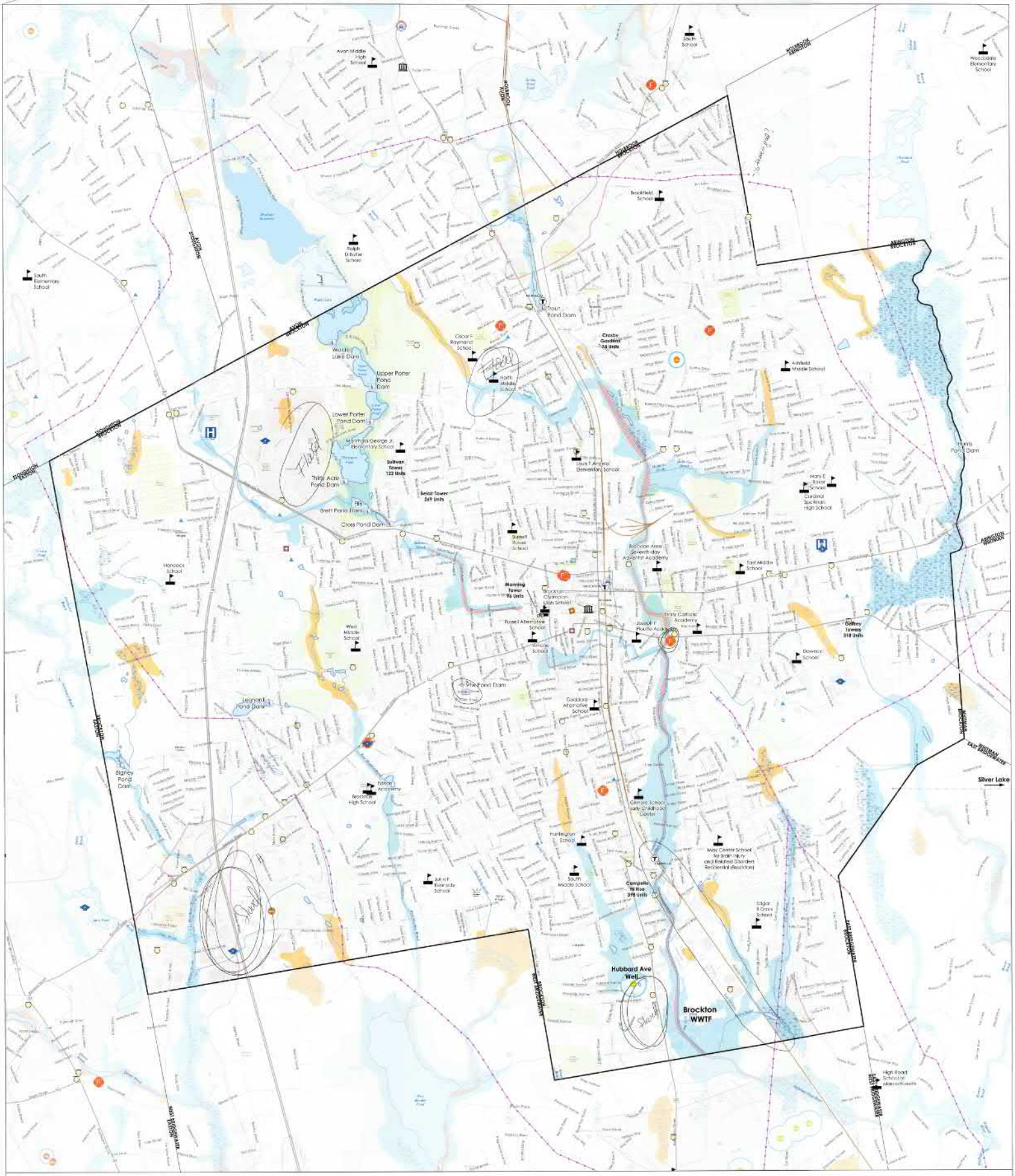
0 0.5 1 Miles

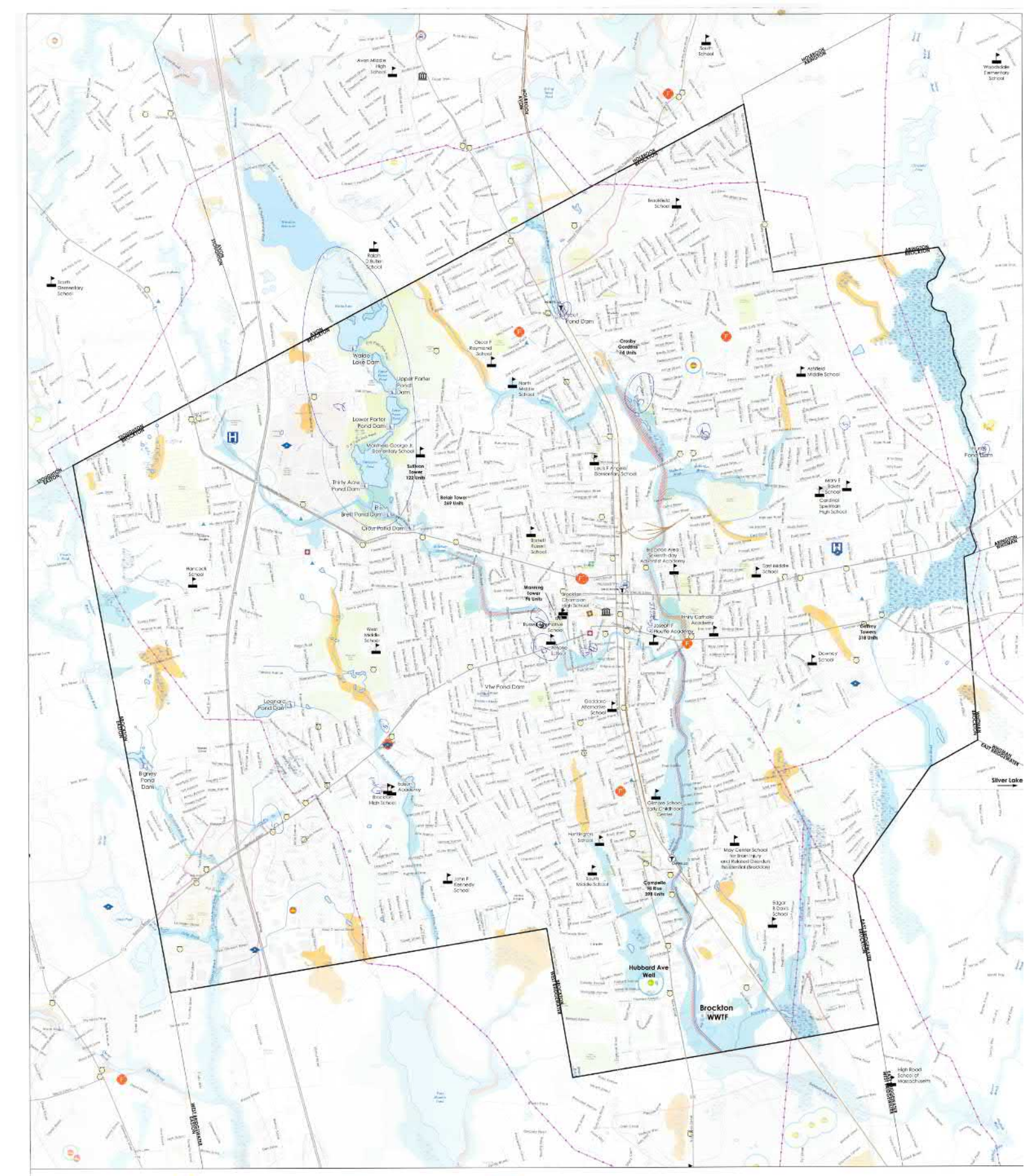
Data sources:
MassGIS - Infrastructure, Hydrology, and Administrative Data
ESRI - World Topographic Map - Base Map

BROCKTON, MA

MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM

FUSS & O'NEILL


Avon Middle High School
South School
Woodside Elementary School
Brockton High School
Ralph D Butler School
South Elementary School
Oscar F Raymond School
North Middle School
Crosby Gardens 218 Units
Ashfield Middle School
Upper Porter Pond Dam
Lower Porter Pond Dam
Manthala George Jr. Elementary School
Sullivan Towers 122 Units
Thirty Acre Pond Dam
Selick Tower 249 Units
Ellis Brett Pond Dam
Cross Pond Dam
Louis F Angelo Elementary School
MARY E Baker School
Cardinal Spellman High School
Hancock School
Barrett Russell School
Brockton Area Seventh-day Adventist Academy
Manning Tower 96 Units
Brockton Champion High School
Russell Alternative School
Joseph F Plouffe Academy
Trinity Catholic Academy
Gaffney Towers 318 Units
West Middle School
Downey School
Leonard Pond Dam
Goddard Alternative School
Bigney Pond Dam
Gilmore School Early Childhood Center
Huntington School
May Center School for Brain Injury and Related Disorders Residential (Brockton)
John F Kennedy School
South Middle School
Campello 96 Rise 378 Units
Edgar R Davis School
Hubbard Ave Well
Brockton WWTF
Silver Lake
High Road School of Massachusetts
Town Hall
Police Station
Fire Station
Hospital
School
Colleges and Universities
Main Health Center
Satellite Health Center
Homeless Shelter
Long Term Care Residences
Community Groundwater Source
Surface Water Intake
Non-Community Groundwater Source
Underground Storage Tanks
Dams
Railroads - Active Service
MBTA Commuter Rail Station
Powerline
Landing Strip/Airport
Perennial or Intermittent Stream
Shoreline
Ditch/Canal
Aqueduct
Pond, Lake, Ocean
Reservoir
Wetland
Wellhead Protection Zone I
Wellhead Protection Zone II
Flood Zone Designations
1% Annual Chance of Flooding
Regulatory Floodway
0.2% Annual Chance of Flooding
Area Not Included
N
W
E
S
0
0.5
1
Miles
Data sources:
MassGIS - Infrastructure, Hydrology, and Administrative Data
ESRI - World Topographic Map - Base Map
BROCKTON, MA
MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM
FUSS & O'NEILL



- Town Hall
- Police Station
- Fire Station
- Hospital
- School
- Colleges and Universities
- Main Health Center
- Satellite Health Center
- Homeless Shelter
- Long Term Care Residences
- Community Groundwater Source
- Surface Water Intake
- Non-Community Groundwater Source
- Underground Storage Tanks
- Dams
- Railroads - Active Service
- MBTA Commuter Rail Station
- Powerline
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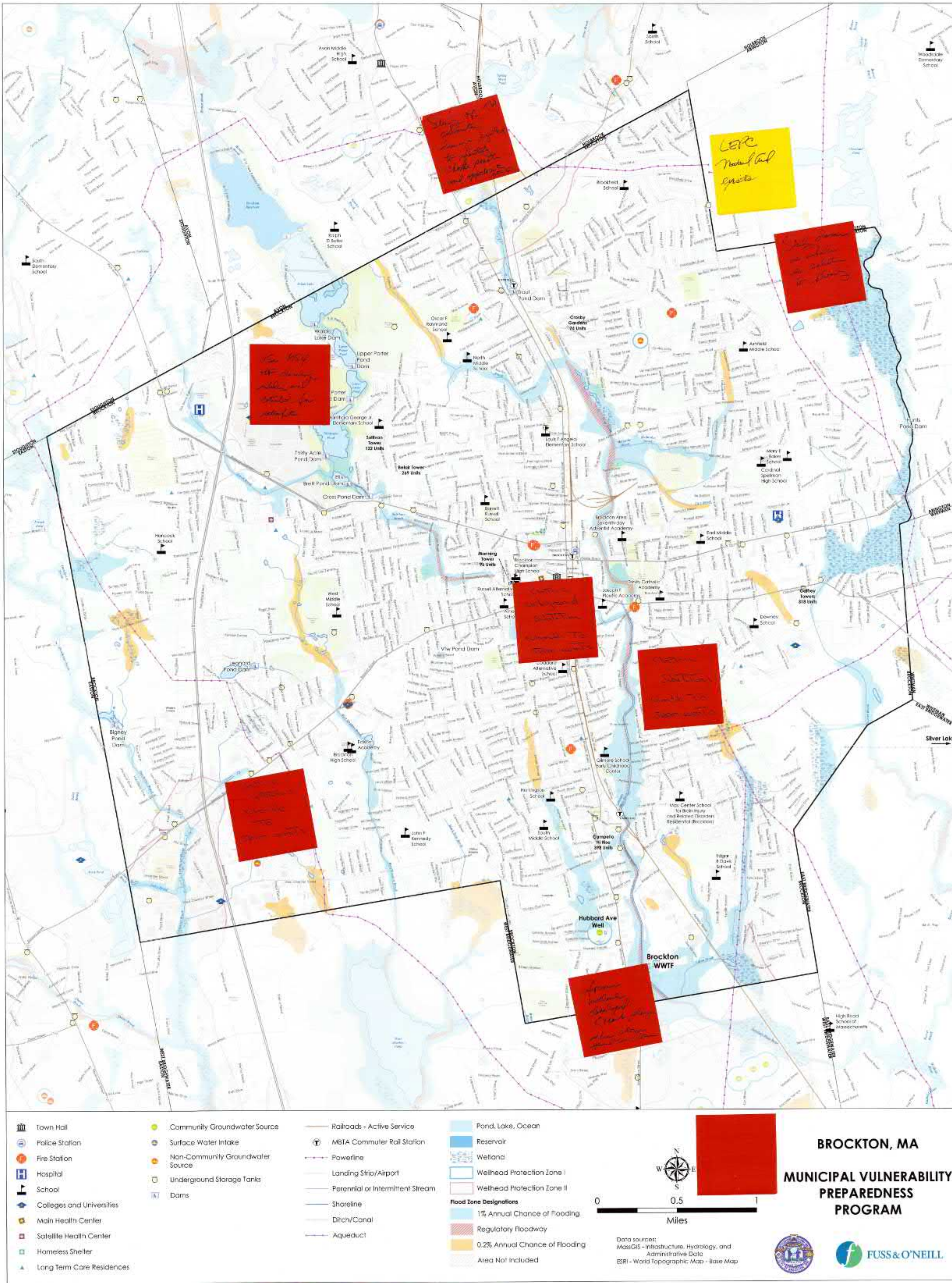
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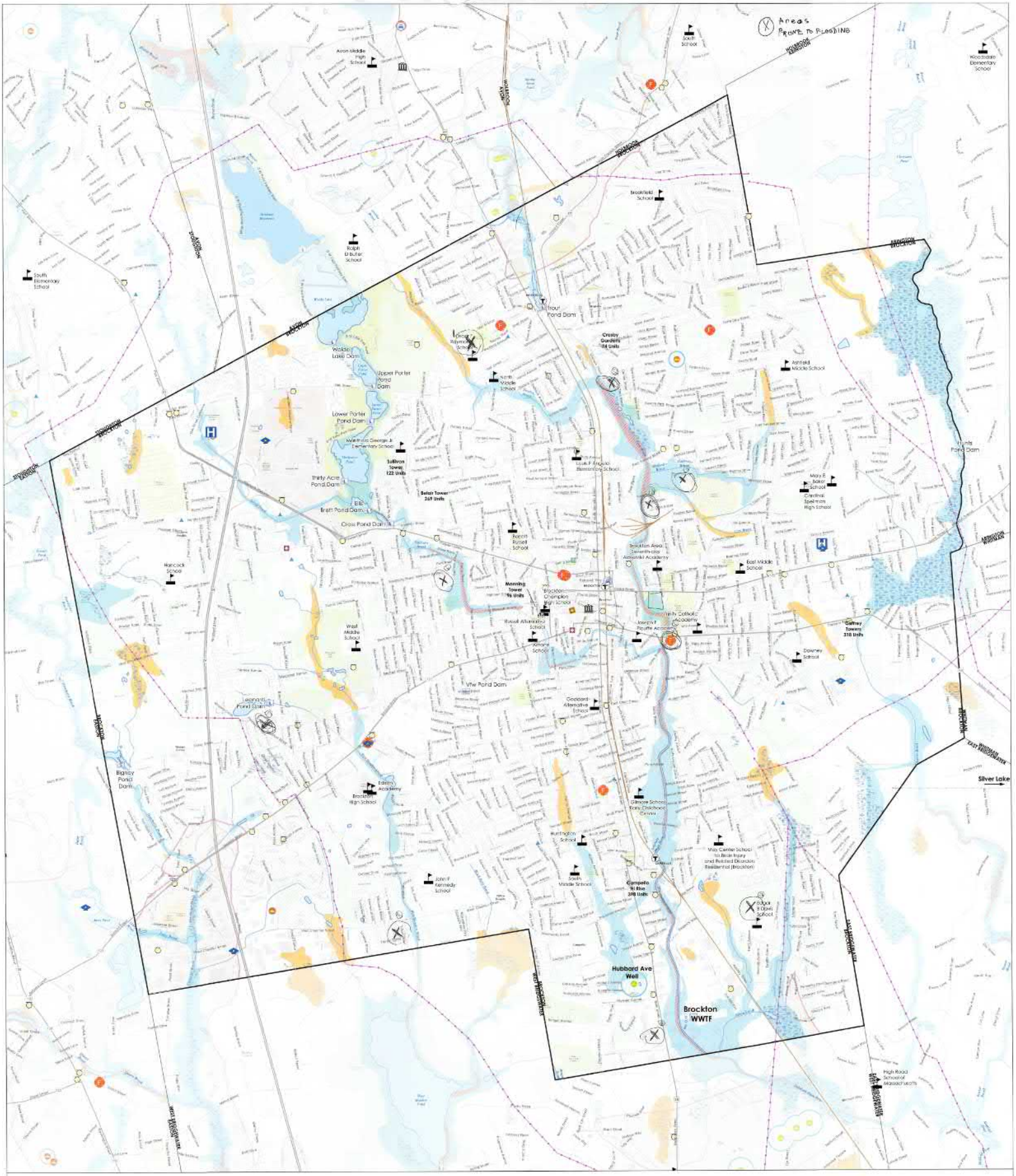
FUSS & O'NEILL
Hubbard Ave Well
Brockton WWTF
Silver Lake



BROCKTON, MA

MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM

FUSS & O'NEILL

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.com

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding	Storm Event Hurricanes Winter Storms Tropical	Extreme Temperatures	Drought	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
undersized culverts (1) (2)				hydrolic study (2)					
~~dams~~ (2) dams (2)		DPW							
Brook Reservoir		DPW		hydrologic study					
Trout Pond		City?							
Hunts Pond		DPW							
other DPW Field		part							
Sewer collection system (6)			V S						
Stormwater storage									
~~Societal~~ Isolated areas of flooding (3)									
loss of electricity	Housing Authority								
~~Emergency~~ Command Center Ground New	War Memorial		S						
Emergency Centers Athome School COA			S						
Cooling Centers (4)			S						
Power Substations (5)									
~~Environmental~~									
Underground Storage Tanks									
Wastewater Treatment			S - recently						
Schools				✓		✓			
Housing - flooding basements									
Water Supply			S V				✓		

Public Safety
Staffing
Equipment

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.com

H-M-L priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features (Red)	Location	Ownership	V or S	FLOODING	STORM EVENTS	EXTREME TEMPERATURES	DROUGHT	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
GIS maps Delayed. Need funds $ + Plan to Complete process for Assessors maps which are 60 years old, put online for property owners, Banks, & appraisers	City Wide	City	V	- Map/Route Locations of Lots - Delineate land sizes - FLOODING AREAS				H.	O
Emergency Gate access Mass Com College to Shaws Plaza on Crescent St for FEMA access in Area Wide/State Emergency for vehicle access to College for Staging Area	Mass. Com. College Shaws Plaza	State Retail Plaza (Ahold)	V	Aff Any Type of Areawide Emergency!	✓	✓	✓	H	O
Oak St @ Main St. (Traffic Delays are extreme.) need alt Route to get by Main St to North (continue N Warren Av to evacuate Area.	City Streets.	City	V	✓	✓	✓	✓		
Increase the Holding Capacity for Ponds + Basins									
Calvary Cem. Area. Future Dev. will Require Storm Wtr Management Lower Ames St. Future Dev. will Require Storm Wtr. Management.	Cary St Lower Ames St.	City Streets City Streets	V V	V ✓				H H	O O
+ Raymond School flooding Remediated.	Raymond School Oak St.	City	S	Interior [illegible] longer Damaged	✓			L	O
- City Need a Stronger + Well Defined Improvement/Plan to Attract Businesses for Tax Base / Very Increases to Reduce the Tax Burden to All Residents + Business / Land Owners	City wide	Private / City	V	✓	✓	✓	✓	H	O
Societal (Yellow)									
- Regional N'bhd to Evac. Routes for Homeless + Elderly	Regional	N/A	V					H	O
- NHBR Affluent Communities Sending Displaced/Homeless to Brockton	Region City wide	N/A	V	✓	✓	✓	✓	H	O
+ Mass. Com College Designated as Em. Helicopter Site	State College	State	S	✓	✓	✓	✓	H	O
+ BEMA used to supply water + City wide updates in Emergency Shelter management.	City wide	City	S	✓	✓	✓	✓	H	O
+ Reverse 911	City wide	City	S	✓	✓	✓	✓	H	O
Environmental (Blue)									
- Freezing of Public Buildings - Generators needed at various locations to protect Infr. + People in emergencies Close of Power) - Mosquito Control in Flood Areas, Swamp Zones, Brooks	City Wide		V V	✓	✓			H H	O O
+ Tree Plantings	City Center Corridor	City	S	✓	✓	✓	✓	M	O
+ Parks Built in Place of former Industrial + Comm'l Sites	Warren Ave (Eg) Belmont St	City	S	✓		✓	✓	M	O
+ Arnone School - use as Em. shelter or Warming/Cooling Center		City	S					M	O
+ Brockton Public Schools use Green Cleaning Products	City Wide	City	S	✓					
+ Campus Sustainability - Education for Env. Improvements learning tool	Com College	State	S	✓	✓	✓	✓	M	O
+ Solar Expansion Project @ Parking Lots	Com College	State	S	✓	✓	✓	✓	M	O
- stormwater management is Lacking Affecting Homes + Neighborhoods	City	City/Private	V	✓	✓			H	O

Community Resilience Building Risk Matrix

DRAFT

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H-M-L priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding (water)	Storms (More & heavy; winds, hail, precip, etc.)	Extreme Temps	Drought	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Transmission lines from Digton & Silver Lake	Multi community	private	V	? Don't know	? → assess vulnerabilities	?	?	H	?
[illegible] better [illegible]	Brockton	City	V + S	more basins	more frequent cleaning			H	S
Transmission lines from Silver Lake	multi comm.	City	V	?	? [illegible]	? Assess comm. infrastructure + vulnerabilities		H	?
[illegible] Roadway capacity	Brockton	City + state	V		Optican upgrade			M	O
Campello rail line	[illegible] Campello	Private	V		Advanced management, improved drainage			[illegible] L	L
[illegible]	city wide	public + private	V + S	increasing capacity, inter community coordination	improve [illegible]			M	L
High capacity fiber line communication [illegible]	city wide	private	V	?	Assess vulnerabilities + protect	?	?	M	?
[illegible] water supply	multi community	Private, state [illegible]	V						
[illegible]						Assessment of vulnerabilities + coordinated action	Third supply, water efficiency, reduce consumption	H / M	S/O / O
[illegible]	[illegible]	private	V		Down feed needed				
Wastewater treatment plant	Campello	City	V	Dyke it up/levees	Continue [illegible] Assess vulnerabilities			H	O
Too much impermeable [illegible]	city wide	priv + pub	V	[illegible] Use MS4 to actively increase infiltration	: infrastructure improvement projects to increase infiltration			H	S
Societal Infrastructure									
[illegible] Arboreal infrastructure	city wide	public + private	V + S	more trees for slow flow	prevent erosion	Cool temps/shade	Species suitability	L	L / O
Schools – [illegible] flooding	[illegible]	city	V	Assessment of vulnerabilities				M	O
[illegible]									
Encroachment + illegal fill on wetlands	city-wide	pub + priv	V	wetlands ordinance enforcement - mitigation			city wide supply to all properties	H	S
Private supply well water users [illegible]	city wide	priv.	V				Groundwater [illegible]	M	O
Waste transfer stations in floodplain → contamination of waterways	[illegible] + Campello	priv.	V		assess vulnerabilities			L	O
Environmental Societal						Stretch code			
[illegible]	city	public	V + S	wetlands + stormwater + grading [illegible]	MS4 stormwater	Tree planting ordinance planning + zoning regs	water efficiency	H	S [illegible]
Schools – cooling (older schools only?)	city wide	city	V			air conditioning		M	S
[illegible]									
Seniors and respiratory issues	citywide	—	V + S	have good EMS response already		GHG reduction plan		M	S
Increased contamination [illegible] flooding / [illegible]	citywide	public	V		Assess streambeds			M	O
Preserve last farm (Gerrys)	Gerry farm	private	S		local resiliency / local food / community cohesion			H	S
Commuter rail - 3 stops	citywide	[illegible] state	S		← Reduced GHGs → / EMS planning asset / improved mobility			H	S
[illegible] Comprehensive bus transit network	citywide	quasi public	S		← improved mobility →			H	S
Communication barriers to reduce vulnerability	citywide	private public	V		Assess communication needs			H	O

Community Resilience Building Risk Matrix

FINAL

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Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

H-M-L priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

	Features	Location	Ownership	V or S	Flooding	Storms	Extreme Temps	Drought	Priority H-M-L	Time S L O
	Infrastructural									
1	Transmission lines from Dighton + Silver Lake	multicommunity	private + city	V	Assess vulnerabilities from aging infrastructure →	→		→	H	S
2	Water Supply	multicommunity	private, State, City	V			Assessment of water quality + coordinated effort	Third water supply. Water efficiency	H	S/O
3	Campello rail line	Campello	private	V	Advanced management + improved drainage →				L	L
4	High roadway capacity (impediment to emergency vehicles)	City wide	city / State	V		Upgrade optican to all intersection lights			M	O
5	High capacity fiber line (communication breakdown)	City wide	private	V	Assess vulnerabilities →			→	M	S
6	Downtown power network	Downtown	private	V		Dual feed needed			M	O
7	Waste water treatment plant	Campello	City	V	Levees / flood prevention				H	O
8	School buildings	city wide	city	V	Assess Vulnerabilities				M	O
9	Flood Storage	~~City wide~~ multicommunity	public + private	V+S	Increase capacity, especially upstream				M	L
10	Too much impermeable surface (increased runoff)	City wide	public + private	V	Use MS4 to promote infrastructure improvement to increase infiltration →				H	S
11	Catch basins (Stormwater management system)	City wide	city	V+S	← more catch basins, different locations, more frequent street sweeping + basin cleaning →				H	S
	Societal									
1	Seniors and vulnerable populations (respitory issues)	Citywide	—	V	←	←	improving air quality → reduce green house gases →	→ GHG Reduction Plan	M	S/L
2	~~Evacuation Plan~~ Cooling Schools	City wide	City	V			air conditioning		M	S
3	~~Commuter Rail~~ Comprehensive bus transit network	City wide	quasi-public	S	← Good EMS response already in place. Future:		Greenhouse gas reduction	plan →	M	S
4	Commuter rail	Campello, Brockton, Montello	state	S	← EMS Planning asset; improves mobility	→				
5	Preserve Gary's Farm (last farm)	Pleasant St	private	S	← urban agriculture initiative for local food resiliency →				H	S
6	Communication barriers to reduce vulnerability (eg. locations of cooling centers)	City wide	—	V	← Assess needs and communication breakdowns - Improve outreach to ESL and insular communities			→	H	O
7	Governance	city wide	public	V→S	Wetlands ordinance Stormwater ordinance	MS4 Stormwater ordinance	Tree planting (shade trees) requirement for development projects Green Community (S)		H	S
	Environmental									
1	Encroachment + illegal fill in wetlands + floodplain	City wide	Public + private	V	Wetlands ordinance → improve ~~enforcement~~ and mitigation				H	S
2	Contamination from waste transfer stations	Campello + Montello	private	V	← Assess vulnerabilities →				L	O
3	Private supply wells	City wide	private	V				Houses with private wells need access to city water supply	H	S
4	Contamination from dislodged streambeds	City wide	City	V		Assess Streambed contaminants → MS4 TMDLs			M	O
5	Arboreal infrastructure + forest trees	City wide	City + private	S+V	← conserving forest trees + tree planting for erosion control and improved infiltration →		Planting shade tree species	Choosing suitable planting spaces	L	O

Community Resilience Building Risk Matrix

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H-M-L priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding	Storm Events	Extreme Temps	Drought	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Undersized Culverts (1)	(1)	City	V	✓ prioritize development replacement plan, seek funding					
Dams (2) Brockton Reservoir, Trout Pond, Owfield, Hunt's Pond	(2)		V	✓ conduct engineering studies, identify repair needs, prioritize & repair					
Sewer Collection System	Town wide		S/V	✓ ongoing maintenance & repair identify vulnerabilities					
Power Supply loss of	BHA units/vulnerable Community substations								
Storm water collection + storage	City-wide	City + private sector	V	✓ adopt permitting standards designed to address increase volumes & flows					
Emergency Command Centre	(6)	Emergency Mngmt	S	✓ continue	✓				
Emergency Cent Shelters	Arnone School	Emergency Mngmt	S	✓ Continue +	✓	✓			
Underground Storage Tanks	City-wide	private + public	V	✓ identify, notify, upgrade					
Wastewater Treatment		city	S/V	✓	✓				
Schools - older w/o ac	City-wide		V	✓ ?		✓			
Housing - flooding yards + basements	city-wide		V	✓					
Water supply		City	S/V	✓					
Public Safety - Staffing Equipment		city	V	✓	✓	✓	✓ (crossed out)		
Societal									
Large EJ population w/health & income constraints language barriers	City-wide	City, civic orgs	V	✓	✓	✓			
Pet sheltering	City-wide		V	✓	✓				
~~Rescue-evacuation~~									
Oxygen dependent individuals, refrigerated medications, powered devices	Flood areas - loss of power	City, Civic	V V	Education ✓	✓ ✓				
~~Mental Health - depression~~			V						
Safety in Shelters	Shelters		V	✓	✓				
Homeless population and of food change	city-wide		V	✓	V	✓			
Food-feeding sheltered population	shelters		V	✓	✓				
Migration into Brockton of persons/populations displaced by climate change									
Environmental									
Water Quality		City	S V	V - potential contamination		V algae blooms	✓		
Air Quality			V			✓			
Water Body Impacts eg. algae blooms			V	✓ ↑		✓	✓		
Vector borne diseases due ⇒ increase impacts			✓			✓	✓		
~~Impacts~~ Habitat loss - pests, shade			V	✓	✓	✓	✓		
Impacts on plant health			V	✓	✓	✓	✓		
Open Space ⇒ recreation			V	✓	✓	✓	✓		
Loss of trees - tree planting program adopted			V/S	✓	✓	V	✓		
Flood Storage				increased protection of riverfront areas/wetlands/floodplains - policies					

Public Transit

health Centers could they be the common central communications point

Community Resilience Building Risk Matrix

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Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding	Storms	Extreme Temps	Drought	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Green Infrastructure - battery storage backup GREEN INVESTIGATE									
SHELTERS IN Place warming/cooling w/generators	S								
Communication Backup mobile Unit Public Safety and 7 Standard Repeaters	S								
DPW HAS GPS - SO WE DO Know condition	S								
Fire - Congestion/Density/Exposure FIRES MONTHLY/DEATH									
BUILDINGS - Fire+ Police in Need of Capital Plans - Investment									
Societal									
SCHOOLS - Closings Due to Storms+ heat									
ELDERLY - Pro Longed Power Outages Carney towers									
Deaf/Hearing Impaired/Blind/ Oxygen/ventilators Language Barriers									
Shelters In Place w/generators	S								
TRANSPORTATION DISRUPTIONS Cause Missed Work School Delays Work Delays									
Environmental									
BUILDING CODE MAY Need to change to address Climate Change									

Community Resilience Building Risk Matrix

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H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding	Storm Events	Extreme temps	Drought	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Electric Infrastructure - Storms, winds, trees - Identify substation	City wide		V	Identify substations w/ might be vulnerable to flood					
Communication w/ National Grid comprehensive + Robust			S						
N.G. Tree Trimming Program in Place Going From 5YR → 4YR Plan			S						
Manage Stormwater Screen Keeps Debris - storm/waste water				Westgate/Salisbury River use MS4 to solve	Westgate/Salisbury River use MS4 to solve				
Restore Wetlands + River Channels									
Do a Study Culverts	City wide			Study to identify choke + drainage issues					
~~Societal~~ Hospitals - Have 2 Electric Feeds			S						
Rte 28 / Kmart Plaza Flooding	Rte 28		V						
Mutual Aid / Regional Hazard Mitigation Plan / Reg LEPC			S						
Dams - Study all Dams and How They Work together				Consider Natural Solutions Flood Storage / green space	Consider natural solutions using flood storage/green space				
Dighton Desalinization Plant	S								
Gas Infrastructure Vulnerable to Flooding				Work w/ Gas Co. Reg. Rep. Status			Back up water source		
City Tree Program - Planting Maintenance - Provide Climate Relief Trimming / Disease	S/V								
Environmental									
Coordinate Flooding + Drainage Solutions w/ West Bridgewater									
Review and update ordinances to make sure they provide protection /				Increase enforcement Beef up Bylaws					
Water Quality				~~Do we have access to Mosquito Spraying~~ ↓ Increase Spraying?		~~Do we have access to Mosquito Spraying~~ Canals ~~Filter~~ / Algae Mosquito Spraying	Algae / acidity		
Vector Borne Disease									
Restore wetlands and River channels									

Appendix D

CRB Workshop Presentation Materials

FUSS & O'NEILL

Boston Firefighters, January 4, 2018 (Reuters)

Brockton, March 4 2018 (The Enterprise)

Municipal Vulnerability Preparedness Program
Community Resilience Building Workshop
City of Brockton

December 5, 2018

Community Resilience Building Workshop

Agenda

- CRB Team and participant introductions
- Introduction to Massachusetts Municipal Vulnerability Preparedness Program (MVP)
- Introduction to Climate Change and the City of Brockton
- Discussion by Brockton participants on status of current planning and risks
- Introduction to CRB Workshop process

- Large group
  - Review top four hazards

- Small work groups (Using Risk Matrix)
  - Identify Brockton's vulnerabilities and strengths
  - Prioritize response actions

- Lunch

- Large group
  - Report out from small groups
  - Determine overall priority actions for the City

- Discussion on next steps
- Conclusion

Fuss & O'Neill Overview

Fuss & O'Neill is a leading MVP consultant in assisting Massachusetts communities secure grant assistance, achieve designation as a Massachusetts Municipal Vulnerability Preparedness (MVP) community, and execute their MVP priority projects.

The MVP team is experienced in local government, environmental services, civil site engineering, stormwater management, and emergency management.

Fuss & O'Neill assisted new MVP communities secure more than $700,000 MVP Action Grants in the program's first funding round.

MVP Project Team

Mary Monahan

Mary is a municipal public works specialist well-versed in issues related to stormwater management; wastewater collection and treatment; drinking water supply, treatment, and distribution; solid waste management; and sustainable operations. Mary serves as a liaison between the public works project owner and the design team.

Julie Busa

Julie is an environmental scientist in the Water Environment and Natural Resources group of Fuss & O'Neill. She has over 10 years of experience in the areas of global biodiversity and forest conservation, sustainability, and ecological modelling. Julie works extensively with municipalities on MS4 compliance and the MVP program.

Brockton MVP Program - $47,000

- Grant Supports Climate Change Vulnerability Assessments and Resiliency planning
  - Comprehensive Approach
    - o Infrastructure
    - o Society
    - o Environment
  - Scope and Process Use the Guidance in the Community Resilience Building Workshop Guide
  - Municipalities That Complete This Process Will Be Designated Municipal Vulnerability Preparedness (MVP) Municipalities

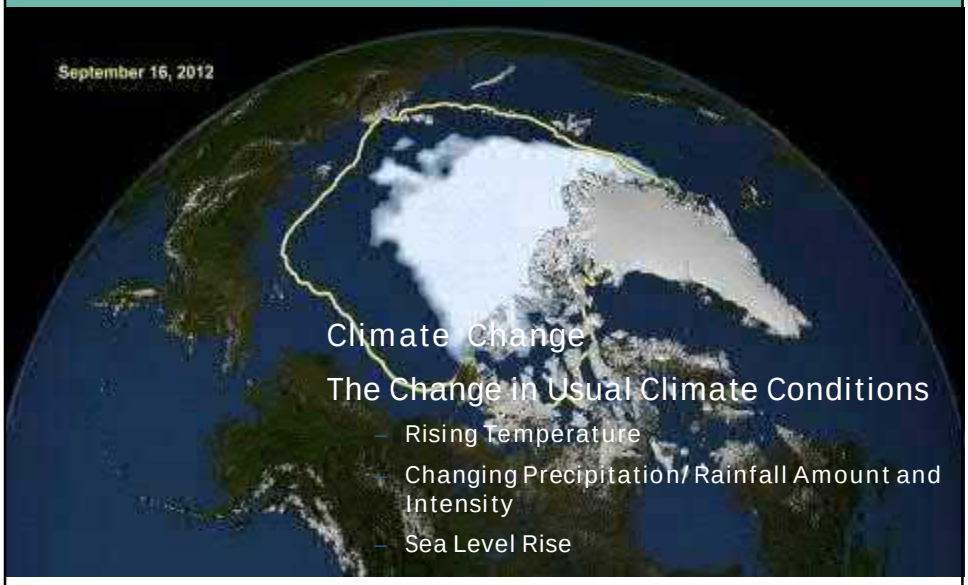
MVP Designation Leads to Enhanced Standing in Future Funding Opportunities

MVP Action Grant NEW

- Grant supports priority actions identified at Community Resilience Building Workshop
- $10,000 - $400,000 available
- Local match of 25% - can be in-kind
- Next funding round anticipated December 2018

Only those communities which have completed the CRB workshop are eligible to apply

Terminology



Climate Change

The Change in Usual Climate Conditions

- Rising Temperature
- Changing Precipitation/ Rainfall Amount and Intensity
- Sea Level Rise

City of Brockton – Taunton Basin

Minimal Boston Harbor Basin

Rising Temperature

Taunton	Observed Baseline 1971-2000	Projected Change in 2030s			Projected Change in 2050s			Projected Change in 2070s			Projected Change in 2090s		
Average Annual Temperature (°F)	49.85	2.03	to	3.77	2.68	to	5.94	3.12	to	8.62	3.43	to	10.49
Annual Days with Maximum Temperature over 90°F (Days)	7.43	5.38	to	14.58	7.20	to	29.31	9.27	to	49.91	11.88	to	65.46
Annual Days with Minimum Temperature below 32°F (Days)	129.76	-13.27	to	-27.89	-18.99	to	-43.59	-23.07	to	-57.04	-24.79	to	-67.94

City of Brockton– Taunton Basin

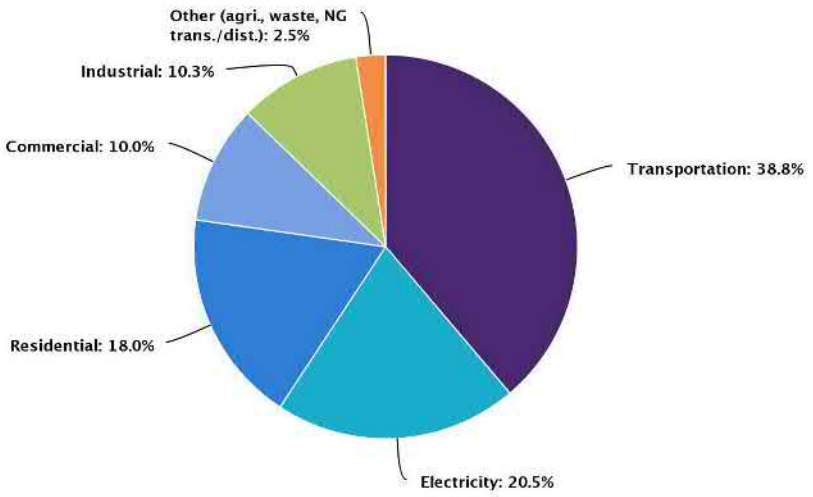
Minimal Boston Harbor Basin

Changing Precipitation

Taunton	Observed Baseline 1971-2000	Projected Change in 2030s	Projected Change in 2050s	Projected Change in 2070s	Projected Change in 2090s
Total Annual Precipitation (Inches)	47.48	-0.05 to 4.11	0.33 to 5.35	0.90 to 6.61	0.38 to 7.34
Annual Consecutive Dry Days (Days)	17.33	-0.23 to 1.29	-0.07 to 2.52	-0.90 to 2.80	-0.34 to 3.65

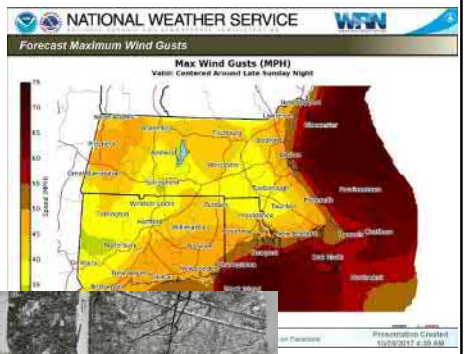
2015 MA GHG Emissions by Sector

76.3 MMTCO2e



Climate Change Impacts - Temperature

- Economic
  - Winter Recreation
  - Snow and Ice
- Agricultural
  - Longer Growing Season
- Health
  - Increased Pests
  - Heat Stroke
- Infrastructure
  - Road Buckling
  - More Potholes
  - Power Outages
- Environment
  - Change in Habitat



Climate Change Impacts - Precipitation

- Economic
  - Dangerous Floods
  - Lost work time
- Agricultural
  - Excessively Wet Spring
  - Drought
- Health
  - Flood/High Water-related Deaths
  - Emergency Response Delays
- Infrastructure
  - Road Washout
  - Environment
  - Sewer System Overflows
  - Compromised Bridges
- Changes in Habitat

Stakeholder Updates

Risk Matrix

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.com

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S					Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Societal									
Environmental									

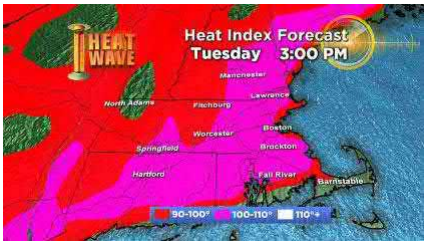
MVP Program

- Identify Top Four Hazards
- Review MVP Sectors
- Maps as tool
- List infrastructure, societal, environmental feature
- Determine whether a vulnerability or strength
- Identify actions to reduce vulnerability or reinforce strength
- Prioritize actions
- Report Out

- Finalize Prioritization Plan

Brockton's Top 4 Climate Change Hazards

- Flooding
- Storm Events
  - Hurricanes
  - Winter Storms
  - Tropical Storms
- Extreme Temperatures
- Drought

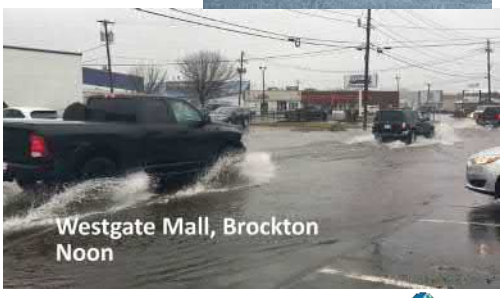


MVP Sectors

- Infrastructure
  - Evacuation routes
  - Schools
  - Roads, bridges, dams
  - Water and wastewater
  - Septic systems
  - Hospitals
  - Commercial Buildings, churches
  - Utilities: electric, gas
  - Factories
  - Emergency management facilities

MVP Sectors

- Societal
  - Emergency shelters
  - Senior housing
  - Schools and campuses
  - Economically challenged populations
  - Evacuation plans
  - Animal shelters
  - Hospitals, pharmacies
  - Grocery stores
  - Utilities: electric, gas
  - Homeless
  - Other



MVP Sectors

- Environmental
  - Drinking water supply
  - Rivers and streams
  - Parklands
  - Agriculture
  - Title V systems
  - Stormwater management
  - Open spaces
  - Flood plains
  - Forest
  - Other

Community Resilience Building Workshop

Next Steps:

Public Review of Priorities
Monitor and Update
Annual Review

Community Resilience Building Workshop

Questions?