

Governance for a Changing Climate

Adapting Boston's Built Environment for Increased Flooding



Sustainable
Solutions Lab





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Sustainable Solutions Lab,
University of Massachusetts Boston

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To read the full report please visit [www.umb.edu/ssl/
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Sustainable Solutions Lab

The Sustainable Solutions Lab (SSL) is an
interdisciplinary partnership among four
schools within UMass Boston: The College
of Liberal Arts, College of Management,
McCormack Graduate School of Policy and
Global Studies, and School for the Environ-
ment. SSL's mission is to work as an engine
of research and action to ensure that all
residents of Greater Boston, and cities
across the world, are prepared equitably
for the impacts of climate change.

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scholarship, dedicated teaching, and
engaged public service are mutually rein-
forcing, creating new knowledge while
serving the public good of our city, our
commonwealth, our nation, and our world.

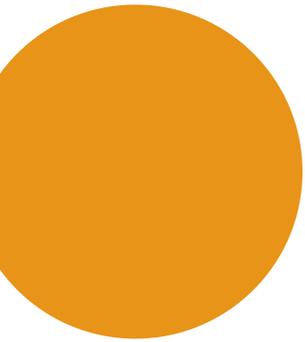


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Preface

Climate Change is impacting everything in our society and in our world. The changes we are already experiencing are starting to multiply and accelerate. Determining how to respond to this new reality wisely within the governance and governmental structures that we have built is a complex challenge. Some might argue it is humankind's greatest test.

Given the monumental size of this task, it is difficult to simultaneously address all

of the related issues both broadly and deeply. This is the third and final in a series of reports from the Sustainable Solutions Lab that were sponsored by the Boston Green Ribbon Commission with the generous support of the Barr Foundation. The goal of these reports was to build on the work done by the Climate Ready Boston process and explore select topics in more depth. The first, *Financing Climate Resilience: Mobilizing Resources and Incentives to Protect Boston*



from *Climate Risks*, assessed the projected costs of climate resilience in Boston and evaluated various options to finance these needs. The second, *Feasibility of Harbor-wide Barrier Systems: Preliminary Analysis for Boston Harbor*, was focused on the costs, technical functionality and environmental impacts of a harbor-wide flood barrier. This report takes a deep dive into a single issue: how the structure and tools of the local, regional, and state government can be modified and enhanced to minimize the impacts of climate changed-induced flooding (due to both sea level rise and increased precipitation) on Boston's built environment. The goal here is to build on the two previous reports and help chart a path forward with both immediate next steps and transformational thinking.

Given the report's necessarily narrow focus, it is worth highlighting some of the important related issues that are not addressed:

- While governance extends far beyond government, this report focuses on tools available to the public sector and does not address the broader landscape of social networks, nonprofit organizations, tribal governance or corporate relationships and the ways these groups interact to foster climate resilience. It also does not look at culture, social norms or societal expectations about how things are currently done or should be done in the future.
- There are many challenges to effective climate adaptation governance from local realities like "home rule," to more global issues like the time lags in climate systems or difficulties associated with any collective action. These have been explored in depth elsewhere and are not included in this report.

- As a follow on to the Climate Ready Boston project, this report is grounded firmly in the City of Boston and looks beyond municipal boundaries primarily to understand what is needed for true adaptation within city limits. It does not evaluate policies and regulations in other neighboring cities and towns.

This report is grounded firmly in the City of Boston and looks beyond municipal boundaries primarily to understand what is needed for true adaptation within city limits.

- This report is focused on what we can do in advance of a disaster, not during or after one.
- Since the focus is on flooding and preventing flood damage, heat and drought and their resultant impacts on water quality, food access, infectious disease, and public health more broadly are beyond the scope of this report.
- The report primarily focuses on impacts to and government-related solutions for private property. Solutions for public property are created through different mechanisms. Also, most of the governmental mechanisms that deal with private property are relevant at the beginning of a project. Programs to incentivize more resilient retrofits are not discussed.
- Finally, the report concentrates on the built environment and, as a result, broader societal challenges are not generally addressed.

As we continue to move toward greater resilience as a city and region, we must also address these interrelated topics in the depth that they, too, deserve.

1

Introduction

READY OR NOT...

If a storm the magnitude of Superstorm Sandy or Hurricane Florence hit the Boston region, would we be ready? In New York, New Jersey and Connecticut, 65 deaths were directly attributed to Superstorm Sandy.¹ In addition to the loss of human life, there were huge financial impacts. In New York City, this single event caused \$19 billion worth of losses, crippling New York's public

transit system, shutting down its energy systems, damaging commercial, residential, and industrial properties, and reshaping communities. An estimated \$32.8 billion was required for restoration across the state.² This triggered a broad range of public sector responses. One was the creation of the NYC Mayor's Office of Housing Recovery Operations, whose Build It Back program has spent over 6.5 years serving 99% of the approximately 12,500 impacted households. Another was

Damage to South Ferry 1 subway station in New York City after Superstorm Sandy.



the establishment of the Governor’s Office of Storm Recovery (GOSR) in June 2013 to coordinate statewide recovery efforts for Superstorm Sandy (October 2012), Hurricane Irene (August 2011) and Tropical Storm Lee (September 2011).³

The efforts in New York demonstrate that it is expensive and time consuming to depend on ad-hoc measures to recover from damaging coastal storms. They also demonstrate that existing modes of governance did not lead to New York being resilient in the face of these kinds of events. As climate change makes damage from storm surge, extreme precipitation, and sea level rise more and more likely, it makes even less sense to address it reactively. If we do not prepare in advance for climate change, Boston is also very likely to experience high losses in terms of impacts to people, communities, property, infrastructure, and the economy.

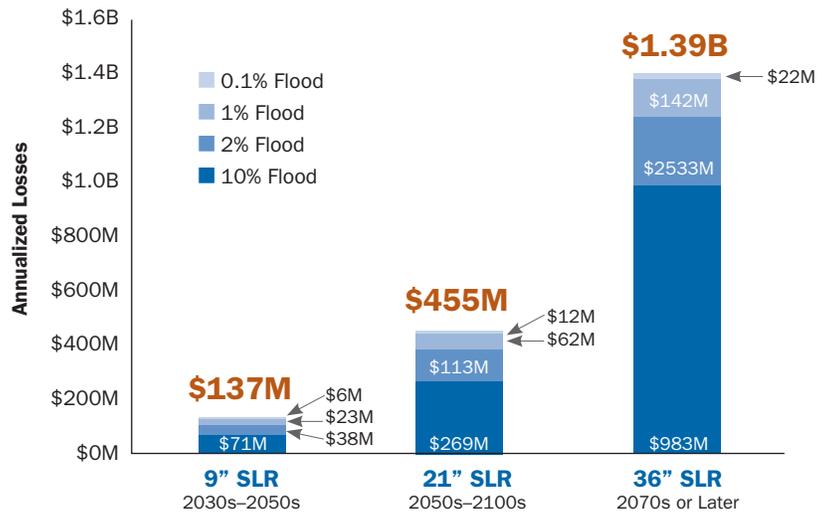
For example, the relocation costs alone for the 1% annual chance flood event occurring with 9 inches of sea level rise are estimated at \$35.6 million.⁴ While the projected cost of low-probability, one-time event consequences can be quite high, their risk of occurrence is, by definition, low. For this reason, we use annualized losses⁵ to represent the expected value of losses spread out over time to account for an event’s risk of occurrence. According to the Climate Ready Boston (CRB) report, due to sea level rise the city will become vulnerable to annualized losses of \$137 million starting in the 2030s; \$455 million starting in the 2050s; and \$1.39 billion starting in the 2070s (Figures 1 and 2). If this is indeed the future we face, how can Boston become more climate resilient?

WHAT IS RESILIENCE?

The Intergovernmental Panel on Climate Change (IPCC) definition of resilience is the “capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding

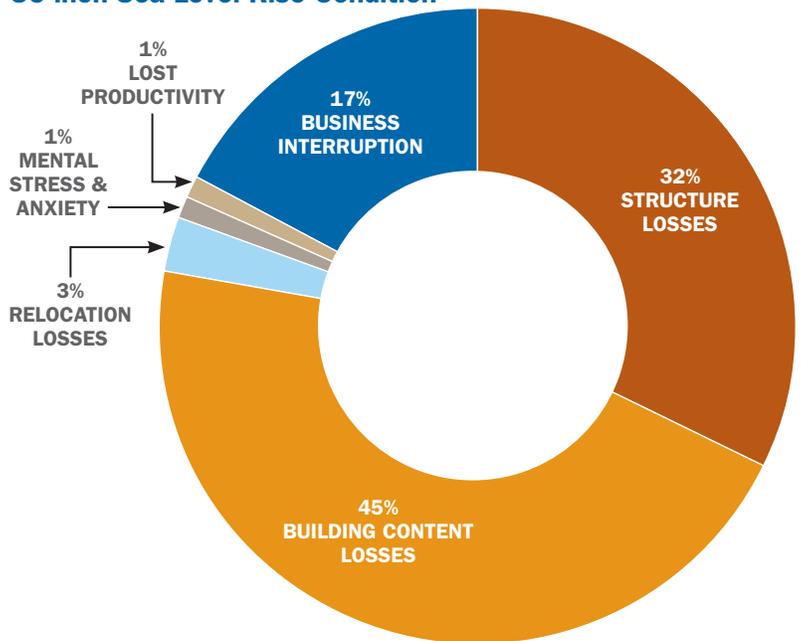
Resilience is the capacity of a system to cope with a hazardous event or trend while maintaining its essential functions and ability to adapt.

FIGURE 1
City of Boston Projected Annualized Losses



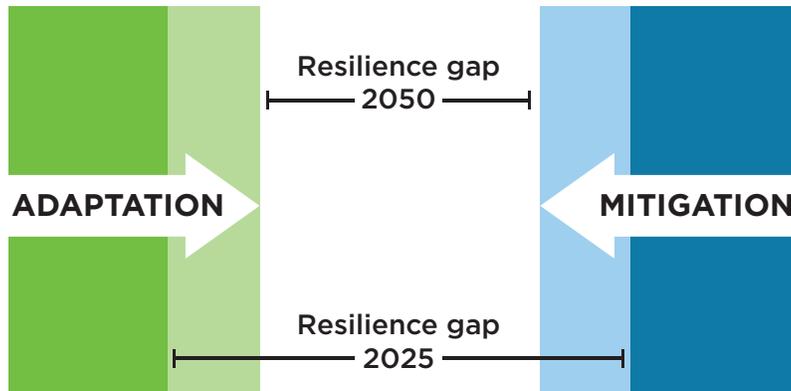
Source: City of Boston, Climate Ready Boston, 2016

FIGURE 2
City of Boston Annualized Losses:
36 inch Sea Level Rise Condition



Source: City of Boston, Climate Ready Boston, 2016

FIGURE 3
Adaptation, Mitigation, and Resilience



Source: Union of Concerned Scientists. *Toward Climate Resilience: A Framework and Principles for Science-Based Adaptation*. 2016.

In the context of climate change, a system’s capacity for resilience depends on three factors: the severity of a given hazard, the likelihood that the hazard will affect the system, and the vulnerability of the system (assuming it’s fully exposed to the hazard).

or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.”⁶ In the context of climate change, a system’s capacity for resilience depends on three factors: the severity of a given hazard, the likelihood that the hazard will affect the system, and the vulnerability of the system (assuming it’s fully exposed to the hazard). The concept of resilience recognizes that the capacity for it can be increased by both reducing the hazards to which a system is exposed (mitigation) and reducing a system’s vulnerability to those hazards (adaptation) (Figure 3). In other words, resilience recognizes that mitigation and adaptation are two sides of the same coin. Thinking of resilience as a capacity built through different practices can give individuals, communities, and governments flexibility in deciding which measures make the most

sense for building resilience to the specific impacts of climate change they face.⁷

Climate change mitigation activities typically fall into three categories: measures to reduce resource consumption (e.g. energy efficiency, mode shift to public transportation, recycling, water conservation, efficient land use); measures to substitute renewables for fossil fuels (e.g. promoting solar, wind, hydroelectric, biomass, hydrogen and fuel cell, and geothermal power); and measures to capture and store carbon. Climate change adaptation measures may overlap with mitigation measures, and often include developing district energy and alternative energy sources; green infrastructure; flood protection systems; regulatory changes; adaptive stormwater management; land use planning strategies; infrastructure and building retrofits; and new design standards.

THIS REPORT

Boston has the ability to build up its climate resilience in a proactive, thoughtful manner, without the burden of simultaneously recovering from a major catastrophe. We can do this because the City has made the effort to determine what we are up against. The Climate Ready Boston (CRB) report⁸ has identified the location and likelihood of various climate change impacts and many of the steps that we need to take to become resilient in the face of those impacts. In addition, the city has undertaken detailed resilience planning efforts in the most at-risk neighborhoods in the city, including East Boston, Charlestown, South Boston and (starting in late 2018), Downtown and Dorchester. These resilience plans give us a detailed sense of the nature and scope of the investments that we will need to make to protect these parts of the city from future climate impacts.

One of the recommendations of the CRB report is to evaluate governance structures for managing the implementation, operations, and maintenance of adaptation actions. This

report responds to that recommendation by outlining the governance challenges that face the City of Boston related to flooding as well as possible paths forward to support wise governance for adaptation efforts that will increase our resilience. One of the challenges is that Boston cannot create a resilient future in isolation, and for this reason governance beyond the local level—including regional, state, and federal governance—is considered in this report.

While the ultimate purpose of adaptation is to ensure the long-term well-being of people and communities vulnerable to all aspects of climate change, similar to the companion report, *Financing Climate Resilience*, this report focuses on governance aimed at reducing the physical risks to the built environment of increased flooding, due to both sea level rise and increased precipitation. Since the focus of this report is not on heat stress or other public health challenges, more work needs to be done to integrate those issues.

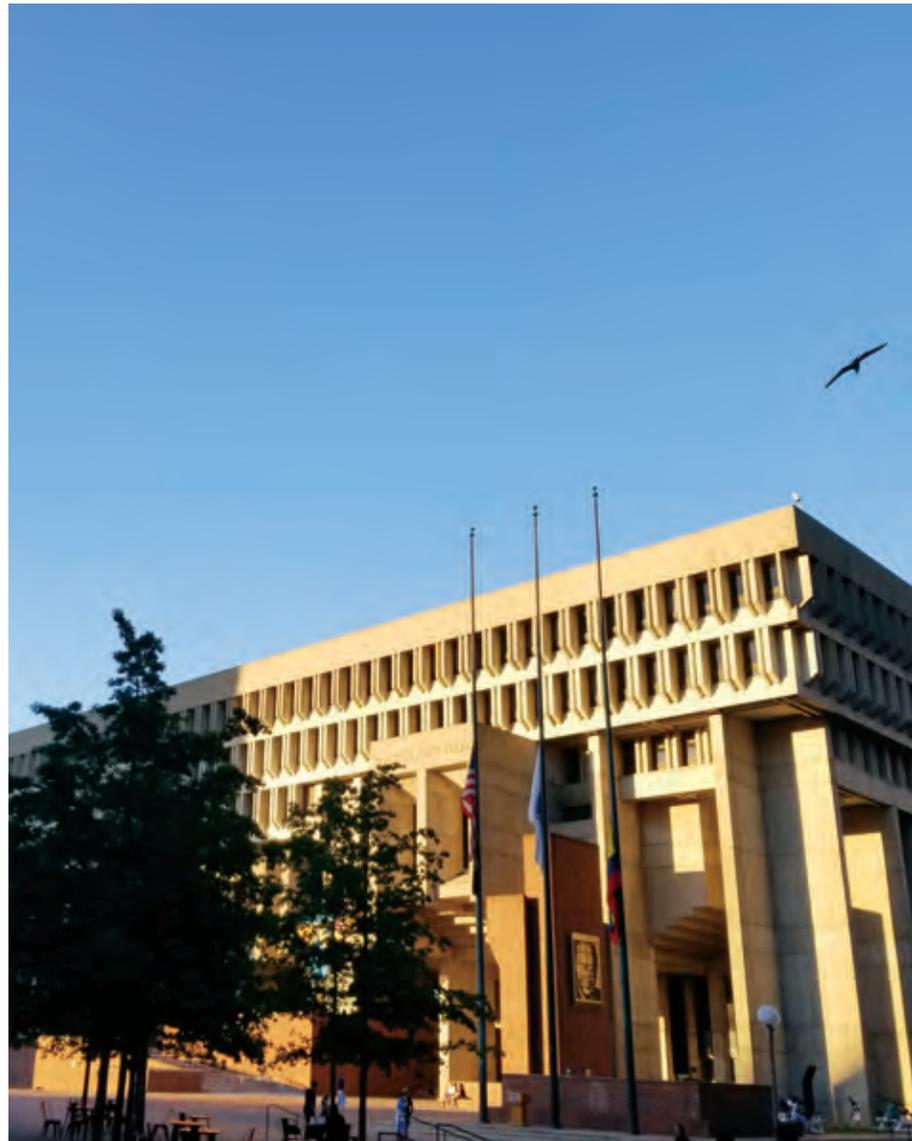
This report is organized as follows:

- Chapter 2 begins by defining what we mean by “governance,” then continues by discussing what it means to govern in a changing climate, outlining the functions needed to manage adaptation to a changing climate, and pondering some of the challenges this entails.
- Chapter 3 describes the laws, ordinances, regulations, policies, and plans at the local, regional, state, and national level that play a significant role in Boston’s flood adaptation efforts. Some private sector governance tools are covered here as well.
- Chapter 4 identifies the initiatives recommended in the CRB report that involve governance mechanisms aimed at reducing the impacts of increased flooding on the built environment. For each initiative, the appropriate governance scale, responsible organization, governance tool, and governance function is indicated. Important

This report focuses on governance aimed at reducing the physical risks to the built environment of increased flooding, due to both sea level rise and increased precipitation.

governance functions that are not addressed by the CRB report are identified.

- Chapter 5 provides specific recommendations for prioritizing changes to existing tools and implementing CRB initiatives including establishing an Infrastructure Coordination Committee, convening a Climate Research Advisory Organization, and establishing governance for district-scale coastal flood protection.



2

Governance

WHAT IS GOVERNANCE?

Governance extends far beyond “the government.” It involves the processes that enable people and institutions to interact and societies to plan, make decisions, and implement activities. Governance includes all of us—public agencies, businesses, civic and academic organizations, and residents—and the rules and norms that shape who we are and what we do. Societies always have

multiple centers of power—in government and across the public sector, in individual firms and across the private sector, and in a broad array of community institutions and across civil society. Legal and social institutions, including mindsets, habits, and expectations, shape markets, incentives, investments, communities, and a host of other individual organizational choices. Governance refers to how things are done, rather than what is done. Governance can be thought of as a continuum, using less formal concepts



FIGURE 4
Governance Continuum

FORMALITY 	Laws/Ordinances	The law says this is what must/must not be done.	Government	Private Sector
	Regulations	This is the way the law must be implemented.		
	Policies	This is the way this organization has decided to do it, “as a rule.”		
	Procedures	These are the steps this organization usually takes to do it.		
	Norms	This is the way we do it.	Society	
	Expectations	This is the way it should be done.		
	Aspirations	This is the way we hope it will be done.		
	Ideas	These are the ways it could be done.		

Source: VHB

and tools within the realm of society, to using more formal ones in the private and government sectors (Figure 4).

Effective governance requires the coordinated actions of three types of actors: public agencies, private for-profit enterprises, and private non-profits. Each plays a different role, and each is necessary. In this report, we focus on the role that public agencies, a.k.a. the government, play in governance for a changing climate.

CHANGING CLIMATE, CHANGING GOVERNANCE

In the past, we managed our societies based on the assumption that the climate is static, because for thousands of years it generally was. But around the middle of the last century, human activity began to have dramatic impacts on the Earth’s landscape and systems, driving significant atmospheric, chemical, physical and biological changes.⁹ The advances resulting from these activities have allowed many of us to experience high levels of comfort and economic opportunities in our everyday lives. However, these endeavors have also permitted us to become more ensconced in our human-created world and less cognizant of our connection to the natural world.

Governance extends far beyond “the government.” It involves the processes that enable people and institutions to interact and societies to plan, make decisions and implement activities.

People and nature are intertwined in what are known as social-ecological systems, which are complex adaptive systems composed of many diverse human and non-human entities that interact. The entities adapt to changes in their environment and their environment changes as a result.¹⁰ The phenomenon of climate change has reacquainted us with the fact that the line between social systems and ecological systems is artificial and arbitrary. As humans burn fossil fuels and release greenhouse gases into the atmosphere, we are able to see the impacts of these actions on both the environment and on our everyday lives, and our lives are in turn changed by the changes in our environment.

Over the past 40 or so years, the fact that the climate had already begun to change and was projected to continue to change at an increasing rate has been debated or denied in many circles. During that time, we continued to pass laws, adopt regulations, and plan our

cities under the assumption of a fixed climate based on past trends. For example, our storm-water systems were designed based on precipitation volumes and intensities that were calculated at a particular moment in time and were expected to remain more or less the same indefinitely into the future. We did not account for the fact that between 1958 and 2010, the Northeast would see more than a 70% increase in the amount of precipitation falling in very heavy events, and our regulations do not currently acknowledge that if greenhouse gas emissions continue to increase at the current rate, the frequency of heavy downpours will continue to increase.¹¹

While many governance problems are not unique to the realm of climate change, the scope, pace, and significance of climate change may warrant unique solutions.

Similarly, buildings erected in areas with a 1% chance of flooding each year, as modeled based on historical storm patterns, are required to meet certain floodproofing standards. But updated models that use current and projected climate conditions show that the areas subject to flooding are often more extensive, and subject to deeper flooding, than indicated on official maps, leaving both existing and new buildings underprepared for inundation.

It is clear that the climate is not in fact static and has not been for some time. We now need to adjust our manner of governing to that reality. There is a need, therefore, to advocate for approaches to governance capable of confronting landscape-scale problems in a manner that is flexible and responsive enough to adjust to complex, often unpredictable feedback between social and ecological system components, such as those anticipated to result from a changing climate.

NECESSARY FUNCTIONS FOR RESILIENT GOVERNANCE

In the context of improving the resilience of the built environment to increased flooding due to both sea level rise and increased precipitation, our governance system would need to provide the following functions:

- Generate, communicate, and integrate complicated, rapidly evolving **information**;
- Conduct **outreach** and develop **plans** that engage a variety of stakeholders;
- Develop and apply transparent, objective, and equitable criteria for project **prioritization**;
- Create and implement **laws, regulations, and policies** that are equitable and provide both stability and flexibility while promoting a resilient built environment;
- Develop the capacity to design, finance, construct, and maintain a system of shore-based **district-scale flood protection** measures;
- Develop the capacity to design, finance, construct, and maintain **infrastructure** that will continue to function in a changing climate; and
- Institutionalize flexibility through **monitoring** and **evaluating** outcomes.

The functions listed above are described in more detail below, along with potential roadblocks, leverage points, and key questions.

Generate, communicate, and integrate complicated, rapidly evolving information.

Understanding regional and local effects of climate change has evolved quickly and the Boston region has some of the most sophisticated assessments of likely impacts for decision makers. Some gaps still remain in the understanding about the timing, intensity, and specific scale of the threat, primarily because of continuing uncertainty about whether, when, and how much global emissions

will be reduced, but also due to emerging understanding of processes that have not yet been included in climate models, such as certain glaciological processes, abrupt permafrost thaw, and wildfire soot emissions, among others. Nevertheless, the types of risks posed by climate change are well known.

While many sectors are aware of, and communicate to others, the risks posed by climate change, some are not. As was noted in the *Financing Climate Resilience* report, “market signals in insurance and property markets are not yet fully reflecting climate risks,”¹² and government regulation does not require better climate risk information in the insurance market. In addition, there is also much more to learn about how the effects of climate change will impact different communities differently and how our responses to climate change could inadvertently amplify racial, economic, and other inequities that already exist.

Even when accurate information is available, and has been communicated to its intended audience, it is not always clear how to act on it. This type of challenge is related to the problem of linking science and policy. The emerging field of sustainability science argues that “too much potentially valuable knowledge produced by committed researchers languishes in libraries, unused by society; and too many of society’s greatest needs for new knowledge remain relatively unexplored by researchers.”¹³ Solving this challenge requires a new culture of research, one that accounts for multiple interests and seeks to create actionable findings.

An additional challenge in this realm is that research and policy-making are historically accomplished in silos. Climate change is inherently a multi-sector, interdisciplinary problem. To effectively respond to the challenges of climate change, we need to have a comprehensive view of the drivers and responses and their relations to each other in real time. Very few, if any, institutions have that capacity currently.

Finally, in a future world of rapid change, and rapid revising of our understanding of that change, we need to figure out how to use information adaptively within our governance structures, and how to update plans, rules, regulations, and incentives as new knowledge emerges.

Even when accurate information is available, and has been communicated to its intended audience, it is not always clear how to act on it. This type of challenge is related to the problem of linking science and policy.

Conduct outreach and develop plans that engage a variety of stakeholders.

Through the Green Ribbon Commission, the CRB report, and Imagine Boston 2030, Boston has embarked on wide-ranging planning, bringing climate change to the forefront of an already crowded agenda of citizens’ concerns. Multiple additional planning exercises on the state and regional levels and in the transportation and utility sectors are beginning to take climate risks into account, but such efforts are not yet as comprehensive as they could be, nor as integrated. As it becomes clearer that shore-based and community-based efforts will be required to both protect Boston from climate impacts and allow communities and businesses to seize opportunities, comprehensive planning that launches both investments now and decades into the future will be critical. Some Boston residents mistrust the government due to a history of urban renewal and lack of sufficient engagement in planning processes. Mayor Marty Walsh has attempted to address this history through reforming and renaming the Boston Redevelopment Authority into the Boston Planning and Development Agency and through the more extensive and inclusive planning processes listed above. In order to build on this work, long term and deep engagement are necessary, beyond specific

Governance and Equitable Adaptation

In April 2016, the Georgetown Climate Center and the Urban Sustainability Directors Network (USDN) convened a workshop bringing together nearly 50 thought leaders on equity and climate adaptation. The workshop focused on city-level actions that would support social justice goals and better prepare communities for the effects of climate change.¹⁴

Participants included city officials, representatives of environmental justice and social justice organizations, state and federal partners, and funders who support this work.

Workshop participants were challenged to reflect on their own planning processes and identify ways that communities can address unequal risks; increase diversity, community participation, and leadership in adaptation planning; and ensure that climate change preparation efforts are benefiting and not negatively affecting those most at risk of impacts. Workshop participants discussed adaptation strategies, policies, and projects that could help cities achieve social justice, economic development, and climate adaptation goals.

Participants identified the following key lessons over the course of the workshop:

- Achieving equitable adaptation outcomes will require an inclusive process that gives community members, especially low-income residents and people of color, the opportunity to envision and set adaptation priorities and influence investments, policies, and programs pursued in their communities.
- In many cities, a long history of mistrust between public agencies and community members will need to be addressed before and throughout the process for collaborative planning to be successful. This will require a long-term commitment to relationship building that is institutionalized and not project-specific.
- Cities can address inequity within their own agencies by hiring more inclusively and identifying ways that city agencies currently reinforce inequities (e.g. holding meetings at inconvenient times for working people or failing to include interpreters or notices in representative languages).
- Public agencies will benefit from partnering with others, including community-based organizations, community institutions, and foundations, to address climate and equity goals.
- Recognizing that climate change will affect some people and groups disproportionately, cities can address equity concerns by directing resources to those areas and groups facing the greatest risks.
- Equitable adaptation asks city leaders and staff to think not only about how and where they direct resources, but also how certain policies might have negative consequences for particular groups or communities. For example, low-income homeowners in floodplains will face increasing economic strain from rising flood insurance rates; this may force some homeowners to drop insurance coverage, which is the last line of defense in the event that flood impacts occur.
- Climate policies can address larger issues such as poverty, housing security, and racial equity. Likewise, policies and activities that are not traditionally seen as “climate adaptation,” such as workforce development and arts festivals, can be linked with adaptation initiatives to improve the economic and social resilience of residents.
- Addressing climate change and equity will involve a long process of experimentation and creativity. Some cities and community-based organizations are already pushing boundaries and trying to identify best practices.



planning processes or projects. (See “Governance and Equitable Adaptation” sidebar on p. 12).

Develop and apply transparent, objective, and equitable criteria for project prioritization.

In order to gain support for solutions that will involve multiple stakeholders, significant tradeoffs, time, and money, it is vital that projects are prioritized in a fair and transparent manner. As the CRB report points out, it is critical to consistently quantify the social, environmental, and economic benefits of each alternative intervention—with particular attention to social equity and the needs of socially vulnerable populations—so that they can be weighed both against the costs of the project and against each other. The CRB report establishes an evaluation framework that includes considerations such as flood risk reduction benefits; other co-benefits; environmental impacts; cost; land ownership; permitting and regulations; and intergovernmental coordination. Other specific commu-

In order to gain support for solutions that will involve multiple stakeholders, significant tradeoffs, time, and money, it is vital that projects are prioritized in a fair and transparent manner.

nity goals may need to be incorporated into such a framework. (See “Boston Neighborhood Slow Streets,” sidebar on p. 14).

Create and implement laws, regulations, and policies that are equitable and provide both stability and flexibility while promoting a resilient built environment.

Legal systems are purposely structured to foster stability and predictability.¹⁵ Nevertheless, building codes, zoning laws, and state and federal guidelines and regulations that have developed over the last several decades have responded to changes in technology, demands for more energy efficiency and

Community meeting to discuss Climate Ready Boston hosted by Boston Harbor Now.

Boston Neighborhood Slow Streets: A Transparent and Accessible Process

The Boston Neighborhood Slow Streets Program aims “to reduce the number and severity of crashes on residential streets . . . lessen the impacts of through traffic, and add to the quality of life in our neighborhoods.”¹⁶ It is the City of Boston’s first traffic calming program and was designed to be a transparent and accessible process that would “prioritize areas with the most need.” In this case, one of the most heavily weighted factors is the concentration of youth, older adults and people with disabilities in a neighborhood. These groups are more vulnerable to injury if involved in a collision because their bodies are more fragile.

How it works

Neighborhood associations, community groups, faith-based institutions or other organized groups of neighbors can apply for traffic calming in a specific neighborhood. From the pool of completed applications, the Boston Transportation Department (BTD) selects 3 to 5 neighborhoods based on pre-determined, objective criteria. Once a neighborhood is selected, BTD staff work hard to be responsive to community needs and tap into community expertise in the design process. This begins with a “walk-through” that helps develop a plan for the problem areas in the zone. A concept plan is then presented to the neighborhood at a public meeting hosted by the City (this is important to insure that everyone feels welcome even if they are not affiliated with the organization that submitted the application). BTD staff incorporate the feedback they receive at the community meeting and present a final plan at a second community meeting. This second meeting is an opportunity for small changes. Finally, there is a pre-construction meeting and then the project begins.

Application and Selection Process¹⁷

The application is very basic and consists of the contact information for a primary contact, a map of the proposed traffic calming zone, 24 signatures from supportive community members and 3 letters of support from community institutions or officials. Since the only thing that needs to be drafted are the letters of support from neighborhood institutions (which, presumably have English speaking staff), the application can be

completed by non-English speakers. In addition, the process is structured so that there is no benefit to having a submission that goes above and beyond the application requirements. This means that wealthier communities with residents who have relevant professional expertise or with more political connections do not have an unfair advantage in getting their project chosen. Once the requirements are met, staff in the Boston Transportation Department “use objective evaluation criteria to select 3 to 5 communities that:

- Are home to higher percentages of youth, older adults, and people with disabilities
- Experience higher numbers of traffic crashes per mile that resulted in an EMS response
- Include, or border, community places: public libraries, BCYFs, schools, and parks
- Support existing and planned opportunities for walking, bicycling, and access to transit
- Are feasible for the City of Boston to implement improvements”

Instead of the burden of collecting the required data resting on those applying, for this program it is the responsibility of BTD to pull the demographic information, crash data, location and so on. This keeps the barriers to applying low, ensures that the same data sets are used, and that the neighborhood profiles BTD staff are comparing are consistent. The entire evaluation process is posted on the City of Boston website, including graphs of the analysis done to select neighborhoods and an interactive map to see the locations of proposed zones throughout the City. By transparently using objective criteria that are set up to favor neighborhoods with the most traffic calming needs, the Neighborhood Slow Streets program is an exemplary model of equity-based decision making and government accessibility.

This program is only in its second year but it is clear there is a lot of demand: in 2017, 47 applications were submitted.

greater emphasis on safety. They have been developed, however, with an assumption of a relatively static climate. With a climate that is already changing and the magnitude and timing of that change uncertain, a new regulatory framework is warranted that accounts for anticipated (and unanticipated) changes in sea level, tides, coastal and inland flooding, extreme storms, extreme temperatures, high winds, and other weather variables. Such a framework also needs to account for the evolving knowledge of potential local impacts on people and their communities in addition to the built environment.

For example, the likely range of sea level rise by 2070 in Boston Harbor under the business-as-usual emissions scenario is currently estimated to be between 1.5 and 3.1 feet.¹⁸ As we approach 2070, more accurate sea level rise estimates will become available. To protect property, businesses, homes, and communities in such a dynamic world will require an equally adaptable regulatory framework that can be responsive to new information, while still providing enough predictability to encourage investment.

Develop the capacity to design, finance, construct, and maintain a system of shore-based district-scale flood protection measures.

UMass Boston's Sustainable Solutions Lab's (SSL) recent report, *Feasibility of Harbor-wide Barrier Systems: Preliminary Analysis for Boston Harbor*, advises against pursuing a harbor barrier flood protection strategy in the coming decades. The analysis found such a strategy to be technically impractical and less effective, dollar for dollar, than continued investment in shore-based coastal protection solutions such as those described in the CRB report.¹⁹ The study's lead author noted that the most effective strategy that the City can pursue is to stay focused on neighborhood, shore-based resilience, moving quickly and working closely with communities and land owners. Multiple challenges associated with



Flooding at the MBTA Aquarium Station in downtown Boston, March 2018.

this strategy include studying, selecting, and designing the appropriate flood protection measures, as well as securing land, permits, and financing for these measures. Boston and the region will need to renovate existing governance institutions and tools, innovate new ones, or combine these approaches to encourage such actions.

Develop the capacity to design, finance, construct, and maintain infrastructure that will continue to function in a changing climate.

As noted in the CRB report, the continued reliability of Boston's infrastructure, including water and sewer, transportation, energy, and telecommunications systems, is vulnerable to changing climate conditions. These systems are not directly under municipal control, and while there is currently coordination among key private and public infrastructure owners and operators in the Boston metro area, it tends to vary in its quality and outcomes. For some issues there is long-standing and well-structured coordination, and in others coordination is weak or absent. While many owners and operators have taken steps to understand their systems' vulnerabilities and make plans for improvements, not all have, and there are no universally-shared climate

design standards and no way to track investments in climate resilient infrastructure. Bringing all infrastructure players together in a coordinated, perhaps more formal, fashion is yet another challenge, although one that is not unique to the field of climate change adaptation.

We must prioritize, integrate and fund a robust monitoring and evaluation program. Currently, there is no large-scale effort at systematic and purposeful observation or measuring the effectiveness of climate-adaptation programs and activities.

Institutionalize flexibility through monitoring and evaluating outcomes.

In order for us to collectively learn, reflect and evolve our strategies over time we must prioritize, integrate and fund a robust monitoring and evaluation program. Currently, there is no large-scale effort at systematic and purposeful observation or measuring the effectiveness of climate-adaptation programs and activities. Through active monitoring and evaluation, we can create a culture of learning that can provide a continuous flow of new information used to coordinate resource management across multiple systems. The concept of “adaptive management,” which is often used in conservation and international development settings, is applicable here. Adaptive management is an intentional approach to making decisions and adjustments in response to new information and changes in context. It emphasizes flexibility and requires that we avoid tying up the future with rigid agreements. It can be especially useful for decision making in the face of uncertainty, as it allows participants to change the path being used to achieve goals in response to changes in the environment. Who might perform this monitoring

and evaluation function, what type and scale such an organization might fit within, and what tools it might use must be addressed.

GETTING TO RESILIENT GOVERNANCE

Having identified the necessary functions for resilient governance, the next step is to determine how we can make resilient governance a reality. One way is to take an incremental approach, which involves taking small, yet meaningful steps toward improving our existing institutions, tools, and methods. This approach is useful when we want to do what we already do better. Small, cumulative wins are an important start to produce the type and scale of adaptation needed, and, given the slow and complex nature of changing institutions, it is essential we begin this incremental change now.²⁰

It is also likely that, due to the rate or extent of climate change, incremental change is inadequate. More in-depth, larger scale, and/or faster changes are likely necessary (although changes that meet those three criteria simultaneously are likely impossible).²¹ A transformational approach to governance may be necessary, which involves innovative governing strategies, changes in power structures, and the introduction of new institutional arrangements and regulatory frameworks. This type of approach is useful when we want to completely change the way we do things. The scope, pace, and significance of climate change may warrant unique solutions that can only be realized through transformational governance.

This report champions an approach that combines renovating and improving tools that we already have, and crafting innovative new tools of governance that are commensurate with the urgent and complex nature of climate change.

3

Tools

OUR TOOLBOX

Various governance tools at the local, regional, state, and federal levels are available to encourage implementation of flood adaptation measures on private land.²² These tools define the set of actors that will be part of the cast during the crucial implementation process that follows program enactment, and they determine the roles that these actors will play.²³ This section identifies the most salient public sector tools for Boston (for links see Appendix C). Each tool is listed below along with:

- a description of its purpose;
- its applicability as it relates to climate change;
- its limitations in a changing climate, either of its applicability or the way in which it limits that which it regulates; and
- suggestions for ways the tool can be altered to improve resilient outcomes.

When attempting to increase resilience for any particular tool, it is worth highlighting the importance of trying to achieve both flexibility and predictability. Because climate resilience is a new policy focus where well-defined mandates are not yet appropriate, performance standards, voluntary measures, incentives, and other forms of regulatory experimentation are more appropriate.

Public governance tools include laws, ordinances, regulations, policies, and plans. Laws are written statutes, passed by either

the U.S. Congress or state legislatures. Regulations are standards and rules adopted by administrative agencies that govern how laws will be interpreted, implemented, and enforced. Regulations often have the same force as laws, since, without them, regulatory agencies wouldn't be able to enforce laws. An ordinance is simply a law enacted by a municipality. A policy is a statement of intent to guide decisions and achieve rational outcomes and is implemented as a procedure or protocol, but it is not binding law. A plan is the product of a public process whereby the land use, economic, environmental, and social trends are analyzed, and an optimal land use and infrastructure vision may be established. Plans can be adopted as binding rules or regulations, but most often serve as guidance

East Boston residents provide feedback during the first East Boston Community Open House.



documents that contain recommendations for implementation measures such as adopting ordinances and regulations, implementing projects, and conducting additional studies. Each of these tools has an important role in guiding climate adaptation actions.

The public governance tools described below are organized by level of governance—local, regional, state, and federal. However, they could also be organized by function or when they become applicable during the development process. For example, the Massachusetts Environmental Policy Act (a state law) and Article 80 Development Review (part of the local Zoning Code) both require development impact review. Other Zoning Code articles, Chapter 91, and the Wetland Protection Act (both state laws) are part of the discretionary approval process. The former are early stage public reviews, rather than approvals, that have broad content areas and wide public participation. Their purpose is to inform agency decision making. As such, they are highly useful for addressing climate resilience in a project-specific fashion. In contrast, the discretionary approvals focus on specific subject areas and are subject to standards that originated before climate change was a policy focus. They often present more limitations in a changing climate.

There are also many private sector governance tools that can be used to implement climate change adaptation measures. This chapter focus on two legal tools that can have a prominent impact on both the public and private sector's implementation of flood adaptation measures: lawsuits and professional standards of care.

Laws are written statutes, passed by either the U.S. Congress or state legislatures. An ordinance is a law or statute enacted by a municipality.

LOCAL GOVERNMENT

Local governments, such as the City of Boston, have at their disposal a variety of tools useful in climate change flood adaptation including articles of the Zoning Code, policies, strategic planning, and land use planning, which are described below.

Zoning Code

- Purpose:** Zoning is allowed as a proper function of Boston's police power, which is defined as the power to regulate for the advancement and protection of the health, morals, safety, and general welfare of the community as a whole. One of the goals of Boston's Zoning Code is to protect its distinct neighborhoods from the development of buildings or uses that do not harmonize with their surrounding context. The Zoning Code allows the Zoning Commission to adopt regulations that regulate the use of land and buildings, as well as their dimensions, including first floor elevation (the elevation of the top of the first habitable floor of a structure); the maximum ratio of floor area and lot coverage; minimum lot sizes; minimum lot area for each dwelling unit or equivalent; minimum lot width; minimum dimensions of front, side, and rear yards; and maximum height of structures. It also provides requirements for open space, parking and loading, and accessory structures.²⁴ The role of the Boston Planning and Development Agency (BPDA) in this context is to shape the Zoning Code and review large and unique development projects, which may require variances from existing code. The Zoning Code consists of over 100 articles, two of which (Articles 25 and 80) are described in more detail below. The City of Boston has its own Zoning Enabling Act (Chapter 665 of the Acts of 1956) and is not subject to Massachusetts State Zoning—M.G.L c. 40A (with some minor exceptions).

- **Applicability:** When any structure or land is erected, reconstructed, extended, or altered, it must be done in conformity with the Zoning Code. While the Zoning Code regulates massing, building placement, and use, the Massachusetts Building Code regulates the details of the structures themselves, such as load requirements and building methods and materials (for example, flood proofing materials).
- **Limitations in a Changing Climate:** Existing buildings that are not being altered are not subject to the Zoning Code, making it ill-suited to impact the vast majority of Boston's built environment. In addition, state and federal projects are not subject to local zoning ordinances. Finally, by law, the Zoning Code cannot be construed to regulate aspects of structures that are the domain of the State Building Code—780 CMR.
- **Increasing Resilience:** Existing zoning districts may be amended to improve resilience. For example, the CRB report suggests increasing open space requirements in the Waterfront Commercial subdistrict to allow space to erect regional flood barriers and including coastal flood protection infrastructure in the list of Planned Development Area (PDA) zoning district public benefits. New districts may also be added to the Zoning Code. For example, a Flood Resiliency Overlay District requiring integration with flood protection systems has been suggested in the CRB report and is described below. In July 2018 the BPDA issued a request for proposals for a consultant to provide such zoning recommendations and related resilient design guidelines.

ARTICLE 80 DEVELOPMENT REVIEW AND APPROVAL

- **Purpose:** The purpose of Article 80 of the Zoning Code is to provide clear, predictable, and unified requirements for the review of development projects throughout the City, and to provide opportunities for community



BPDA Model of the City of Boston.

involvement in development review activities. It establishes requirements to protect and enhance the public realm, to mitigate the impacts of development projects on their surroundings and on City resources, and procedures for project review by the BPDA.

- **Applicability:** Projects may be subject to review under four separate categories based on their location and characteristics: Large Project Review; Small Project Review; Planned Development Area Review; and Institutional Master Plan Review.
- **Limitations in a Changing Climate:** Since the topic of climate adaptation is currently presented as guidance rather than regulation (see Climate Change Preparedness and Resiliency Policy below), a proponent might not consider a resilient approach from the outset. If the concept is introduced too late in the lengthy Article 80 review process, adaptation measures are more costly and difficult to incorporate into design and are therefore less likely to be implemented. As the review process currently stands, climate adaptation measures are but one of many features that are not mandated and are therefore

subject to negotiation. On the flip side, the more frequent amendments that may be necessary to adapt the built environment to a changing climate may also contribute to preventing Article 80 from achieving its purpose of providing predictable development review requirements.

- **Increasing Resilience:** To streamline climate resilience review, rather than, for example, altering or creating new sub-districts, projects subject to Article 80 within the BPDA SLR-Flood Hazard Areas (SLR-FHAs) could be made subject to review by a new Climate Resilience Design Commission, which would develop and enforce General Design and Environmental Standards and play a role similar to that of the Boston Civic Design Commission. Assuming these standards would be applied consistently, they would help level the playing field, wherein resilient investments would begin to be considered a standard cost of doing business.

ARTICLE 25, FLOOD HAZARD DISTRICTS

- **Purpose:** Article 25 is a section of the Boston Zoning Ordinance administered by the BPDA, the purpose of which is to promote the health and safety of the occupants of land against the hazards of flooding, to preserve and protect the streams and

other water courses in the city and their adjoining lands, to protect the community against detrimental use and development, and to minimize flood losses. It was adopted to comply with the minimum requirements of the National Flood Insurance Program (NFIP), which states that all participating communities “must agree to adopt and enforce sound floodplain management regulations and ordinances.” Article 25 identifies the map adopted by the community that identifies the locations in which the flood-related portions of the Massachusetts Building Code are applicable.

- **Applicability:** As a zoning district, Article 25 is applicable when structures are erected, reconstructed, extended, or altered on land within a specific geographic area. The boundary of Article 25 (which is essentially an overlay district) is currently the same as the Special Flood Hazard Area (SFHA) depicted on the effective FEMA Flood Insurance Rate Maps (FIRMS), and further defined by the base flood elevations (BFEs), which is the elevation of the water associated with a flood that has a 1% chance of occurrence in any given year, described in the Suffolk County Flood Insurance Study. FIRMs are created by FEMA using computer simulations of coastal storms based on data from past storms. While their

Flooding in downtown Boston, March 2018.



purpose is to identify risk premium zones for insurance purposes, they are also often used for floodplain management purposes for lack of a more appropriate tool.²⁵

- **Limitations in a Changing Climate:** Article 25 is currently only applicable within the boundaries of the SFHA as defined by the FEMA FIRM maps, which do not identify areas that are prone to flooding from events other than the current 1% and 0.2% annual chance flood events. Because most buildings have a life span of 60 years or more, much of the new development that is now being permitted and constructed in coastal areas outside the current floodplain will likely be subject to damage from future 1% annual chance floods due to sea level rise. Article 25 is also subject to the same limitations as other articles of the Zoning Code.
- **Increasing Resilience:** The NFIP explicitly encourages communities to tailor their floodplain management activities to local conditions by a) recommending that communities adopt floodplain regulations that are more restrictive than the minimum requirements of the NFIP and b) noting that communities may enforce some or all of their floodplain management requirements in areas outside the SFHA.²⁶ Article 25 currently contains no additional requirements beyond the Massachusetts Building Code. To ensure that Article 25 continues to serve its stated purpose throughout the design life of the structures to which it applies, two aspects of Article 25 could be revised as per the NFIP guidance. These are its geographic extent, and the measures it requires to protect people and property from flood hazards. To address the issue of the regulation's geographic extent, the area to which Article 25 (and thus the flood-related portions of the Building Code) applies could be expanded to the entire BPDA SLR-FHA. To provide increased flood protection to people and property, design standards could be developed in conjunc-

tion with a new Flood Resilience Overlay District as described in the section on the “New Flood Resilience Overlay District” below.

NEW FLOOD RESILIENCE OVERLAY DISTRICT

- **Purpose:** The purpose of a new Flood Resilience Overlay District (FROD) would be to codify the BPDA's recommended Sea Level Rise—Design Flood Elevations²⁷ (SLR-DFE) as the minimum performance target for assessing sea level rise impacts and for reducing or eliminating flood risk, potential damage, and related adverse impacts.

Existing buildings that are not being altered are not subject to the Zoning Code, making it ill-suited to impact the vast majority of Boston's built environment.

- **Applicability:** As a zoning district, the FROD would be applicable when structures are erected, reconstructed, extended, or altered on land within a specific geographic area. The geographic area of applicability could be the BPDA SLR-FHA. Design standards could also be incorporated.
- **Limitations in a Changing Climate:** As indicated above, existing buildings that are not being altered are not subject to the Zoning Code, making it ill-suited to impact the vast majority of Boston's built environment. In addition, state and federal projects are not subject to local zoning ordinances. Finally, the Zoning Code regulates the use of land and buildings, as well as their dimensions, and cannot regulate or restrict the use of materials or methods of construction of structures (including floodproofing requirements), which are regulated by the state building code.
- **Increasing Resilience:** A new zoning overlay district would provide a fresh opportunity to create regulations specifically geared toward resilience, rather than having

to retrofit a regulation that was originally created for another purpose (such as Article 25, which was created to comply with the NFIP and to identify the area within which the flood-related portions of the Building Code are applicable). To provide increased flood protection to people and property, zoning and design standards could be developed that promote resilience, for example:

- Require first floor elevations above the BFE that is anticipated during the lifetime of new structures.
- Allow increases in building height to accommodate freeboard (additional distance between the BFE and the Finish Floor Elevation (FFE)) without changing height limits within underlying zoning district by changing the method of measuring building height. Zoning height could be measured from the minimum required elevation of the lowest floor (in accordance with 780 CMR 1612.4), or from a future BFE, rather than from the average adjacent grade.
- Incorporate sacrificial floors (first stories that are relegated to non-occupiable uses when they become subject to flooding) into building design to accommodate changes in sea level.

A policy is a statement of intent to guide decisions and achieve rational outcomes and is implemented as a procedure or protocol.

- In existing structures where the first floor is below the minimum required elevation, allow that floor to be relegated to a use other than for human occupancy, wet floodproofed, and removed from the total floor area calculation. This could then allow the addition of new upper floors for those buildings with the necessary structural capacity.
- Allow non-complying buildings to be elevated or reconstructed to an increased

height, even if it creates a new non-compliant structure or increases the degree of an existing non-compliant structure.

- Create incentives or requirements to adjust ground-floor uses to maintain an active public realm, where possible, in cases where ground floors are substantially above adjacent grade.
- Incentivize, allow, or require architectural elements and streetscape provisions to mitigate visual disconnection between the elevated first floor and the street. This can be accomplished with planting buffers and porches in residential areas, and dry floodproofed fenestration, entrances, and retail floor space in commercial areas.
- Modify street wall requirements, floor area ratio (FAR), and height regulations to allow larger building access elements to be placed outside or inside the building, as needed. For example, the space necessary for ramps and stairs could be exempted from the floor area when placed inside the building. This could be especially helpful in meeting Americans with Disabilities Act (ADA) accessibility requirements.
- Expressly permit temporary flood control devices in required setback areas and in publicly accessible open areas, rather than require Public Improvement Commission review on a case-by-case basis.
- Ensure that project siting and design do not preclude implementation of district-scale flood protection measures.

Policies

ARTICLE 37 CLIMATE CHANGE PREPAREDNESS AND RESILIENCY POLICY

- **Purpose:** The BPDA Board approved in 2011, and updated in 2017, the Climate Change Preparedness and Resiliency Policy (the “Resiliency Policy”), which requires that all projects consider present and future climate conditions in assessing project environmental impacts, including

carbon emissions, extreme precipitation, extreme heat, and sea level rise. Projects must identify building strategies that eliminate, reduce, and mitigate adverse impacts including those due to changing climate conditions. It is administered by the Interagency Green Building Committee (IGBC), which also reviews the related Climate Resiliency Checklist (the “Checklist”).

- The Checklist provides a framework and specific resilience targets for assessing project vulnerabilities and adverse impacts. Projects must identify initial strategies for reducing vulnerabilities and adverse impacts and future adaptation strategies for meeting or exceeding resilience targets and further reducing vulnerabilities and adverse impacts due to future climate conditions.²⁸ BPDA’s appended guidance document states that projects within the FEMA Special Flood Hazard Area (SFHA) or the BPDA SLR-FHA should use its recommended SLR-DFE as the minimum performance target for assessing sea level rise impacts and for reducing or eliminating flood risk, potential damage, and related adverse impacts. The SLR-DFE is currently based on a modeled 1% annual chance flood event with 40 inches of SLR plus additional freeboard of at least 12–24 inches.
- **Applicability:** The Resiliency Policy must be addressed during the Article 80B Large Project Review process. The Climate Resiliency Checklist must be submitted with the Project Notification Form—the first document submitted as part of a potential three-submission process.
- **Limitations in a Changing Climate:** While completing the checklist is mandatory, implementation of measures to increase resilience is not. The BPDA must rely on negotiations during project review to effect resilient outcomes. In addition, the Resiliency Policy is only applicable to projects that are subject to Article 80B Large Project Review, which is mostly limited to new construction over 50,000 square feet.²⁹

For these reasons, the beneficial impact of this policy is limited.

- **Increasing Resilience:** With the adoption of the revised Resiliency Policy and Climate Resiliency Checklist, the City has made some progress in educating development proponents and requiring consideration of future climate conditions. As described above, the establishment of a Climate Resilience Design Commission that would review all Projects within the BPDA SLR-FHA subject to Article 80 (not just those subject to Article 37) could help increase the resilience of the built environment. In addition, moving aspects of the policy into the regulatory realm would help ensure more resilient outcomes.

A plan is the product of a public process whereby the land use, economic, environmental, and social trends are analyzed, and an optimal land use and infrastructure vision may be established.

Plans

Local planning can be an effective avenue for achieving climate change adaptation. This is due, in part, to its relatively direct interface with the public, as well as to its ability to respond to geographically-specific climate impacts, such as sea level rise, changes in precipitation patterns, and heat impacts. Both strategic planning (visioning, goal-setting, and action-identification) and land-use planning are key tools that can be used to adapt at the local scale to a changing climate.³⁰

IMAGINE BOSTON 2030

- **Purpose:** *Imagine Boston 2030* is the City’s first comprehensive development plan in 50 years. It serves as both a strategic and land use plan for Boston, and articulates the following thorough approach to climate change adaptation:

- “Boston’s approach to climate adaptation will protect our existing housing and job centers and catalyze future growth that is climate-ready. Our work will be grounded in practical, economic decision-making and creative engineering and design and supported by strong partnerships with our residents, businesses, institutions, and federal and state partners. Boston will employ urban climate-adaptation solutions that produce multiple benefits—such as protective systems that also function as parks and active public realm. This approach will ensure that new value is captured to help fund improvements as we simultaneously leverage public funding. We will create layers of protection—from the district plan to community preparedness. We will take advantage of cycles of building and infrastructure rehabilitation and replacement to make investments, and we will design flexible, adaptable solutions that can evolve as climate conditions continue to change. Just as Boston has been a leader in reducing greenhouse gas emissions, we will become a global leader in protection and adaptation of waterfront cities, and in doing so, create new jobs and transferable expertise and unlock opportunities for growth.”³¹
- **Applicability:** The plan covers the geography of the entire city, and outlines programs, policies, and investments related to housing, health and safety, education, the economy, energy and the environment, open space, transportation, technology, arts and culture, land use and planning. As a planning document, *Imagine Boston 2030* has no enforceability and does not identify financial resources for many of its recommendations. However, an implementation strategy is woven throughout the plan.
- **Limitations in a Changing Climate:** *Imagine Boston 2030* doubles down on waterfront growth. It declares that “the waterfront must continue to play a critical role in meeting the needs of future generations by providing spaces where new jobs can locate and where housing growth can alleviate pressure in existing neighborhoods.”³² Four of the five growth areas identified in this plan are shown to be vulnerable to future coastal flooding, including the Sullivan Square section of Charlestown, Suffolk Downs, and Widett Circle. By growing in these areas, Boston is essentially committing to protecting them, making the development of successful adaptation strategies all the more important. *Imagine Boston 2030* commits to partnering with federal, state, and private entities to invest in nature-based and hard-engineered flood protection to protect Boston’s neighborhoods and strengthen its shoreline. The City plans to develop new infrastructure, prioritizing shoreline investments that integrate co-benefits, such as open space, and supporting infrastructure investments including improved storm-water infrastructure, as part of public and private capital projects.
 - The upside of this approach is that promoting these areas, which are already developed to varying degrees, as growth centers helps generate the investments that will be needed to protect them. The downsides include: It may end up putting more citizens in harm’s way, thereby requiring further investment in emergency services; it may end up directing resources to areas that investors, businesses, and residents ultimately reject in favor of inland neighborhoods less prone to coastal flooding; and allowing new development in flood prone areas could have a serious impact on the City’s budget in the future, when its responsibility to new residents and property owners requires it to make increasingly large expenditures to either maintain infrastructure or incentivize property owners to relocate.
 - **Increasing Resilience:** Not all growth identified in *Imagine Boston 2030* is located along the waterfront. Neighborhood enhancement and expansion, as well as mixed-use



core area, are identified in inland locations as well. Actions in these areas could be prioritized to increase resilience.

CLIMATE READY BOSTON

- **Purpose:** The 2016 *Climate Ready Boston* report set the foundation for the City's ongoing climate preparedness activities through a strategic planning effort. The report included:
 - Updated projections of climate change in Boston;
 - A detailed vulnerability assessment of the city and specific focus areas; and
 - Principles, strategies, and initiatives to achieve the City's climate preparedness goals.
- *Climate Ready Boston's* vulnerability assessment identified East Boston, Charlestown and South Boston as three of the neighborhoods most vulnerable to sea

level rise and coastal flooding. *Climate Ready Boston* recommended that the City "prioritize and study the feasibility of district-scale flood protection" for these and five other focus areas, and "develop local climate resilience plans in vulnerable areas to support district-scale climate adaptation."³³ *Coastal Resilience Solutions for East Boston and Charlestown* is the City's first neighborhood coastal resilience plan. A local climate resilience plan will soon be completed for South Boston.

- **Applicability:** The CRB report covers the entire city of Boston, with special emphasis on eight focus areas where the results of the Vulnerability Assessment and the climate resilience initiatives are applied in more detail to illustrate the risks Boston faces and how Boston can address them. As a planning document, the CRB report itself has no enforceability

East Boston residents "build a berm" at a community outreach event.

and does not identify financial resources for many of its recommendations. However, it recommends multiple regulatory changes that would be enforceable, and subsequent district-level plans such as *Coastal Solutions for East Boston and Charlestown* identify project costs and funding sources. It identifies multiple parties responsible for implementation of various recommendations, many of which are listed in Chapter 4 of this report.

- **Limitations in a Changing Climate:** The policy, planning, programmatic, and financial initiatives address the risks identified in the Vulnerability Assessment, noting that the climate projections used to assess vulnerability will need to be updated every five years.
- **Increasing Resilience:** Implementing the initiatives in the CRB report is necessary but not sufficient to prepare Boston for the

flooding anticipated to result from climate change. Actions at the federal, state, and regional levels, additional municipal actions, and private-sector actions are needed as well. Chapters 4 and 5 of this report provide suggestions for moving the recommendations contained in the CRB report forward to improve the City's resilience.

MUNICIPAL HARBOR PLANS

- **Purpose:** A Municipal Harbor Plan (MHP) is a municipally-created, state-approved plan developed in compliance with 301 CMR 23.00, Review and Approval of Municipal Harbor Plans. It establishes a community's objectives, standards, and policies for guiding public decisions pertaining to private use of land and water within Chapter 91 jurisdiction. Additional purposes served by the regulations include steward-



ship of trust lands, application of state environmental policy, balanced resource utilization, restoration and reclamation of degraded areas, compliance with national coastal policy, and protection of certain of the people's rights under the Massachusetts Constitution. MHPs include detailed instructions for allowing amplifications, substitute provisions, and offsets to provide an appropriate level of mitigation and public benefits to balance potential impacts to the waterfront with comparable or greater effectiveness than Chapter 91-compliant development scenarios, and to meet local planning objectives established during the required public participation process.

The City of Boston has several neighborhood-specific MHPs in place, including the Downtown Waterfront District MHP (Downtown MHP), the South Boston Waterfront MHP, the Fort Point Downtown Waterfront Harbor Plan, and the East Boston MHP. A new Downtown MHP was recently approved by the Commonwealth but is now the subject of litigation.

- **Applicability:** MHPs apply to Harbor Planning Areas within a specified segment of a coastal or other waterway within Chapter 91 jurisdiction, including filled tidelands. The MHP process is voluntarily undertaken by a municipality. The provisions of an MHP come into play when a development undergoes the Chapter 91 licensing process. Chapter 91 jurisdiction applies to flowed tidelands to the mean high water (MHW) line as well as filled tidelands.
- **Limitations in a Changing Climate:** As noted in the Downtown MHP, the effectiveness of an MHP is based to a large degree on the document's use of specific components of the waterways regulations. However, climate resilience is not a focus of the waterways regulations, so there are few provisions that can be substituted or amplified with a direct effect on climate resilience, and an MHP cannot supersede applicable building codes with enforceable provisions.

- **Increasing Resilience:** The Downtown MHP, which was approved April 30, 2018, included creating a climate-resilient waterfront as one of its six goals. It addresses two specific elements of climate resilience: amplifying the engineering and construction standards by specifying that areas improved for public open space shall also be incrementally elevated to improve resilience and providing a substitute provision for building height allowing additional building height for existing structures to accommodate relocated mechanicals. In addition, to the extent possible, the City of Boston has agreed to encourage design standards and construction methods that improve the resilience of interior Facilities of Public Accommodation (FPA) space within the Downtown MHP. Finally, the Downtown MHP requires any property owner within the planning area filing for a new Chapter 91 License or Amended License, regardless of whether they are subject to the provisions of the MHP, to conform with the climate change preparedness and resilience standards specified in the MHP, as informed by the ongoing Climate Ready Boston initiative.

Existing and new MHPs could follow the lead of the Downtown MHP and adopt similar resilience strategies. In addition, Boston and other municipalities could establish a Resilience Fund, which could receive and hold offset payments to be applied to MHP district-wide resilience studies and/or implementation projects, similar to Boston's existing Water Transportation Fund. MHPs could also include an amplification that ties requests for extended-term permits to the necessity for climate impact analysis. For example, most proponents will automatically apply for an extended term license of 95–99 years (the standard license term is 30 years). The regulations require the applicant to provide justification for the extended term request including “the expected life of the structure.” An MHP (or the regulations

themselves) could require the applicant to demonstrate that they have taken into consideration climate impacts for the requested term of the license and that the structure will be able to withstand impacts within that term.

To further improve the use of MHPs as a tool for resilience, 301 CMR 23.06 could be amended to require existing MHPs to address resilience prior to their designed expiration date, and/or prior to any requested amendment. Possible resilience updates could include specifically establishing resilience as a public benefit. However, as indicated above, revisions to Chapter 91 are a necessary first step to making MHPs a vehicle for increasing resilience to the impacts of climate change.

BOSTON WATER AND SEWER COMMISSION WASTEWATER AND STORM DRAINAGE SYSTEM FACILITIES PLAN

- **Purpose:** In 2015 the BWSC finalized a *Wastewater and Storm Drainage Facilities Plan* that establishes a sustainable framework for planning and management for the next 25 years of capital and operational improvements. It included the development and evaluation of climate change adaptation strategies for changing wet weather conditions, SLR, and storm surge scenarios. The goal of the climate change evaluation was to define the risks associated with climate change that would affect the Commission's operation and long-term capital plans. The data analysis used in this report served as one of the inputs for the BRAG report and the City of Cambridge's Climate Change Vulnerability Assessment.
 - **Applicability:** The recommendations in this document are applicable to the BWSC's facilities and operations.
 - **Limitations in a Changing Climate:** Because the majority of the existing stormwater system consists of "grey" infrastructure, or the engineered structures made of concrete, masonry, and metal, most of which is buried underground, it is difficult and expensive to modify. System upgrades are intended to be made based on the updated parameters as components are replaced based on their design life maintenance schedules. Due to the connectedness and interdependency of all components in the system, capacity in upstream components cannot be increased until the capacity has been appropriately increased in downstream components, which increases the difficulty of upgrading the system. Because of this, emphasis is being placed on above-ground green rather than grey infrastructure, and the BWSC is looking for innovative ideas for how to increase capacity, as described in several of the recommendations below.
- **Increasing Resilience:** Recommendations from the plan intended to increase the resilience of the city's stormwater system include identification of an annual rainfall volume for use in identifying the frequency, overall magnitude and operational costs of wet weather discharges; specifying the depth of the 10-year, 24-hour design storm that should be used for drainage and conveyance engineering, planning, and design based on the lifecycle of the project through the year 2010; mainstreaming data collection, analysis, and research procedures; applying a citywide design flood elevation (DFE) for construction of new infrastructure and capital improvements and to existing infrastructure based on projected storm surge and sea level rise; protecting CSO outfalls and private storm drain outfalls with tide gates; developing and piloting alternatives to limit future storm surge flooding around catch basins; examining potential solutions to help prevent surcharging; and identifying areas for temporary surface storage of stormwater and best management practices to alleviate stress on low-capacity sections of the stormwater and sewer systems. While these recommendations are intended to be implemented by the BWSC, several of them could be adapted by private

property owners to increase resilience on their own sites.

REGIONAL GOVERNANCE

Regional agencies, authorities, and organizations serve an important cross-jurisdictional role, and can even be considered tools of governance in and of themselves. Here we discuss the flood resilience-related policies of several regional associations, authorities, and commissions.

WATERSHED ASSOCIATIONS

- **Purpose:** The City of Boston lies within two major drainage basins—the Charles River Basin and Boston Harbor Basin. The latter is comprised of the Mystic River, Neponset River, and Weir River Watersheds (which is outside of Boston). Independent non-profit organizations have established themselves for various purposes related to each of these drainage basins, or watersheds. The Charles River Watershed Association (CRWA) “is laying the groundwork for a system-wide approach to climate change preparedness, working to support current systems so they may cope with and rebound from major storm events.”³⁴ It has established the Blue Cities Initiative, whereby it is evaluating the potential of restored streams and wetlands to reduce flood impacts. The Mystic River Watershed Association (MyRWA) updated its core mission and resources in June 2018 to help the 21 cities and towns within the watershed manage the extreme weather associated with climate change. The Neponset River Watershed Association (NepWRA) considers virtually everything it does as an effort to improve climate change resilience, from advocating for better water conservation policies to increase drought resilience and working with local governments to develop and implement stronger storm-water regulations to reduce flooding and water pollution, to pursuing policies to

preserve floodplain storage and projects that restore habitats and make them more resistant to climate change.

- **Applicability:** The work each of these organizations does is applicable to the entire watershed, which has several advantages.

Watershed associations are private non-profit organizations. While they have local expertise and strong relationship networks, they generally do not have the authority or capacity to implement large-scale adaptation efforts.



Amelia Earhart Dam

Stormwater inundation, SLR and storm surge impact watersheds beyond political boundaries, and analyzing impacts and developing solutions at the watershed scale holds the promise of more holistic solutions. In addition, watershed associations can leverage resilience projects at key locations within a watershed to protect larger areas that may lie in separate municipalities. For example, if upgrades to the Amelia Earhart Dam could be coordinated at the watershed level, upstream communities would have more input regarding the timing and extent of those upgrades, which could then be incorporated into their own flood protection programs.

- **Limitations in a Changing Climate:** Watershed associations are private non-profit organizations. While they have local expertise and strong relationship networks, they generally do not have the authority or capacity to implement large-scale adaptation efforts.
- **Increasing Resilience:** Watershed Associations could play a larger role in adaptation planning. Recognizing their local expertise and commitment and drawing them into formal processes could help grow local understanding of natural processes and related support for watershed-based adaptation planning.

MASSACHUSETTS PORT AUTHORITY FLOODPROOFING DESIGN GUIDE

- **Purpose:** Massport was enabled by the Massachusetts Legislature in 1956 as an independent, quasi-public authority. New construction on Massport's properties is subject to the *Massport Floodproofing Design Guide*, which aims to make buildings and operations more resilient to anticipated flooding threats. Using the Boston Harbor Flood Risk Model (BH-FRM), a Design Flood Elevation (DFE) is set, and then structures and facilities are either elevated or flood proofed to that elevation, as applicable.
- **Applicability:** The design guide is intended to be used by Massport staff, tenants,

third-party developers, design professionals, and contractors during planning, design, and construction at Logan Airport, Conley Terminal, Fish Pier, Flynn Cruiseport Boston, or other Massport properties in South Boston. Projects subject to the standards include new structures and additions; substantial repairs or improvements; and retrofits with the explicit objective to make them resilient to flooding. Critical infrastructure is subject to specific Floodproofing Performance Standards.

- **Limitations in a Changing Climate:** These standards are only applicable to Massport's properties, and therefore their beneficial impact is limited.
- **Increasing Resilience:** In an effort to keep the Floodproofing Design Guide relevant and up-to-date, Massport actively seeks best available information and, when appropriate, changes their standards. Massport could coordinate to align their standards with those of other state and local government entities. They could also provide their Floodproofing Design Guide as a model to those entities that do not currently have their own standards.

MASSACHUSETTS WATER RESOURCES AUTHORITY (MWRA) CLIMATE CHANGE APPROACH

- **Purpose:** The MWRA provides wholesale water and sewer services to 3.1 million people and more than 5,500 large industrial users in 61 communities in eastern and central Massachusetts. It includes in its "Pragmatic Approach to Climate Change" a commitment to provide these services under a wide variety of circumstances, including future climate conditions; periodic assessments of the vulnerability of its own facilities to climate threats; and physical adaptations to mitigate anticipated flooding impacts, which are codified in its master plan and business plan.
- **Applicability:** MWRA takes a pragmatic, incremental approach to climate change adaptation, and efforts have focused on the evaluation and implementation of

measures to allow MWRA facilities to withstand a significant storm event that could occur in Eastern Massachusetts. Staff have looked at potential impacts on water supply, wastewater transport, and treatment facilities. Most water facilities are located inland and were found to have very limited exposure to coastal flooding. Wastewater facilities are, however, generally located closer to the coast and were the focus of staff investigations. MWRA staff recently generated vulnerability assessments for 30 coastal or near-coastal wastewater and administrative/operational facilities for potential impacts of sea level rise, and regularly assess equipment and facility envelopes for repair and rehabilitation needs. The most current information available on climate change scenarios and sea level rise has been and will continue to be incorporated into design and construction contracts to ensure hardening against potential impacts.

- **Limitations in a Changing Climate:** Upon completion of MWRA's site-specific vulnerability assessment, sixteen facilities were determined to be within the most recent 100-year flood elevation as set by the Federal Emergency Management Agency (FEMA) when 2.5 feet of sea level rise were added to the analyses. This benchmark appears to provide protection to a little beyond 2070 even for the highest CO₂ emissions scenarios, and staff are using it as an appropriately conservative measure of vulnerability, addressing issues of both storm intensity and sea level rise. MWRA will continue to monitor the evolving science and consensus on sea level rise and change benchmarks as appropriate.
- **Increasing Resilience:** Where major rehabilitation is not occurring in the short-term, staff have identified immediate needs for flood proofing improvements; short-term measures have already been made at ten of the highest priority facilities, and three additional sites are in the

process of design or procurement of materials. Evaluations of the impact of climate change on the water supply system indicate that MWRA's safe yield will likely increase slightly, while many neighboring communities will see reductions in reliability due to the more variable future precipitation patterns. MWRA will be able

The MAPC's regional climate change strategy includes recommendations for local, regional, and state action to reduce vulnerability to future hazards and impacts of climate change within Eastern Massachusetts.

to provide both emergency and regular supply to more surrounding communities in the future. As described in Chapter 5, it may be possible for the MWRA to take on additional responsibilities related to stormwater and flood control.

METROPOLITAN AREA PLANNING COUNCIL (MAPC) REGIONAL CLIMATE CHANGE STRATEGY

- **Purpose:** The MAPC is Metro Boston's regional planning agency. Its regional climate change strategy prepares recommendations for local, regional, and state action to reduce vulnerability to future hazards and impacts of climate change within Eastern Massachusetts. Specifically, it outlines sub-strategies and recommendations to meet the regional plan's goal for adaptation, which is to help the region to be prepared for and resilient to natural disasters and climate change.
- **Applicability:** The *Regional Climate Change Strategy* report provides climate change information and identifies vulnerabilities of the 101 cities and towns of Metro Boston that are MAPC communities.
- **Limitations in a Changing Climate:** As a regional planning agency, MAPC plays a coordination/advisory role. While it engages in important activities such as outreach, education, research, planning,

and technical assistance, it lacks the ability to create regulations or policies for its member communities, which limits its ability to implement the adaptation measures it recommends.

- **Increasing Resilience:** In fall 2018, MAPC is launching an update to MetroFuture the region’s long-term plan. Climate change, including adaptation and resilience, will be a critical component of the planning process. MAPC is continuing to support municipalities, identify partnership and funding, and coordinate with state agencies on these topics.

project to be subject to many or even all of the laws and regulations listed below, which sometimes complement, and other times contradict, each other. These tools are in various stages of being updated to address climate change. Interestingly, one of the reasons why it is difficult to keep laws and regulations current is because references to studies and data must be specific at the time of their adoption- they cannot reference future anticipated updates to publications because all aspects of a law or regulations must be available for review during the statutory public comment period.

STATE GOVERNMENT

Massachusetts has several laws, regulations, policies, and plans that are important for adaptation to climate change-induced flooding. It is not uncommon for a single development

Laws

While only the state government can revise its own laws, local governments can provide comments to the agencies and enter into discussions to encourage changes such as those recommended below.

Chapter 91 enabled the creation of Boston’s Harborwalk.



CHAPTER 91, THE MASSACHUSETTS

PUBLIC WATERFRONT ACT

- **Purpose:** The Massachusetts Public Waterfront Act is a state law (M.G.L. c. 91) with implementing legislation (310 CMR 9), known as the Waterways Regulation Program or collectively as “Chapter 91.” It is administered by the Massachusetts Department of Environmental Protection (MassDEP). In Massachusetts, private property ownership is recognized to the low tide line. Chapter 91 guarantees public access to tidelands and waterways for the purposes of navigation, fishing, fowling, and passing over or through the water and intertidal area. Enforcement of Chapter 91 has resulted in, for example, the creation of Boston’s Harborwalk, a continuous 40-plus-mile public walkway along the water’s edge.
- **Applicability:** Chapter 91 regulates activities on both coastal and inland waterways, including construction, dredging, and filling in tidelands, great ponds and certain rivers and streams. Chapter 91 jurisdiction applies to flowed tidelands to the mean high water (MHW) line and filled tidelands to the further of the first public way or 250 feet from mean high water along the coast, great ponds, and non-tidal rivers and streams. Activities subject to Chapter 91 include construction, placement, excavation, addition, improvement, maintenance, repair, replacement, reconstruction, demolition, or removal of any fill or structures not previously licensed, or a change in use or structural alteration of fill or structures authorized under a prior license. If the MHW were allowed to migrate inland, or additional fill were permitted to be placed within flowed tidelands, Chapter 91 would be applicable to additional areas of land.
- **Limitations in a Changing Climate:** Sea level rise has long-term impacts on the protection of the public trust. While Chapter 91 does require that sea level rise during the design life (undefined in Chapter 91) of the buildings be taken into account,

it currently allows this rise to be based on historical rates. However, even this provision is not consistently applied during the review process. Also, due to sea level rise, the shoreline will move more rapidly than it has in the past, complicating the ability (and perhaps willingness) of private land owners to provide long-term access to ever-narrowing intertidal areas and more-frequently-flooded waterfront walkways. This will also call property lines into question since state ownership typically moves with tide lines. Currently, resilience to climate change is not recognized as a public benefit under Chapter 91 regulations, which often results in a direct conflict between implementation of resilience measures and Chapter 91 requirements. For example, nonwater-dependent uses are required to reserve ground floor space for facilities of public accommodation (FPAs) and usable open space and preserve access and/or sight lines to the water, which is often in direct conflict with implementation of resilient measures such as raising first occupiable floors and seawalls. While Chapter 91 does not categorically restrict the use of fill for flood protection purposes, it does not expressly allow it for that purpose either. Under the existing regulations, in-water coastal flood protection measures could potentially be licensed as a water dependent use project; as a water dependent infrastructure project; or through the variance process.

- **Increasing Resilience:** MassDEP is currently seeking to determine what actions are appropriate to accommodate predicted SLR.³⁵ An advisory group has crafted several possible approaches to increasing resilience, such as using projected rates of SLR in the engineering standards; creating a regulatory definition of SLR; adjusting licensing requirements to account for SLR; and allowing building height exemptions/modifications for nonwater-dependent buildings. Other ideas for increasing resilience include allowing resilient structures/

measures to be considered public benefits, and to be counted toward, rather than against, open space requirements, and to specifically categorize “flood protection structures” as either water dependent infrastructure or a water dependent use. Once climate resilience is better-incorporated into the Waterways regulations, there will

Although the WPA allows municipalities to adopt a local wetland bylaw/ordinance to further regulate wetlands, the Boston City Council has not yet adopted a local wetland ordinance.

be more provisions that can be substituted or amplified with a direct effect on climate resilience through MHPs, thereby strengthening that tool as well.

WETLANDS PROTECTION ACT

- **Purpose:** The Wetlands Protection Act (WPA) (M.G.L. c 131 §40) is a state law, regulated under 310 CMR 10, and is administered in Boston by the Boston Conservation Commission. The WPA protects eight important public values, or “interests,” including protection of public and private water supply; protection of groundwater supply; flood control; storm damage prevention; prevention of pollution; protection of land containing shellfish; protection of fisheries; and protection of wildlife habitat.

The WPA is applicable to inland and coastal resource areas, including (but not limited to) land under the ocean, designated port areas, coastal banks, and land subject to coastal storm flowage (LSCSF). LSCSF is coterminous with the 1% annual chance flood BFEs identified on the FEMA Flood Insurance Rate Maps (FIRMs) (not necessarily the boundaries depicted on the FIRM) or flooding from the storm of record, whichever is higher. Unlike virtually all other resource areas defined in the WPA, LSCSF

has no dedicated preambles, definitions, or performance standards in the WPA. There is also no buffer zone to LSCSF.

Although the WPA allows municipalities to adopt a local wetland bylaw/ordinance to further regulate wetlands, the Boston City Council has not yet adopted a local wetland ordinance.

- **Applicability:** The WPA is applicable to projects that constitute work within jurisdictional resource areas. Project proponents must seek and obtain an Order of Conditions (OOC), Determination of Applicability (DOA), or Order of Resource Area Delineation (ORAD) prior to the start of work. The OOC describes the environmental protections that must be in place before, during, and after the proposed work is completed.
- **Limitations in a Changing Climate:** The main limitation to the WPA in a changing climate is that it assumes resource areas are static. However, today’s resource areas do not have the same boundaries as tomorrow’s resource areas. For example, LSCSF will encroach landward as time passes, and buildings constructed today outside of LSCSF may soon be within that resource area. Another limitation is that the Act does not distinguish between urban, developed LSCSF (which often does not perform most natural floodplain functions) and less- or un-developed LSCSF, which will be impacted differently by climate change. Any conditions placed on work in LSCSF are required to regulate the impact of development on the wetlands resource interests protected by the WPA, and not the impact of the environment on development, or the development’s ability to function under different climate conditions. This makes it challenging to address projected flooding impacts to development using this regulation. Another limitation is the regulations’ silence on the categorization and treatment of flood control projects. Finally, while fill is not prohibited in many of the resource areas that would be impacted

by shore-based flood protection measures, Conservation Commissions would be unfamiliar with reviewing such projects and could benefit from guidance on how to apply the WPA's performance standards in such instances.

- **Increasing Resilience:** It is generally accepted that LSCSF is significant to the interests of storm damage prevention and flood control and that building appropriately in LSCSF can be accomplished by following the NFIP standards as incorporated in the State Building Code at 780 CMR 3107. If the State Building Code were to change to require that buildings in the future floodplain be constructed to reduce flood damage, LSCSF would be positively impacted. In April 2014 Mass-DEP convened an advisory group to discuss revisions to the WPA related to developing performance standards for LSCSF.³⁶ The group was disbanded prior to issuance of such standards but was reconvened in June 2018 and is anticipated to produce recommended revisions. Regarding flood control, in concert with categorizing flood control structures as water dependent uses in the Chapter 91 regulations, guidance should be developed for how impacts to coastal resources, including Land Under Ocean, Coastal Banks, Rocky Intertidal Shores, Land Containing Shellfish and Fish Runs, should be evaluated related to projects involving the creation of fill within those resource areas for the purpose of increasing resilience.

EXECUTIVE ORDER NO. 569, "ESTABLISHING AN INTEGRATED CLIMATE CHANGE STRATEGY FOR THE COMMONWEALTH"

While not technically a law, an executive order can have the force of law, and generally functions as a formalized statement to the public regarding how the Governor intends to solve an administrative problem or discharge executive duties.

- **Purpose:** E.O. 569 lays out a comprehensive approach to set targets to further

reduce greenhouse gas emissions; enhance the resilience of government investments, promulgate rules, regulations and standards that could impact the private sector's building and operations; publish a comprehensive energy plan; develop a state-wide Climate Adaptation Plan and update it at least every five years; and provide a framework and technical assistance for executive agencies and cities and towns to assess their vulnerability to climate impacts. The order also establishes climate change coordinators to oversee adaptation and resiliency efforts across each executive branch of state government.

- **Applicability:** The order applies to agencies of the Commonwealth, with specific direction for certain agencies including the Executive Offices of Energy and Environmental Affairs and Public Safety and MassDEP
- **Limitations in a Changing Climate:** While an executive order can have the force of law and is a helpful tool for immediate action on an issue, it is also vulnerable to administration changes. A new governor can revoke, modify, or supersede any existing E.O. Key aspects of the adaptation sections of the executive order, including the state plan, municipal assistance program, state agency vulnerability assessments, and climate coordinators have now been codified into law through the Environmental Bond Bill, signed by Governor Baker in August of 2018 (see p. 36).
- **Increasing Resilience:** E.O. 569 provides a framework for the state to tackle climate resilience issues, but it has largely been left up to state agencies and officials to implement the terms of the E.O. in an effective way. The result has been a huge step forward in the administration's commitment of resources to adaptation and more strategic systems to evaluate and mitigate risk. One of the most impactful outcomes of the E.O. has been the creation of the Municipal Vulnerability Preparedness (MVP) program, which offers technical assistance and grants to cities and towns

to identify climate risks and implement adaptive solutions. Another important outcome has been the development of the integrated State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), which is intended to guide state policies and practices for reducing climate risk. The administration has chosen to integrate this plan with the state's natural hazard mitigation plan (see p. 39) that is required by FEMA, becoming the first state in the country to do so.

ENVIRONMENTAL BOND BILL, “AN ACT PROMOTING CLIMATE CHANGE ADAPTATION, ENVIRONMENTAL AND NATURAL RESOURCE PROTECTION, AND INVESTMENT IN RECREATIONAL ASSETS AND OPPORTUNITY”

Massachusetts Governor Charlie Baker recently signed into law a bill that provides significant resources, technical assistance, and directives to state agencies and municipalities for pursuing climate adaptation strategies. Most notably, the bill codifies several of the provisions of E.O. 569 discussed above.

- **Purpose:** The Environmental Bond Bill is legislation that is periodically (about every four years) proposed in Massachusetts to authorize funding for a variety of the state's capital projects and grant programs, primarily under the oversight of the Executive Office of Energy and Environmental Affairs. The 2018 Environmental Bond Bill includes significant new funding for climate adaptation projects and also includes policies to increase Massachusetts climate preparedness. The bill was signed into law by Governor Baker as Chapter 209 of the Acts of 2018. Significant authorizations include:
 - \$40 million for a state-administered coastal buyback program that will acquire coastal land at risk of flooding from willing sellers for the purposes of open space, recreation, and conservation.
 - \$75 million to support the municipal vulnerability preparedness grant program established under E.O. 569 to support technical assistance for climate-related vulnerability assessments and action-oriented resiliency plans.
 - \$10 million for a climate change science and data program to support development and maintenance of statewide climate change projections, and maintenance and expansion of the state's climate change clearinghouse.
 - \$100 million for implementation of the statewide climate adaptation and hazard mitigation plan.
- The law also formally adopts the requirements of E.O. 569 for the development of a statewide climate adaptation plan to be updated every five years; and development of a framework for executive offices, agencies and municipalities to assess climate vulnerabilities.
- **Applicability:** The law applies to agencies of the Commonwealth, with specific direction for certain agencies including the Executive Offices of Energy and Environmental Affairs and Public Safety and MassDEP Funding authorized under the law will also be made available to cities and towns, and certain coastal property owners who choose to participate in the coastal buyback program.
 - **Limitations in a Changing Climate:** Although the law requires implementation of several items including the statewide adaptation plan, it does not provide a specific time-frame for implementation. It also does not require executive offices, agencies or municipalities to update regulations and policies to address climate risks although it does provide technical assistance and grant funding to do so voluntarily. Moreover, the environmental bond bill is typically reauthorized every four years and similar to the uncertainty of an E.O., some of the provisions of the law that are tied to specific funding authorizations including the MVP program and the coastal buyback program, could be vulnerable to modification or elimination during reauthorization.
 - **Increasing Resilience:** The Environmental Bond Bill is a critical step forward for climate



resilience. It writes into law important provisions of E.O. 569, authorizes significant funding for climate adaptation activities, and formalizes a necessary framework for adaptation at the state and local level. Specifically, funding authorizations for the Municipal Vulnerability Preparedness grant program and the implementation of the statewide climate adaptation and hazard mitigation plan will be essential for the next phase of adaptation work. Notably, the law also provides that the secretary of energy and environmental affairs may provide guidance for planning, prioritizing, selecting and implementing projects in furtherance of the goals of climate change mitigation and adaptation and consistent with the integrated state hazard mitigation and climate change adaptation plan.

Regulations

THE MASSACHUSETTS BUILDING CODE

- **Purpose:** The MA Building Code is a state regulation (780 CMR: Massachusetts Amendments to the International Building Code 2009) adopted by the Board of Build-

Regulations are standards and rules adopted by administrative agencies that govern how laws will be enforced. Regulations often have the same force as laws, since, without them, regulatory agencies wouldn't be able to enforce laws.

ing Regulations and Standards (BBRS). It is locally administered by the City of Boston's Inspectional Services Department (ISD). The stated purpose of the Building Code is "To establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment and to provide safety to fire fighters and emergency responders during emergency operations." The Building Code provides

minimum requirements for flood-resistant design and construction of applicable structures, as well as energy efficiency.

- **Applicability:** The flood-related portions of the building code are applicable to structures within the Special Flood Hazard Area (SFHA) delineated on the currently effective FEMA Flood Insurance Rate Map (FIRM). Compliance is required for new construction that includes: (a) new structures, including subsequent work to such structures; (b) work classified as substantial repair or substantial improvement of an existing structure that is not a historic structure; and (c) substantial repair of foundations. New and replacement mechanical

Municipalities can regulate land use, density, height, open space, setback, occupancy and parking, etc., through zoning, but cannot require buildings to use specific floodproofing materials or mechanisms or require building design to be resilient for future flood conditions.

and electrical systems must comply with the elevation and/or floodproofing requirements, even if not part of a substantial repair or improvement.

- **Limitations in a Changing Climate:** Since the building code only applies to new construction or substantial repairs/improvements of existing structures, it cannot be used to address the resilience of existing buildings that do not need substantial improvements. Also, while the code emphasizes that the standards are only minimum standards, there is generally little incentive to build to a higher standard, particularly if doing so would increase the cost of the project. Another limitation is that requiring code compliance only for buildings within SFHAs indicated on FIRMS, which are backward-looking, does not

promote resilience to future climate conditions. Finally, with the exception of fire codes and the Green Communities Act energy “stretch codes,” Massachusetts communities cannot develop local building codes that are stricter than the State’s. That is, municipalities can regulate land use, density, height, open space, setback, occupancy and parking, etc., through zoning, but cannot require buildings to use specific floodproofing materials or mechanisms or require building design to be resilient for future flood conditions.

- **Increasing Resilience:** In order to address climate change induced flooding, the State Building Code would need to be revised; a Stretch Code for Flood Resistant Construction would need to be adopted under the State Building Code; or more stringent requirements for Flood Resistant Construction in the current and future 100 year floodplain in Boston would have to be adopted in accordance with MGL c. 143 §98.³⁷ Code amendments could include basing first floor and floodproofing elevations on the flood conditions that are projected to be present during the lifetime of the structure. Another amendment could be to require, over time, flood-resilient retrofitting of existing structures that are currently, or will become within their lifetime, vulnerable to flooding (San Francisco’s Mandatory Soft Story Retrofit Program (MSSP) could serve as a model for this type of regulation).

Policies

THE MASSACHUSETTS ENVIRONMENTAL POLICY ACT—DRAFT CLIMATE CHANGE ADAPTATION AND RESILIENCY POLICY

- **Purpose:** The Massachusetts Environmental Policy Act (MEPA)(M.G.L. c. 30 §61) and its implementing regulations (301 CMR 11) are intended to provide meaningful opportunities for public review of the potential environmental impacts of Projects for which Agency Action is required, and to assist each Agency in using all feasible means to avoid, minimize, and mitigate

damage to the environment. MEPA is administered by the Massachusetts Office of Energy and Environmental Affairs (EEA) MEPA Office. MEPA staff review Environmental Notification Forms (ENF) and Environmental Impact Reports (EIR); interpret the MEPA regulations; and publish the Environmental Monitor.

In 2014, MEPA released a Draft Climate Change Adaptation and Resiliency Policy for public review. The goal of the Policy is to meet MEPA's obligations pursuant to the Massachusetts Global Warming Solutions Act of 2008, including incorporating the evaluation of "reasonably foreseeable climate change . . . effects, such as predicted sea level rise" into projects within its purview. The MEPA Office intends to revise and update the Draft Policy on a periodic basis, with input from stakeholders, to reflect new data and resources as they become available and to incorporate benchmarks and standards for review and mitigation, including specific design criteria, where appropriate.

- **Applicability:** MEPA is applicable to projects that meet or exceed applicable MEPA review thresholds related to impacts on land; state listed species; wetlands, waterways and tidelands; water use; wastewater generation; transportation; energy; air quality; solid and hazardous waste; historical and architectural resources; areas of critical environmental concern; and regulations, and also meet the following jurisdictional criteria:³⁸
 - Projects that are undertaken by a state Agency (department/office, board/commission of the Commonwealth including municipal redevelopment authorities);
 - Projects that are subject to state or federal review;
 - Projects that include financial assistance by a state agency; or
 - Projects that involve a land transfer by an agency.
- The Draft Climate Change Adaptation and Resiliency Policy is applicable to those

projects that are required to submit an EIR. For projects in Boston, MEPA review is often conducted in parallel with Article 80 review.

- **Limitations in a Changing Climate:** The Draft Climate Change Adaptation and Resiliency Policy has not yet been finalized and adopted, although MEPA has begun to apply it through its scoping determinations. The draft policy stops short of requiring specific conditions or actions to adapt to changing climate conditions. Finally, MEPA review is applicable to only a limited array of projects, leaving many projects without the benefit of this type of review.
- **Increasing Resilience:** Prior to finalizing and adopting the Draft Climate Change Adaptation and Resiliency Policy, it could be revised to require evaluation of the potential to adapt to specific sea level rise scenarios, and to apply to all projects requiring an ENF, rather than only those subject to an EIR. In addition, specific types of analyses and procedures for undertaking them could be established and communicated to applicants so that they have a better understanding of what level of effort is expected during the environmental review process. Information, data, and technical assistance should also be made readily available to applicants undergoing the MEPA review process to encourage them to give adequate consideration to future conditions.

Plans

COMMONWEALTH OF MASSACHUSETTS INTEGRATED STATE HAZARD MITIGATION AND CLIMATE ADAPTATION PLAN (SHMCAP)

- **Purpose:** This plan, which is currently under development, serves as an update to the Commonwealth's existing 2013 State Hazard Mitigation Plan, and is also driven by E.O. 569. It will address the Commonwealth's federally mandated hazard mitigation plan requirements and result in a first-of-its-kind statewide climate adaptation plan.



Aquafence around Atlantic Wharf to protect the building from flooding during a Nor'easter, March 2018.

- **Applicability:** In accordance with E.O. 569, the SHMCAP was adopted by Governor Baker in September 2018, and includes strategies for incorporating the best available climate science; guidance and strategies for state agencies and municipalities to address climate impacts through adaptation and resilience measures; clear goals, expected outcomes, and a path for implementation; approaches for increasing the resilience of government operations; policies and strategies for ensuring that adaptation and resilience efforts complement efforts to reduce greenhouse gas emissions; and strategies that conserve and sustainably employ the natural resources of the Commonwealth to enhance climate adaptation, build resilience and mitigate climate change.
- The SHMCAP will serve as a roadmap for state agencies and cities and towns undertaking climate adaptation and resilience strategies.
- **Limitations in a Changing Climate:** While the plan will provide the necessary information, science, and data for under-

standing and prioritizing statewide climate adaptation efforts, it does not have the force of a law or regulation. Integrating the statewide climate adaptation plan with the state's hazard mitigation planning requirement for the Federal Emergency Management Agency does not impose any legally enforceable rights or obligations. Some of the priorities or strategies identified in the plan may require buy-in or action from outside state government, which could present challenges as participation in implementation efforts would be voluntary.

- **Increasing Resilience:** The final plan will provide a necessary foundation for local climate adaptation and hazard mitigation planning efforts, particularly those undertaken as part of the Municipal Vulnerability Preparedness grant program; provide a consistent, statewide climate projection dataset for use by state agencies, cities and towns, and private sector entities; integration of climate change data with natural hazard risk profiles to identify how these hazards are likely to change as the climate changes, and analyze and make recommendations on what state regulations and policies may require modernization to adequately address climate risks. Finally, the plan will guide the selection and prioritization of activities and funding for climate adaptation activities in accordance with Chapter 209 of the Acts of 2018 (recently signed into law) including infrastructure projects and natural resource restoration and conservation projects.

FEDERAL GOVERNMENT

Similar to the state, the federal government has several laws and policies that are important for adaptation to climate change-induced flooding, and a single development project may be subject to some or all of the laws and regulations listed below.

Laws

While only the federal government can revise its own laws, local governments can provide comments to the agencies and enter into discussions to encourage changes such as those recommended below.

RIVERS AND HARBORS ACT—SECTION 10

- **Purpose:** The purpose of Section 10 of the Rivers and Harbors Act (33 U.S.C. 401 et seq.) is to protect navigable waters in the development of harbors and other construction and excavation. Authorization from the U.S. Army Corps of Engineers

is required for the construction of any structure in or over any navigable waters of the United States, the excavation and dredging or deposition of material, or any obstruction or alteration to a navigable water.

- **Applicability:** Activities requiring Section 10 permits include structures (e.g., piers, wharfs, breakwaters, revetments, riprap, bulkheads, jetties, and pilings) and work such as dredging or disposal of dredged material, or excavation, filling, or other modifications to the navigable waters of the United States. Projects must comply with the conditions of the Massachusetts

U.S. Department of Defense and Climate Change

The U.S. Department of Defense (DoD) must operate globally within the realities and complexities of a changing climate. Climate change acts as a threat multiplier, sparking and accelerating conflict, increasing the need for disaster relief, dramatically changing the physical conditions of contested environments such as the Arctic, and degrading military capabilities through flooding and other extreme weather.³⁹ DoD has put a series of policies and strategies in place that address the threat of climate change and stress the need for adaptation and resilience measures.

DoD policy originates in the Office of the Secretary of Defense (OSD). Secretary of Defense Jim Mattis has a track record of incorporating the risks of global warming into strategy and policy,⁴⁰ and he highlighted the security implications of climate change in testimony provided to the U.S. Senate following his confirmation hearings in 2017:

“I agree that the effects of a changing climate—such as increased maritime access to the Arctic, rising sea levels, desertification, among others—impact our security situation. I will ensure that the department continues to be prepared to conduct operations today and in the future, and that we are prepared to address the effects of a changing climate on our threat assessments, resources, and readiness.”

OSD previously released the Climate Change Adaptation Roadmap in 2014,⁴¹ which laid out goals for assessing the effects of climate change on DoD, integrating climate change considerations across the Department in order to manage the risks, and increasing collaboration with both internal and external stakeholders on climate change challenges. OSD subsequently issued Directive 4715.21—Climate Change Adaptation and Resilience,⁴² which establishes policy and assigns responsibilities to ensure that DoD has “the resources necessary to assess and manage the risks associated with the impacts of climate change.” The DoD Directive establishes broad policy, which DoD components, such as the Military Services, must implement within their own areas of responsibility.

In addition to policy promulgated by OSD, DoD also receives direction on climate and resilience from the U.S. Congress. DoD recently published the results of a study—required by Congress—of military base climate change vulnerabilities and adaptation strategies. The study found that over 50% of DoD’s 3,500 facilities have experienced effects from extreme weather such as drought, damaging winds, flooding, wildfire, and high temperatures.⁴³ The National Defense Authorization Act for Fiscal Year 2019 further directs DoD to incorporate changing environmental conditions such as climate projections into military construction and requires that military installation master plans take climate resilience into account.⁴⁴

Programmatic General Permit (PGP) or, in the case of larger projects, the conditions of an Individual Permit.

- **Limitations in a Changing Environment:** As district-scale flood control projects are developed, new or enhanced rip-rap, bulkheads, or other structures that may require fill along the shoreline are likely to be proposed. These would likely be difficult to permit through the Section 10 process, as they would be responding to flooding based on projected sea levels rather than current conditions.
- **Increasing Resilience:** This law could be improved by defining flood control projects to include controlling current and projected flooding and making allowances for fill for resilience projects.

CLEAN WATER ACT—SECTION 404

- **Purpose:** The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Section 404 establishes a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands.
- **Applicability:** Activities regulated under this program include fill for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports) and mining projects. The basic premise of the program is that no discharge of dredged or fill material may be permitted if: (1) a practicable alternative exists that is less damaging to the aquatic environment or (2) the nation's waters would be significantly degraded. The U.S. Army Corp of Engineers administers this program, while the U.S. Environmental Protection Agency develops and interprets policy, guidance, and environmental criteria used in evaluating permit applications.
- **Limitations in a Changing Environment:** Flood protection measures that involve fill in waters of the United States would

require permitting under Section 404. Mitigation includes avoidance, minimization, and compensatory mitigation. Compensatory mitigation means mitigating an aquatic resource impact by replacing or providing substitute aquatic resources for impacts that remain after avoidance and minimization measures have been applied, and is achieved through appropriate and practicable restoration, establishment, enhancement, and/or preservation of aquatic resource functions and services. These requirements would make a flood protection measure that involved fill extremely difficult to permit.

- **Increasing Resilience:** Filled land that incorporates new wetlands, stormwater retention, and pollution prevention measures could be deemed to be self-mitigating to reduce barriers to constructing flood protection projects.

NATIONAL FLOOD INSURANCE ACT

- **Purpose:** The National Flood Insurance Act of 1968 is legislation passed in the United States that led to the creation of the National Flood Insurance Program (NFIP). When the NFIP was originally written in 1968, the goal was to identify properties that were at risk of flooding and to try to mitigate that risk through floodplain management, zoning and a variety of other programs and activities, including the provision of flood insurance. Providing insurance to aid in financial recovery after a damaging flood was but one aspect of the program. Although the NFIP is run by the federal government, daily operation of the program is handed off to private, so-called "Write Your Own" (WYO) insurance companies, that issue the policies and make the payout determinations based upon government rules of what is and is not covered.
- **Applicability:** All structures with federally-backed mortgages within FEMA's SFHA must carry flood insurance (there are currently approximately five million NFIP

policies-in-force).⁴⁵ The NFIP insures losses of up to \$250,000 for a residential building, and \$500,000 for a non-residential building and up to an additional \$500,000 for its contents. It is important to note that these policies only cover buildings and their contents, not property outside of those buildings (e.g., fences, walkways, surface parking lots, plantings).

- **Limitations in a Changing Climate:**

Sea-level rise, changing precipitation patterns, increasing urbanization and development, and aging and undersized infrastructure are all contributing to the devastating flood impacts that are more frequently affecting communities throughout the country. According to FEMA, approximately 20% of flood claims are on structures that are outside of the current SFHA, where flood insurance is not required (although it is available at a discounted rate). Due to these combined factors, as of July 2017, the NFIP is more than \$24 billion in debt, resulting in increased insurance rates and a dearth of funding to support risk mitigation activities. Furthermore, subsidized insurance rates continue to mask the real risks of flooding to properties; the Community Ratings System program fails to adequately reward community-level actions to reduce flood risks; and the floodplain maps that serve as the basis for rates and local land-use decisions are out-of-date, and do not account for current risk, let alone future risk.⁴⁶

- **Increasing Resilience:** Cities can significantly reduce flood risks by investing in flood risk reduction projects, or by installing green infrastructure broadly throughout a watershed to manage stormwater and could more easily do so if the NFIP were structured to adequately reward those that make proactive investments or implement policies to better manage development in floodplains. Currently, most cities struggle to secure funds to support proactive investments in mitigation, as most federal funds for these types of projects are only

available after a disaster has already occurred. One way to encourage proactive funding is to continue to demonstrate the cost-effectiveness of mitigation investment through Losses Avoided Studies (LAS). To date, FEMA has published 14 Flood LAS's on projects in 10 states that have employed a variety of mitigation measures resulting in returns on investment (ROI)

Most cities struggle to secure funds to support proactive investments in mitigation, as most federal funds for these types of projects are only available after a disaster has already occurred.

ranging from 0.37 to 18.29.⁴⁷ A recent report by the National Institute of Building Sciences claims that for every dollar invested by the federal government in pre-disaster mitigation, society saves \$6 in post-disaster recovery costs.⁴⁸

Creating maps for informational purposes that would make property owners aware of current and future flood risks could encourage them to invest in cost-effective loss reduction measures that would reduce their premiums, and potentially increase the resale value of their property. Such maps could be paired with multi-year insurance policies tied to the structure rather than the property owner, which would encourage investments in adaptation measures.⁴⁹ Congress could also direct FEMA to require landlords to disclose to tenants the flood zone classification of a property, whether the property is covered by flood insurance, and the availability of contents coverage. It could also direct FEMA to develop a portal for easy access to reports on past flood damage and claims for properties that can be accessed by the public and develop "right to know" provisions that require property owners to disclose a property's flooding history and

flood zone classification to potential buyers. Alternatively, these disclosure requirements could be enacted at the state level.

Policies

US ARMY CORPS OF ENGINEERS PROCEDURES TO EVALUATE SEA LEVEL CHANGE: IMPACTS, RESPONSES AND ADAPTATION (ENGINEER TECHNICAL LETTER NO. 1100-2-1)

- **Purpose:** Recognizing that the climate for which a project is designed can change over its full lifetime to the extent that stability, maintenance, and operation may be impacted, this Engineer Technical Letter (ETL) provides guidance for understanding the direct and indirect physical and ecological effects of projected future sea level change on USACE projects and considerations for adapting to those effects. It establishes a 50-year economic period of analysis and a planning horizon of 100 years.
- **Applicability:** This ETL applies to all USACE elements having responsibility for Civil Works and is effective through March 30, 2019.
- **Limitations in a Changing Climate:** While this ETL requires that projects consider the impacts of SLR, it is not clear how this policy applies to projects whose purpose it is to protect against SLR. In fact, the permitting division of USACE seems to be separate from the project design and implementation branch. The former has not, thus far, been willing to permit flood protection projects involving fill without excessive mitigation requirements that render them infeasible, even when they create co-benefits for ocean resources.
- **Increasing Resilience:** USACE needs to recognize growing necessity to construct flood mitigation projects within their jurisdiction and develop a flexible approach for permitting projects with “self-mitigating” features and environmental co-benefits. As noted by the EPA’s Climate Ready Estuaries program, “It may not be sufficient to restore or maintain historical conditions;

sustainability might require creating and maintaining new environments as well.”⁵⁰

PRIVATE SECTOR LEGAL TOOLS

Lawsuits

- **Purpose:** The laws and ordinances described above are only effective if they are implemented and enforced. Everyone affected by agency actions has the right to seek judicial review of those actions and ordinary citizens and NGOs may file lawsuits to enforce U.S. environmental laws. In addition, states and municipalities may be sued under common law “tort” or constitution theories for causing or exacerbating climate-related flood problems. Specifically, government entities could face claims for failing to consider climate change in their actions. Decision-makers could also face legal challenges both for not doing enough to address adaptation, and for acting in a manner that results in more stringent regulation. Local governments may be particularly vulnerable to these types of claims given the number of decisions they make that could influence impacts such as flooding and erosion.
- **Applicability:** The application of these theories of liability and constraints on action to climate change adaptation is an outgrowth of existing laws and precedent. However, climate change-related litigation is relatively new, particularly as it relates to municipal responsibility for actions to adapt. While existing cases are informative as to how courts might decide future claims, outcomes will ultimately be fact-specific.
- **Limitations in a Changing Environment:** Government entities enjoy fairly broad protections due to sovereign immunity, which is the legal doctrine that the sovereign (e.g. state or federal government) cannot be sued without its consent. While negligence claims are therefore difficult to



bring, they are not impossible. In Massachusetts, M.G.L. c. 258 limits government liability to \$100,000 per claim, which could result in a significant payout depending on the number of successful claims. Moreover, to circumvent the barriers presented by sovereign immunity, plaintiffs may seek alternative vehicles for claims such as statutory requirements and constitutional provisions. In this context, takings claims are being brought more frequently against local and state governments for flood impacts.

- **Increasing Resilience:** Government entities looking to proactively address climate change through climate-informed regulations and other actions may fear the threat of litigation. However, government actions that have a stated public health and safety goal may be more likely to be upheld by courts. For example, if the City of Boston were to implement a flood overlay district that limited residential uses in a highly vulnerable area, a takings claim against

the City by private property owners within that overlay district is not likely to be successful.⁵¹ On the other hand, if a government entity fails to consider climate impacts in its actions, it might also face legal challenge. For example, Farmers Insurance Company filed a class action lawsuit in 2013 against the Water Reclamation District for greater Chicago and various local governments. The lawsuit was filed after a two-day downpour in the Chicago area that caused massive flooding, overflowing sewers, and millions of dollars in property damage.⁵² Farmers argued that the local government's failure to prepare the municipal stormwater system for the intense rainstorm resulted in the flooding and the severe rains were reasonably foreseeable because Chicago acknowledged severe rain as an adverse impact of climate change in its 2008 Climate Action Plan. The lawsuit was eventually voluntarily dismissed but raises questions about whether government entities could be on the hook

Buildings in Massachusetts are not currently required to prepare for climate impacts.

for damages that might occur due to failing to prepare for foreseeable climate change impacts.

Professional Standards of Care

- **Purpose:** Courts consider the “standard of care” to be the standard of professional skill and care ordinarily provided by professionals working in the same profession in the same or similar locality under the same or similar circumstances. The phenomenon of climate change has begun to raise questions about how a design professional integrates their knowledge of new risks with client expectations that projects are designed to comply with current codes and regulations.

Most cities struggle to secure funds to support proactive investments in mitigation, as most federal funds for these types of projects are only available after a disaster has already occurred.

- **Applicability:** This concept comes into practice in relation to professional liability laws, under which a professional’s acts or omissions can be alleged to have caused harm to another party. Design professionals, such as architects and engineers, are subject to the legal landscape specific to the state in which they are licensed. In addition to legal responsibilities, many design professionals are acutely aware of their ethical duty to bring climate-related issues to their clients’ attention.

- **Limitations in a Changing Environment:** Considering climate risk data and designing to a higher or better standard can be inhibited by existing statutes, codes, or regulations that make certain elements difficult or costlier to implement. From a practical standpoint, although ultimate decision-making power lies with the client, design professionals could still be held responsible for how they advise their clients, what information they provide, and how they voice or document concerns. In determining whether a design professional met their standard of care in the context of a negligence claim, courts rely partially on the “foreseeability” of the harm. It is not a question of whether the party actually did foresee the injury, but whether they could have foreseen that such an injury could occur (regardless of whether or not it has ever happened in the past). Compliance with current codes and standards (i.e. the building code) does not necessarily shield a design professional from liability, since many building and design regulations do not incorporate climate changes that have occurred, have become evident since enactment or adoption, or are anticipated during the expected life of the project or permit.
- **Increasing Resilience:** A recent report by the Conservation Law Foundation⁵³ identified a number of potential solutions to reducing climate change adaptation barriers related to Standards of Care including improving client education and research; modifying regulations to account for climate risk; establishing incentives to design for adaptation; providing funding for resilient solutions; and increasing coordination among various government agencies at multiple scales.

4

Climate Ready Boston Overview

CLIMATE READY BOSTON INITIATIVES

In this chapter we examine how Climate Ready Boston's (CRB) recommended initiatives relate to the governance functions and tools described in Chapters 2 and 3. The CRB Report is a planning document, and appropriately explores the problems related to climate change and provides recommendations for implementation measures that will help the city manage those problems. There are recommendations for education and outreach, which are needed to create the political will to accomplish the climate change adaptation goals; developing detailed neighborhood plans; and increasing coordination and adapting regulations to lower the barriers to climate adaptation. The CRB report does not outline initiatives focused on how to finance climate resilience projects, nor does it clearly establish the parties responsible for building specific infrastructure projects. This should not be seen as a shortcoming, as the details around financing and implementation are not typically identified in city-wide planning documents.

While the CRB report is an effective planning document, it is important to note that implementing all of the initiatives recommended in the report would not result in a climate resilient City or Region. It will be essential to build on the success of Climate Ready Boston and the strategic planning that was done as we move toward implementation and building new infrastructure.

The CRB report identifies a set of climate resilience initiatives organized into 5 layers and 11 strategies. Table 4.1 below lists those initiatives that are both related to reducing the impacts of increased flooding on the built environment and have a strong governance component. Each initiative bears the number originally assigned to it in the CRB report. For each initiative, the appropriate actor(s) has been identified, along with the type of organization or institution responsible, the scale of governance, and the associated governance function previously presented in Chapter 2 and listed for reference below. New actors that have been identified and described in the CRB report are identified in italics.

Community meeting to discuss Climate Ready Boston hosted by Boston Harbor Now.



Necessary Governance Functions

1. Generate, communicate, and integrate complicated, rapidly evolving **information**;
2. Conduct **outreach** and develop **plans** that engage a variety of stakeholders;
3. Develop and apply transparent, objective, and equitable criteria for project **prioritization**;
4. Create and implement **laws, regulations, and policies** that are equitable and provide both stability and flexibility while promoting a resilient built environment;
5. Develop the capacity to design, finance, construct, and maintain a system of shore-based **district-scale flood protection** measures;
6. Develop the capacity to design, finance, construct, and maintain **infrastructure** that will continue to function in a changing climate; and
7. Institutionalize flexibility through **monitoring** and **evaluating** outcomes.

Flooding near the New England Aquarium during a King Tide.



GOVERNANCE FUNCTIONS AND CRB INITIATIVES

The CRB report suggests initiatives related to four out of the six functional categories identified in this report as important for improving the resilience of the built environment to increased flooding.

Four connected initiatives are aimed at filling in the information gap, including the creation of an organization that would periodically produce updated climate projections and assist local and state agencies in using the projections to create and/or modify existing policy, design guidelines, and regulations. Another four initiatives are directly related to outreach and planning, one of which is to create local climate resilience plans (Of the five local climate resilience plans identified, three have been completed, and one is underway).

One initiative focuses on developing a framework for evaluating project prioritization.

Of all the categories of functions identified, the regulatory tools category includes the most CRB report initiatives: Ten initiatives are related to state regulations, the local zoning ordinance, design guidelines, local policies, and supporting studies.

Finally, the CRB report introduces five initiatives related to infrastructure (water and sewer, transportation, energy, and telecommunications systems), one of which calls for the establishment of an Infrastructure Coordination Committee (ICC) to serve as the lead regional network organization to set design standards and track investments in climate resilient infrastructure.

While the CRB report identifies efforts necessary for the initial planning of shore-based district-scale flood protection measures, neither the CRB report nor the local plans identify any initiatives associated with comprehensive governance strategies for constructing, maintaining or financing these measures.

The CRB report does not discuss the role of ongoing monitoring and evaluation of climate adaptation activity outcomes.⁵⁴

TABLE 1

Governance-Related Initiatives from the Climate Ready Boston Report

No.	Initiative	Actor (New/Existing)	Org/Inst Type	Scale	Tool	Function
1.1	Periodically update Boston area-specific climate projections; fill research gaps in local climate change knowledge; assist local and state agencies in applying conclusions to policy, design & regulation.	Greater Boston Panel on Climate (GBPC)	Working Group (overseen by COB Enviro Dept, but supposed to assist local & state agencies)	Local/Regional (leading climate scientists from local & regional institutions)	Procedure	1
1.2	Use updated local flood maps to support planning, policy, and regulation.	City (Environment Dept.); Local & State Agencies, BPDA, <i>Infrastructure Coordination Committee (ICC)</i>	Government	Local, Regional, State	Procedure	1
4.1	Develop local climate resilience plans in vulnerable areas to support district-scale climate adaptation.	City (Environment Dept)	Government	Local	Plan	2
4.2	Establish local climate resilience committees to serve as long-term community partners for climate adaptation.	City, local residents, businesses, and institutions	Government + Private Sector	Local	Procedure/Program	2
5.1	Establish Flood Protection Overlay Districts (FPOD) and require potential integration with flood protection.	BPDA, Boston Zoning Commission	Government	Local	Zoning Ordinance	4
5.2	Determine a consistent evaluation framework for flood defense prioritization.	City	Government	Local	Policy	3
5.3	Prioritize and study the feasibility of district-scale flood protection.	City	Government	Regional/local	Research Study	4
5.4	Launch a harbor-wide flood protection system feasibility study.	City	Government + University	Regional	Research Study	4
6.1	Establish an Infrastructure Coordination Committee (ICC).	ICC	Government + Utilities	Regional	MOU, Law	6
6.2	Continue to collect important asset and hazard data for planning purposes.	City (DoIT), Boston Regional Intelligence Center (BRIC)	GBPC	Regional	Policy/Procedure	1
8.1	Develop a green infrastructure location plan for public land and rights-of-way.	City (Energy, Environment & OS Cabinet), BWSC	Government	City	Plan	6
8.2	Develop a sustainable operating model for green infrastructure on public land and rights-of-way.	City (Energy, Environment & OS Cabinet), BWSC	Government	City	Policy	6
8.4	Develop design guidelines for green infrastructure on private property to support co-benefits.	BWSC	Government	City	Policy	4, 6
8.4	Evaluate the opportunity to reinforce these design guidelines through changes to the Boston Zoning Ordinance	BPDA	Government	City	Zoning Ordinance	4, 6
9.1	Establish a planning flood elevation to support zoning regulations in the future floodplain.	BPDA	Government	City	Zoning Ordinance	4
9.2	Revise zoning code to support climate-ready buildings.	BPDA, Boston Zoning Commission	Government	City	Zoning Ordinance	4
9.3	Promote climate readiness for projects in the development pipeline through an expedited review process.	BPDA	Government	City	Policy	2,4
9.4	Pursue state building code amendments to promote climate readiness.	City, BBRS	Government	State	Regulation	4
9.5	Incorporate future climate conditions into area plans including Strategic Planning Areas, Planned Development Areas, Municipal Harbor Plans, and Institutional Master Plans, which are ultimately codified in zoning.	BPDA, Boston Zoning Commission	Government	City	Plans, Zoning Ordinance	1, 2

5

Recommendations

FROM PLANNING TO ACTION—KEY RECOMMENDATIONS

To renovate or innovate—do we improve what we have or create something new?—is a question that occurs in many fields that experience rapid changes, such as public health, technology, and information/data systems. In this report we argue that an acceptable level of resilience can be achieved only if Boston is able to do both: renovate and innovate. There are many paths forward on how to achieve our goals. As a result, we recommend that the Governor of Massachusetts and the Mayor of Boston establish a joint commission to explore the options and develop a strategy. We also recommend that the legislature take a leadership role in this effort in order to evaluate the different options available to the Commonwealth as we attempt to address this dynamic challenge. As a starting point for these groups, we have a number of specific recommendations and have explored various implementation options.

- Reform Existing Tools
- Establish an Infrastructure Coordination Committee
- Convene a Climate Research Advisory Organization
- Establish Governance for District-Scale Coastal Flood Protection

For the second through fourth recommendations above, several options are presented. In some cases, the options are not mutually exclusive and could be pursued simultaneously.

REFORM EXISTING TOOLS

Chapter 3 provides a suite of ideas for increasing resilience by reforming the tools described in that chapter. Changes need to be made so we can do the following:

- Build new buildings that are resilient to the flooding conditions that they are expected to encounter during their design life;
- Adapt existing buildings to improve their resilience to existing and future flooding conditions;
- Construct coastal flood protection measures at the district scale to protect multiple buildings, neighborhoods, and infrastructure;
- Continue to meet community goals such as supporting a vibrant public realm;
- Create co-benefits related to stormwater management and sustainability;
- Improve regional planning and coordination; and
- Provide legal support for the consideration of risk and resilient design.

Below we identify our top priorities for reforming existing tools. Implementation of these recommendations, which would need to take place on the local, state, and federal levels,

is key to being able to adapt existing buildings, build resilient new buildings, and construct district-scale flood protection measures. The goal is to ensure that climate change is factored into all coastal development decisions.

1. Institute Resilient Chapter 91— Massachusetts Public Waterfront Act Amendments

- Categorize “flood protection structures” as water-dependent infrastructure or water-dependent use;
- Create a regulatory definition of SLR;
- Use projected rates of SLR in the engineering standards;
- Adjust licensing requirements to account for SLR;
- Allow building height exemptions/modifications for nonwater-dependent buildings; and
- Allow resilience structures/measures that provide protection beyond licensed projects to be considered as public benefits, and to be counted toward, rather than against, open space requirements.

2. Revise the Massachusetts Building Code

- Base first floor and floodproofing elevations (including elevations for electrical and mechanical systems) on the flood conditions that are projected to be present during the lifetime of the structure; and
- Require, over time, flood-resilient retrofitting of existing structures that are currently, or will become within their lifetime, vulnerable to flooding.

3. Create a New Zoning Overlay District

- Create zoning and design standards that promote resilience, for example:
 - Require first floor elevations above the BFE that is anticipated during the lifetime of new structures;
 - Allow increases in building height to accommodate freeboard;

- Create incentives or requirements to adjust above-grade first-floor uses to maintain an active public realm;
- Incentivize, allow, or require architectural elements and streetscape provisions to mitigate visual disconnection between the elevated first floor and the street;
- Modify street wall requirements, floor area ratio (FAR), and height regulations to allow larger building access elements to be placed outside or inside the building, as needed;
- Expressly permit temporary flood control devices in required setback areas and in publicly accessible open areas, rather than require Public Improvement Commission review on a case-by-case basis; and

“It may not be sufficient to restore or maintain historical conditions; sustainability might require creating and maintaining new environments as well.”

— EPA’s Climate Ready Estuaries Program, 2012

- Ensure that project siting and design does not preclude implementation of district-scale coastal flood protection measures.

4. Update and Provide Guidance related to the Wetlands Protection Act

- Develop performance standards for Land Subject to Coastal Storm Flowage (LSCSF) that distinguish between urban/developed LSCSF and undeveloped LSCSF, which perform different functions and will be impacted differently by climate change; and
- Develop guidance for Conservation Commissions to use when reviewing flood protection projects that impact coastal resource areas to assist them in applying performance standards to this unfamiliar project type.

5. Work with the US Army Corps of Engineers (USACE) to Increase Permitting Flexibility

- Develop a flexible approach for permitting projects with “self-mitigating” features and environmental co-benefits;
- Define flood control projects to include controlling current and projected flooding; and
- Make allowances for fill for resilience projects.

“It may not be sufficient to restore or maintain historical conditions; sustainability might require creating and maintaining new environments as well.”

— EPA’s Climate Ready Estuaries Program, 2012

ESTABLISH AN INFRASTRUCTURE COORDINATION COMMITTEE

The CRB report notes that coordination regarding infrastructure is needed because Boston does not have direct control over all of the infrastructure that serves its population and economy, relying partially on regional systems. It suggests organizations that should be members of a standing Infrastructure Coordination Committee (ICC) in the sectors of water and sewer, transportation, energy, and telecommunications; describes precedents for an ICC, both within and outside of Boston; and lists standards that have already been, and those that need to be developed. The CRB report recommends that the Mayor work with the Governor and other key stakeholders to establish the ICC, and that it be coordinated closely with the Metro Boston Climate Preparedness Task Force, which has been convened by the Metro Mayors Coalition.

As indicated in the CRB report, the ICC should, at a minimum, accomplish the following:

- Use updated climate projections to develop planning and design standards across member agencies for retrofitting or constructing all major infrastructure systems to an agreed-upon set of future climate conditions;
- Collaborate and identify cascading vulnerabilities and opportunities for joint adaptation projects that could improve effectiveness or cost efficiencies by addressing multiple systems’ vulnerabilities at once;
- Integrate adaptation plans with capital improvement plans, in order to upgrade vulnerable assets over time to meet the agreed-upon planning and design standards; and
- Provide the City with regular progress reports in developing adaptation plans and bringing assets up to planning and design standards.

There are three main options for moving forward with this initiative:

- **Option 1:** Continue to Coordinate Informally
- **Option 2:** Establish the ICC through a Memorandum of Understanding (MOU)
- **Option 3:** Formally Establish the ICC through Legislation

These options are explored in more detail in the sidebar, “Planning and Implementing Resilient Infrastructure at the Watershed Scale.”

Option 1: Continue to Coordinate Informally

As described in the CRB report, the City and Commonwealth began the process of building institutional knowledge and overcoming barriers to data sharing related to infrastructure coordination in 2011 as part of the process for preparing Massachusetts’s first Climate Change Adaptation Report. This continued in 2014, when key City departments and commissions helped guide the Boston Natural Hazards Mitigation Plan Update. In 2015, the City convened the Infrastructure Advisory Group to collect data about vulnerable assets and infrastructure system interdependencies and

discuss resilience initiatives. In 2016, the BPDA convened the Smart Utilities Planning Committee to coordinate proactive planning for the Dorchester Avenue Corridor.

In addition, infrastructure is already coordinated to various degrees by each sector at the state level. For example, in January 2018 Governor Baker signed E.O. 579 establishing the Commission on the Future of Transportation in the Commonwealth to advise the administration on future transportation needs and challenges, including impending disruptions due to changes in technology, climate, demographics, and more. Recommendations from this commission are expected in December 2018. Also, the state's Water Utility Resilience Program provides support to ensure climate change resilience is part of an all hazards approach to technical assistance for drinking water and waste water utilities.

Stakeholders across infrastructure sectors could continue to meet informally to share information and collaborate as needed.

Benefits to this approach include:

- Coordination is already underway and existing relationships and channels of communication can be maximized; and
- Formal public/private partnerships (PPPs) could be set up to create financing mechanisms (although PPPs do not provide new funding sources)⁵⁵ for projects that are identified through the informal coordination process.

Drawbacks to this approach include:

- An informal group does not have the ability to enter into contracts as an entity;
- Without clarity of purpose, roles, responsibilities, and understanding around confidentiality, agencies will be less willing to share information and opportunities for collaboration may be limited;
- Cooperation could break down at any time without any formal structure in place;
- Governments are subject to strict procurement rules that present barriers to forming successful PPPs; and

- In an informal environment, attendance/participation may be limited.

Option 2: Establish the ICC through a Memorandum of Understanding (MOU)

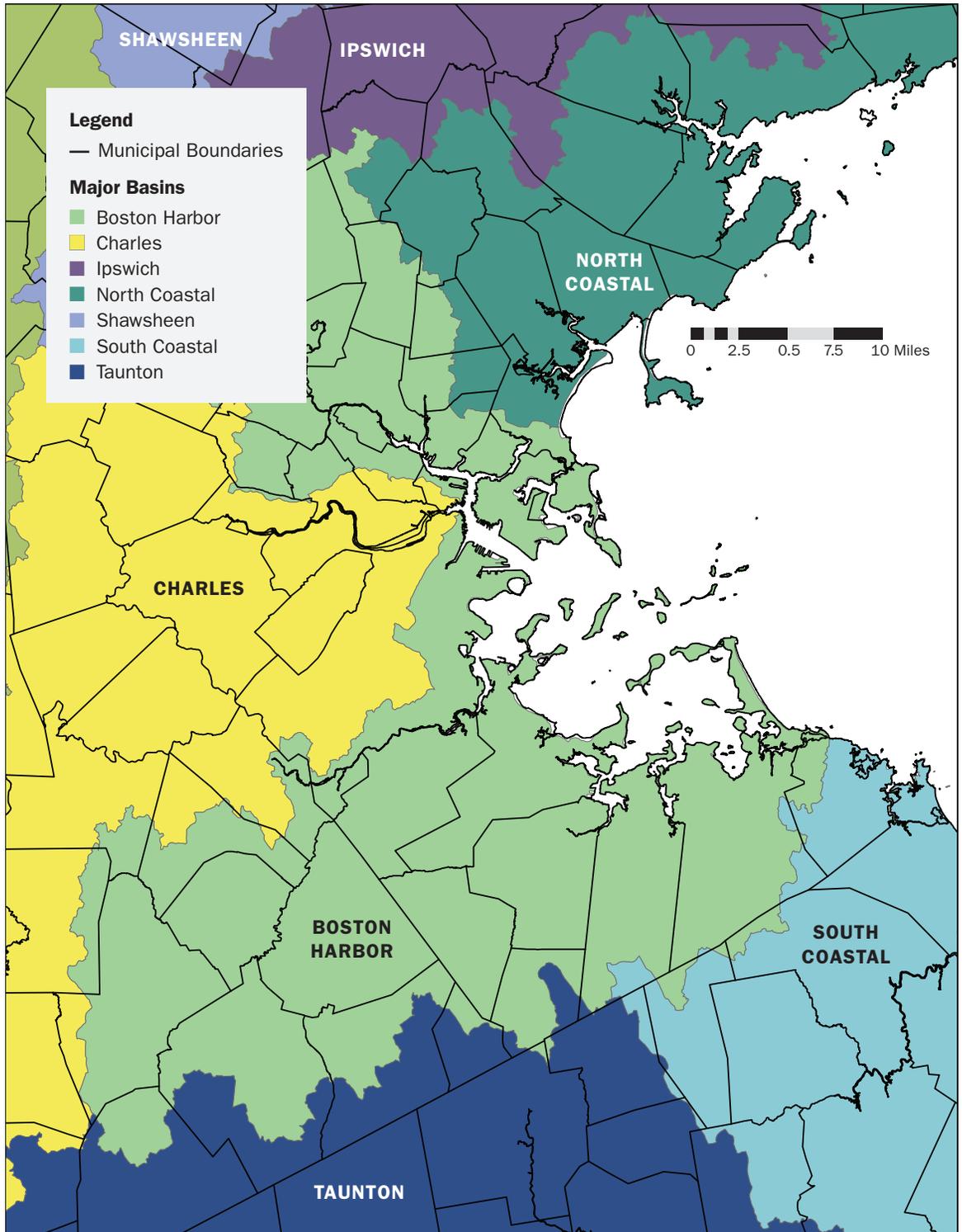
A second approach would be to execute a Memorandum of Understanding (MOU) between the City of Boston (and other municipalities) and the Commonwealth that identifies the mission, roles, responsibilities,

Planning and Implementing Resilient Infrastructure at the Watershed Scale

The CRB report recommends that the ICC engage in district-scale infrastructure adaptation planning to prepare existing infrastructure—and design new infrastructure—for climate change. One option is to use the Commonwealth's major drainage basins/watersheds as the organizing geography for both planning and implementation for the following reasons: Stormwater drainage follows topographic landforms and boundaries, and it can be better-managed by an entity that is also organized based on such boundaries;

- Watershed models provide the capability to simulate the responses of natural systems to natural forces or human activities, promoting a social-ecological perspective;
- Climate data are currently being collected at the watershed level in the Commonwealth. In March 2018, the Executive Office of Energy and Environmental Affairs published the Massachusetts Climate Change Projections—Statewide and for Major Drainage Basins report. As indicated in the title, the drainage basin level is one of the levels at which the authors (researchers from the Northeast Climate Adaptation Science Center at the University of Massachusetts Amherst) developed downscaled projections for changes in temperature, precipitation, and sea level rise;
- Research indicates that watersheds provide an ideal context in which to coordinate management of water, land, and related resources;
- An organization that crosses political boundaries can shepherd projects that will be most beneficial to the communities in the watershed and prioritize projects within the watershed; and
- Watershed-level coordination can be part of transformational governance, providing a structure which could eventually be used to address a broader range of resilience issues, and other issues as appropriate.

FIGURE 5
Boston Area Major Drainage Basins



Source: Lily Perkins-High

operating procedures, anticipated outcomes, and timeline of deliverables for the ICC. It may be useful for the ICC to begin by identifying infrastructure projects that would, if realized over a longer term, help to bring not only greater climate resilience but also other significant economic and quality of life benefits to Massachusetts communities.

Benefits to this approach include:

- An MOU can be executed via executive order without legislative action;
- While cooperation could still break down without a formal structure in place, execution of an MOU indicates a more robust level of commitment from the actors involved than does informal coordination; and
- If missions of municipal and state agencies are aligned, appropriate levels of financing may be generated.

Drawbacks to this approach include:

- A group operating under an MOU does not have the ability to enter into contracts as an entity;
- A more formal structure may be required to ensure cooperation; and
- A formal MOU can take time to draft and execute, and its formation and execution could take attention away from ongoing informal activities.

Option 3: Formally Establish the ICC through Legislation

A third approach would be to take a legislative path by amending the Massachusetts General Laws to establish the ICC as a quasi-public agency. Codifying the ICC would require a vote of the state legislature and approval by the governor. This path could be pursued in conjunction with Option 2. However, this approach comes with a risk: If an informal approach seems to be working sufficiently at the time, there could be a loss of political support for formalizing the organization through legislation, even if in the long-term a more formal legislative approach is preferable.

Benefits to this approach include:

- The long-term nature of adapting infrastructure to climate change would benefit from a solution with the long-term commitment that a legislative approach represents;
- An entity based on a statutory requirement can weather both political changes and staff turnover;
- A legislative mandate increases the possibility of receiving budgetary appropriations;
- A quasi-public agency can be set up to:
 - Be revenue-generating by utilizing a revenue model, which could include user fees, tax surcharges, or additional surcharges or fees on top of existing revenue-generating regimes (e.g. the Community Preservation Act);
 - Take advantage of private financing;
 - Have the authority to enter into contracts;
 - Be exempt from onerous procurement requirements to give it the flexibility to enter into public/private partnerships or sole source for specialized goods and services when necessary or expedient; and
 - As climate change impacts become more intense, government actions will likely become more substantial, making membership in a quasi-public agency even more valuable to private sector organizations.

Drawbacks to this approach include:

- The legislative cycle is long, and it could take more than one cycle to set up the ICC;
- There may not be political capital to pass legislation for such an organization; and
- The ICC may be viewed as an unfunded mandate, causing potential members to prefer a less formal organization.

CONVENE A CLIMATE RESEARCH ADVISORY ORGANIZATION

The Boston Research Advisory Group (BRAG) was a team of scientists overseen by UMass Boston to develop the Climate Projection Consensus for the CRB report. CRB initiative 1-1 recommends establishing an organization to serve as the continuation of BRAG that would periodically produce updated climate projections and assist local and state agencies in using the projections to create and/or modify existing policy, design guidelines, and regulations.

In addition to these two tasks, such a Climate Research Advisory Organization should perform a third function: to monitor and evaluate the outreach and planning, regulatory, flood protection implementation, and infrastructure adaptation initiatives undertaken as part of the larger climate

Flooding along the Harborwalk during a King Tide, October 2016.



adaptation effort. A common practice in the field of public health, engaging in monitoring and evaluation helps track and assess the results of an intervention throughout the life of a program. It helps to close the knowledge feedback loops and provide a source of inputs for changes to existing policies, programs and activities and the creation of new ones.

A monitoring and evaluation plan typically involves identifying program/project goals and objectives; defining indicators; defining data collection methods and timeline; identifying roles and responsibilities; creating an analysis plan and reporting templates; and creating a plan for data dissemination. Including social scientists in this work will be essential. One approach to incorporating monitoring and evaluation into projects intended to improve resilience to flooding could be to conduct pilot projects using “Designed Experiments,” which are projects that combine ecological research with urban design to study and shape buildings, landscapes, and infrastructure.⁵⁶

A Climate Research Advisory Organization would need to:

- Include leading climate scientists from local and regional institutions, organized into working groups focused on key climate factors, such as extreme temperatures, sea level rise, coastal storms, and precipitation;
- Produce projections that reflect the most up-to-date data and theoretical understanding and include consideration of multiple emissions scenarios and time periods, extending at least 100 years in the future;
- Produce these updated climate projections every five years;
- Fill research gaps in local climate change knowledge, including social systems and impacts on people and communities;
- Assist local and state agencies in using the projections to create and/or modify existing policy, design guidelines, and regulations, in particular:

- to the Infrastructure Coordination Committee to support the development of planning and design standards; and
- to the Boston Planning and Development Agency to support efforts to incorporate climate readiness into zoning standards and land-use planning.
- Monitor and evaluate the outreach and planning, regulatory, flood protection implementation, and infrastructure adaptation initiatives, as described above.

Options for convening a Climate Research Advisory Organization include:

- **Option 1:** Continue and Expand the Boston Research Advisory Group (BRAG)
- **Option 2:** Establish a State-Level Climate Research Panel

These two options are explored in more detail in the sidebar, “Monitoring and Evaluation through an Equity Lens.”

Option 1: Expand BRAG

The Boston Research Advisory Group (BRAG) was established in 2015 to develop a consensus on the possible climate changes and sea level rise (SLR) that the City of Boston will face in the future by 2030, 2050, 2070, and 2100. The 2016 *Climate Change and Sea Level Rise Projections for Boston* Report was funded through grants from private foundations, managed by staff and faculty at the School for the Environment at UMass Boston, and researched and drafted by scientists from universities and research organizations in Massachusetts and the Northeast, and the National Oceanic and Atmospheric Administration. The 2016 report has been used not only as a foundation for Climate Ready Boston, but as a source of information for various City of Boston agencies, other municipalities in the Boston Metro area, and for regional vulnerability assessments, climate action plans, and Municipal Vulnerability Preparedness analyses for MAPC communities. For this reason, there is a need to convene a Greater Boston Research Advisory

Group (G-BRAG) to evaluate the scientific consensus on climate change impacts and draft Special Reports that highlight specific near-term threats relevant to the 101 communities within the MAPC region, including Boston. The G-BRAG could also verify the actual amount of SLR that is occurring along the Massachusetts coast and continually

There is a need for further research into how climate change will impact people and communities and the best options for our responses. The BRAG could be expanded to include social scientists and public health researchers in addition to environmental and climate scientists.

validate the accuracy of flood exposure projections by working with other organizations, such as the USGS, to monitor the extent of flooding in major storms.

In addition, there is a need for further research into how climate change will impact people and communities and the best options for our responses. The BRAG could be expanded to include social scientists and public health researchers in addition to environmental and climate scientists.

Benefits to this approach include:

- It continues a successful model for reaching consensus on climate projection data; and
- Participants have a successful track record obtaining funding for and executing climate projection research.

Drawbacks to this approach include:

- BRAG does not have experience with monitoring and evaluation activities;
- Dependence on periodic grant funding does not support long-term monitoring and evaluation activities; and
- There is a need for larger-scale data collection, analysis, monitoring, and evaluation work that this model does not address.

Option 2: Establish a State-Level Climate Research Panel

A state-level climate research panel called, for example, the Massachusetts Regional Climate Advisory Panel (MARCAP), could be established via legislation. Expert panels are often established in this manner to provide information and recommendations to state agencies.⁵⁷

Benefits to this approach include:

- It establishes a more permanent organization that could have the ability to conduct monitoring and evaluation activities over an extended period of time;

- It can provide coordinated data for the entire Commonwealth; and
- It provides the opportunity to design a monitoring and evaluation unit that help to can continuously adjust our adaptation path.

Drawbacks to this approach include:

- Legislation, which can take multiple cycles to adopt, would be necessary to establish such a panel;
- There is a chance that a state level panel could become politicized and lose focus; and
- It may be challenging to continuously fund a new standing committee through budgetary allocations.

Monitoring and Evaluation through an Equity Lens

Research has shown that climate impacts disproportionately harm vulnerable populations. *Resilient Boston's* Resilience and Racial Equity Lens is “an approach to looking at policies and programs to understand how they may be able to maximize resilience investments; how they may be inadvertently increasing racial inequities and social injustices; and how we can intentionally take action to address these challenges.”⁵⁸ As we build monitoring and evaluation systems for our climate adaptation investments, we must filter them through this lens for true climate resilience. The following is a framework taken directly from the *Resilient Boston* report for evaluating equity developed by the National Academy of Public Administration:⁵⁹

- **Outcomes:** Examine whether policies and programs have the same impact for all groups and individuals served. (This differs from the points below in that it focuses on outputs and results rather than procedures and inputs.)
- **Procedures:** Examine questions of fairness within existing policies and programs related to procedural rights (due process), treatment (equal protection), and application of eligibility requirements or criteria (equal rights). This includes fairness in management practices such as hiring, promotion, and awarding of contracts.
- **Access:** Review current policies, services, and practices to determine the level of access to services/benefits and analysis of reasons for unequal access.
- **Quality:** Review the level of consistency in the quality of existing services delivered to groups and individuals.

ESTABLISH GOVERNANCE FOR DISTRICT-SCALE COASTAL FLOOD PROTECTION

The CRB report identifies several efforts necessary for the initial planning of shore-based district-scale flood protection measures. The local climate resilience plans, including *Coastal Resilience Solutions for East Boston and Charlestown*, describe specific flood protection measures, estimate order-of-magnitude costs for design and construction, and, in some cases, identify potential funding sources from both the public and private sectors. However, neither the CRB report nor the local plans identify the comprehensive governance strategies that would be needed to construct or maintain these measures, let alone finance them.

Three separate governance activities are necessary to construct district-scale coastal flood protection measures: planning, financing, and implementation. Responsibility for these activities could all be split among two or three organizations (the “multi-organization approach”), or they could be housed within a

single organization (the “single organization approach”).⁶⁰ These two approaches are explored below.

Multi-Organization Approach

Under the multi-organization approach, the functions of planning, financing, and implementation are split among two or three organizations.

Benefits to this approach include:

- It encourages the formation of appropriate project-based partnerships on an as-needed basis;
- It can take advantage of financing opportunities available to different types of organizations; and
- Dividing responsibilities among various groups allows for checks and balances.

Drawbacks to this approach include:

- Coordination among various organizations can be more difficult and time-consuming than coordination within a single organization.

If these three functions were to be split (“multi-organization path”), the following questions would need to be answered:

- What is the right scale at which to undertake each function?
- What agency would perform each function?

Single Organization Approach

The single organization approach houses the functions of planning, financing, and implementation in one organization.

Benefits to this approach include:

- It can result in improved coordination; and
- Improved coordination can lead to quicker action.

Drawbacks to this approach include:

- Nimbleness can be reduced by creating a propensity to use in-house resources when outside resources and ad-hoc groupings may be better suited for specific projects;
- If a new organization were created, it would add another player to an already crowded arena; and
- It does not benefit from the checks and balances that housing responsibilities in different organizations provides.

If the “single organization” path were to be pursued, the following questions would need to be answered:

- What existing agency might take this on and how?
- What kind of new organization might be created?

Options

Three options have been identified for implementing district-scale coastal flood protection measures using the multi-organization and single organization approaches. These include:

- **Option 1.** Enhance and Expand Local and State Coordination
- **Option 2.** Expand the MWRA
- **Option 3.** Expand MAPC, CZM or DEP

TABLE 2
Expanding Existing Capacity under the Multi-Organization Approach

Function	Scale	Agency
Planning	Watershed or Regional	MAPC, CZM, DEP
Financing	Regional or Sub-regional	Federal, State and City sources through Planning Agency, allocated locally contingent upon compliance with regional plan
Implementation	Local (in concert with Regional Plan)	Project-Dependent (BPDA, DPW, BWSC, Massport, DCR, other property owner)

Source: VHB

Instructive Massachusetts Financing Models

How does governance map back to financing climate resilience? These institutions must mobilize resources and incentives, including for complex land use and infrastructure, to protect Boston from climate risks. The intersection of these two fields—governance and finance—is a common public policy challenge.

There are many actors already working in the environmental and climate policy space (see Appendix B). We explore here two alternative examples of publicly accountable organizations that have either the authority or coordinating ability to raise capital and structure financing. Both the Massachusetts Development Finance Agency (MassDevelopment) and Independent Service Operator—New England (ISO-NE) were created to solve complex, long-term challenges at the state and regional levels. Although their mission does not necessarily map to climate resilience, we nevertheless believe there are certain insights worth sharing about their attempts to connect good governance with innovative finance.

Massachusetts Development Finance Agency (MassDevelopment)

The Massachusetts Development Finance Agency (MassDevelopment) is the state’s economic development and finance agency. It works with businesses, nonprofits, financial institutions, and communities to stimulate economic growth across the Commonwealth. Through these collaborations, the agency helps create jobs, increase the number of housing units, revitalize urban environments, and address factors limiting economic growth including transportation, energy, and infrastructure deficiencies.

MassDevelopment was formed in 1998 from a merger of the Government Land Bank and Massachusetts Industrial Finance Agency. The Massachusetts Health and Educational Facilities Authority was also merged into MassDevelopment in 2010, strengthening the depth of offerings for tax-exempt bond financing of capital projects.

As alluded to above, MassDevelopment’s work in finance and development impacts many facets of the Massachusetts economy in cities and towns across the Commonwealth. Priorities include providing low-cost and creative financing options for a range of organizations, sustainably redeveloping surplus properties, transforming the Commonwealth’s Gateway Cities, and promoting the Massachusetts manufacturing and defense sectors.

Though MassDevelopment does not have a dedicated climate resilience fund, the agency’s Brownfields Redevelopment Fund could be a potential model, which the Massachusetts Legislature established to encourage development in economically-distressed areas. MassDevelopment has administered the program since its inception in 1998 and has provided nearly 700 loans and grants to prepare hundreds of sites for redevelopment.

If decision makers were to explore a strategy for climate governance and finance with MassDevelopment as a model, a state agency could issue debt and invest for the long-term in specific people and places, thereby assuming some of the risk and uncertainty at reasonable rates.



Union Station and downtown Springfield have benefited from MassDevelopment investments.

Independent Service Operator— New England (ISO-NE)

Authorized through federal statute and coordinated by the Federal Energy Regulatory Commission (FERC), the Independent System Operator—New England (ISO-NE) is an independent, not-for-profit corporation comprised of engineers and technical experts that runs the regional electricity grid coordinating grid operation, wholesale electricity markets and infrastructure planning across the six states and ensuring reliability.

In coordination with state-led policy initiatives, programs such as the Regional Greenhouse Gas Initiative (RGGI) and advocates have had success in reducing the carbon content of electricity generation, especially with shutting down coal-fired power plants and bringing renewable energy sources online. Furthermore, through market mechanisms and regulations driven by the states but implemented through the actions of ISO-NE, baseload efficiency has increased as well as peak demand reduced.

ISO-NE's mission includes not only the electricity market of today, but also the future. Through research and analysis, ISO-NE has deep experience in forecasting demand and doing power system planning. To maintain its independence, however, ISO-NE does not handle retail electricity (the rates that end-consumers experience) or set energy policy. In keeping with its regional coordination role, it also does not own, maintain, or repair infrastructure. If decision makers were to explore a similar strategy for climate governance and finance, this would represent a market mechanism leaning on robust technocratic processes with limited public or political influence.

These options can employ different organizational approaches, which are described in the sidebar, “Instructive Massachusetts Financing Models,” followed by a description of each implementation option.

OPTION 1: ENHANCE AND EXPAND LOCAL AND STATE COORDINATION

Option 1 employs the multi-organization approach and is comprised of two activities. First, the City of Boston's capacity to coordinate its own climate change mitigation and adaptation activities would be enhanced. Second, coordination among local municipalities and state entities would be improved, as described below.

Option 1a: Enhance the City of Boston's Climate Change Coordination Capacity

Currently climate change mitigation and adaptation activities are informally coordinated within the City through the Boston Environment Department, in partnership with the Boston Planning & Development Agency, Transportation Department, Parks and Recreation Department, Public Works Department, Boston Public Health Commission, Office of Emergency Management, and other City and State agencies and community partners. Option 1a calls for enhancing the City's capacity to coordinate these activities by providing the Environment, Energy and Open Space (EEOS) cabinet with the tools to take the lead on mitigation and adaptation issues. The cabinet is comprised of the Environment Department, the Inspectional Services Department, and the Parks and Recreation Department. The current mission of the EEOS Cabinet is to coordinate these departments and their programs to enhance sustainability, preserve historic and open space resources, protect the health and safety of the built environment, prepare for climate change, and provide public spaces to gather and recreate in Boston. The Environment Department reviews environmental impact assessments, issues permits and provides information and referral services on environmental issues.

ISD administers and enforces building, housing, and environmental regulations. The Parks Department permits use of park facilities, facilitates beautification projects, provides arts and cultural programs, raises funds, maintains parks and playgrounds, manages the street tree maintenance program, designs and constructs capital parks projects, and runs the city-owned cemeteries. Additional resources to support staff capacity, technical assistance, planning, implementation, coordination, and community engagement would enhance the department's efforts and capabilities.

Option 1b: Improve Local and State Coordination

One way to approach managing the implementation of district-scale coastal flood protection measures is to simply improve the current practices in which local and state agencies are already engaged. For instance, in July 2018, the BPDA issued a request for proposals (RFP) to conduct an analysis of practical and feasible models to finance, construct, maintain, and administer shoreline flood protection measures along East Boston's waterfront identified in the October 2017 *Coastal Resilience Solutions for East Boston and Charlestown* report, specifically the Border Street corridor, demonstrating the agency's interest in identifying such information. Also, the creation of the Metro Mayors Coalition Climate Preparedness Taskforce in 2015 provides a platform to promote regional coordination and integration of existing and planned mitigation and resilience work across the 14 member communities in Greater Boston.

Continuation of this approach may have the following benefits:

- It allows municipalities to move toward flood resilience at their own pace;
- By requiring coordination with others only when absolutely necessary, it helps to reduce instances of political friction;
- It makes use of established channels of communication and activity;

- It can be tailored to local needs; and
- It provides opportunities for learning and piloting at a local scale.

However, flooding is impacted most by topography and does not respect political boundaries. Future flooding in particular is expected to exploit multi-jurisdictional vulnerabilities, both of infrastructure located within municipalities that are connected to regional systems (such as the T stations, rail lines, and highways that help move workers and distribute goods), and of infrastructure located outside of municipalities upon which those municipalities rely (such as power generation facilities and hospitals).

For this reason, there are several drawbacks to the "business-as-usual" approach, which may include:

- Competing/mismatched priorities, differing levels of available resources, and a lack of a mandate to focus on flood resilience will render many municipalities unprepared to deal with future flooding;
- Changes in local administrations affect prioritization and the functioning of ad-hoc organizations and voluntary programs, putting long-term projects with regional impacts in jeopardy; and
- While municipalities may be able to take direct action to address localized flooding, they might be limited to an advocacy or stakeholder role for addressing flooding that crosses jurisdictional boundaries, or that occurs in other municipalities but impacts them nonetheless.

Option 2: Expand the Role of the MWRA

A second option is to expand the mandate of an existing regional agency to include management of coastal flooding using a single organization approach. Many stakeholders have identified the Massachusetts Water Resources Authority (MWRA) as a potential entity to take on this role.

The MWRA is an independent public authority not subject to the supervision of



any political subdivision of the Commonwealth. The MWRA currently provides wholesale water and sewer services to 61 metropolitan Boston communities. In order to take on the responsibilities of designing, financing, constructing, and maintaining a system of shore-based district-scale flood protection measures, their mandate would need to be expanded through legislation.

The benefits of this approach include:

- The MWRA is a well-regarded, proven regional entity that has good working relationships with dozens of municipalities;
- It has the ability to adopt and enforce regulations, collect fees, borrow money, issue bonds, hold title to property, and enter into contracts, among other powers;
- The MWRA's main source of funding is water and sewer usage fees;
- The MWRA has expertise in the design, construction, and operation of water-related infrastructure;

- The MWRA has been operating with climate forecasts and is familiar with making investments to reduce risk and vulnerability; and
- The approach has the additional benefits of the single organization approach listed above.

Drawbacks to this approach include:

- The organization was created for a different purpose and flood protection is not currently authorized under its enabling act;
- Its service area covers a geography focused mainly on the Boston Metro area, which would not contribute to a solution to flooding for other parts of the state and there are municipalities in the Boston Metro area that are not included or only partially included in the MWRA system;
- Without the authority to make local land use and infrastructure decisions, implementation by a single organization would still require massive coordination with

**Deer Island
Wastewater
Treatment
Plant**

local entities, potentially eliminating any benefits of housing all three functions within the MWRA;

- The MWRA performs its current functions very well and adding a new mission may have negative impacts on current operations. Similarly, trying to adapt an existing organization for a purpose for which it was not designed may be challenging;
- The MWRA does not currently possess expertise in flood management or sea level rise;
- Expanding the mandate of the MWRA might be more politically challenging than continuing with the “business-as-usual” strategy of improving local and state coordination; and
- The approach has the additional drawbacks of the single organization approach listed above.

The benefits of this approach include:

- Planning district-scale flood control measures on a regional or sub-regional scale presents opportunities to provide protection for all communities, particularly those that don’t have the resources to plan for themselves;
- Regional funding control allows implementation funds to be tied to regional planning, which can help ensure that local projects also serve a regional purpose and are designed to regionally-agreed upon standards;
- Implementation remains in the control of each municipality, where land use and most infrastructure decisions are also made;
- These existing organizations have many (but not all) of the necessary structures in place to hit the ground running; and
- The approach has the additional benefits of the multi-organization approach listed above.

Implementing CRB is necessary but not sufficient to prepare Boston’s built environment for the fresh water and coastal flooding anticipated to result from climate change.

Option 3: Expand the Role of the MAPC, CZM or DEP

A third option is to expand the mandate of an existing regional agency to include management of coastal flooding using a multi-organization approach. Under this approach, the Metropolitan Area Planning Council (MAPC), the Massachusetts Office of Coastal Zone Management (CZM), and the Massachusetts Department of Environmental Protection—Division of Watershed Planning and Permitting are all organizations that could potentially take on planning functions and serve as a conduit for financing, while local agencies would oversee implementation. This would be considered an “empowered regional planning with coordinated local implementation” approach.

Drawbacks to this approach include:

- Additional resources would need to be provided to these agencies in order for them to take on these additional responsibilities;
- Rather than providing a dedicated revenue source, this approach relies on ad-hoc financing; and
- The approach has the additional drawbacks of the multi-organization approach listed above.

CONCLUSION

If a storm the magnitude of Superstorm Sandy hit the Boston region after all of the flood adaptation initiatives described in the CRB report were implemented, would we be ready?

As this report indicates, implementing CRB is necessary but not sufficient to prepare Boston’s built environment for the fresh water and coastal flooding anticipated to result from climate change. Additional steps we must take include reforming existing

tools, monitoring and evaluating flood adaptation activities, and establishing governance for district-scale coastal flood protection implementation. This report presents an array of options for moving forward. Over the next year or so, the City and relevant stakeholders will need to come together and decide which, if any, of these options provide the best paths forward for a more resilient city and region.

We recommend that the Governor of Massachusetts and the Mayor of Boston establish a joint commission to explore the options and determine a path forward. There is an opportunity for us to learn from the transition to clean energy as we prepare for climate change impacts. We recommend that the legislature take a leadership role in the effort as well, in order to evaluate the different options available to the Commonwealth as we attempt to address this dynamic challenge.

Forums for these conversations may also include the Mayor's Environment, Energy and Open Space Cabinet, the Green Ribbon Commission, and the Metro Mayors Coalition. These discussions, at multiple scales of governance, will also allow us to explore how climate resilience can be compatible with and supportive of the region's equitable economic growth—in fact, Greater Boston's economic resilience is what makes climate adaptation both more important and more doable.

This report suggests two intertwined approaches. The first would be integrating the CRB initiatives and the additional recommended steps into an incremental approach toward resilient governance. Essentially this means improving the tools we already have to respond to the dynamics of a changing climate and leverage the scientific capacities we already have to better guide decision making. Given the slow and complex nature of changing institutions, cultivating incremental change in existing legal institutions will be necessary while more transformational changes are developed. The second approach,

therefore, is to consider transformative changes in governance capable of confronting landscape-scale problems and rapidly changing climate impacts. We will need governance structures that fully integrate the gathering of adequate information about ecological resources and social values, obtaining

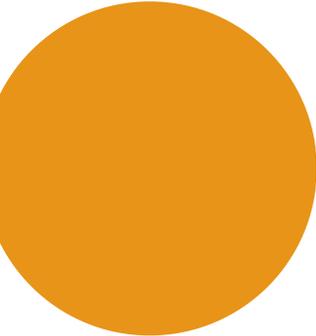
Over the next year or so, the City and relevant stakeholders will need to come together and decide which, if any, of these options provide the best paths forward for a more resilient city and region.

feedback through monitoring, and using this data to inform policies, programs and projects. Instituting changes in power structures and introducing new institutional arrangements and regulatory frameworks is always challenging, but the extreme challenge of climate change adaptation demands such actions.

Finally, we need to keep in mind that while data and coordinated standards are an important part of preparing for a changing climate, as Erle C. Ellis recently wrote:⁶¹

Decisions informed by scientific evidence will, of course, create better outcomes for people and the planet. But no amount of scientific evidence, enlightened rational thought or innovative technology can resolve entirely the social and environmental trade-offs necessary to meet the aspirations of a wonderfully diverse humanity—at least not without creating even greater problems in the future.

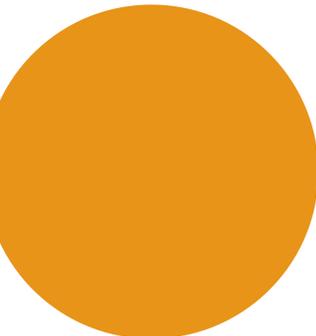
The object of governance should be, after all, to articulate our values, identify the future we want, and focus on opportunities for improving our lives and our communities. In a changing climate, market forces alone are not enough to create a resilient future. The role of governance is more important than ever.



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APPENDIX A

GOVERNANCE ACTORS

There are many different local and state actors who play a variety of roles in helping the City of Boston and the region and state prepare for the impacts of climate change. Massachusetts leads the nation in efforts to protect our climate and reduce greenhouse gas emissions. Under the authority provided in the Commonwealth's 2008 Global Warming Solutions Act (GWSA), Massachusetts Executive Office of Energy and Environmental Affairs (EEA) convened the Climate Change Adaptation Advisory Committee in May 2009 to develop a report identifying sector-based climate change vulnerabilities and strategies to reduce climate-related impacts. The 2011 Massachusetts Climate Change Adaptation Report provided a menu of options for developing practical strategies to adapt to the projected changes in climate across all major sectors of the Commonwealth.

In September 2016, Governor Baker signed Executive Order (EO) 569 to establish an integrated climate change strategy for the Commonwealth. This is the first time climate change adaptation and impacts have been addressed across all branches of state government. The Order requires the Secretaries of Energy and Environmental Affairs (EEA) and Public Safety and Security (EOPSS) work together to develop a framework for each Executive Office to assess its agencies' vulnerability to climate change and identify adaptation strategies. Under the directive of EO 569, EEA and the Massachusetts Emergency Management Agency (MEMA) have led an inter-agency effort in creating the Commonwealth's

first integrated State Hazard Mitigation and Climate Adaptation Plan, adopted by Governor Baker in September 2018.

Massachusetts has a long history of demonstrating its commitment to advancing risk reduction and resilience across the state. This encompasses a broad range of State-supported initiatives and activities that include a combination of outreach, training, technical assistance, funding, partnerships, regulatory codes and statutes, infrastructure projects, and other activities to increase statewide resilience. Some specific examples include, but are not limited to, the following:

- The Commonwealth actively manages a statewide program of hazard mitigation and climate adaptation through the development of legislative initiatives, multi-agency committees or councils, public/private partnerships, and/or other executive actions that promote hazard risk reduction and resilience.
- The Commonwealth supports local hazard mitigation and climate adaptation planning by providing workshops and training, planning grants for municipalities, and other coordinated resource and capability development of local officials. Most recently the Commonwealth launched the Municipal Vulnerability Preparedness (MVP) grant program, which provides financial and technical support for cities and towns in Massachusetts to begin or enhance the process of planning for resiliency to extreme weather and other natural or climate-related hazards. Additionally, the MVP Program

provides municipal grants to implement high priority climate adaptation strategies identified through the climate adaptation planning process. Currently, over 40% of cities and towns in the Commonwealth are enrolled in the MVP program and therefore completing plans to build resilience and address climate change impacts.

- In May 2018, the Governor released the Administration's Capital Investment Plan for Fiscal Year (FY) 2019-2023, providing a \$2.34 billion investment for the Commonwealth's capital needs. The plan incorporates climate change adaptation and greenhouse gas mitigation as a critical new component. The plan fully integrates climate change preparedness and resiliency, with 100 percent of its investments analyzed for climate impact and more than \$60 million to directly address climate change, including \$12 million to repair and rebuild seawalls and inland dams, \$11 million to help cities and towns plan for and protect against the impact of a changing climate, and \$5 million for energy efficiency improvements in public housing.

The Commonwealth continues to take many steps to enhance its hazard mitigation and climate adaptation efforts. Some state agencies and offices routinely conduct hazard mitigation and resilience building as part of their organizational missions, and the legal foundation for such work is part of each agency's enabling legislation.

Leading Massachusetts's efforts, the Executive Office of Energy and Environmental Affairs (EEA) seeks to protect, preserve, and enhance the Commonwealth's environmental resources while ensuring a clean energy future for the state's residents. Through stewardship of open space, protection of environmental resources, and enhancement of clean energy, it leads the Governor's cabinet-level responses, overseeing the Massachusetts Office of Coastal Zone Management (CZM), Department of Conservation and Recreation (DCR), Department of Environmental

Protection (DEP), Department of Fish and Game (DFG), Department of Energy Resources, Department of Public Utilities (DPU), and the Energy Facilities Siting Board (EFSB) among others. Under the Baker-Polito Administration, EEA now has a specific focus on climate change with an integrated climate change program that works across state government and with cities and towns led by an Assistant Secretary of Climate Change, to address both climate change mitigation and climate change resilience.

At present, some key obstacles and challenges for the Commonwealth to address include, but are not limited to, the following:

- The need to incorporate climate change adaptation into all state agencies business practices;
- Need for increased capacity to address vulnerabilities and implement key adaptation strategies both within and outside of state government; and
- Currently there are not enough practical examples of adaptation strategies for the Commonwealth and its communities to follow and pursue the implementation of their own projects. Most of the expertise and innovative work in this area has been conceptual, other than the reapplication of existing techniques for wetlands restoration and preservation. The creation of more innovative models with examples of proven success to showcase in Massachusetts is needed.

While it is important to consider potential challenges, the Commonwealth of Massachusetts realizes we must also be mindful of emerging capabilities and opportunities.

Some of these include, but are not limited to:

- In August 2018, Governor Baker signed legislation to authorize an Environmental Bond Bill amounting to more than \$2.4 billion in capital allocations over the next five years for investments in safeguarding residents, municipalities, and businesses from the impacts of climate change; for protection of environmental resources; and for

investments in communities. Over \$500 million will be dedicated to adaptation and resilience strategies, including \$75 million for the MVP program and \$100 million for implementation of the State Hazard Mitigation and Climate Adaptation Plan. The Bill also codifies key aspects of Governor Baker's Executive Order, including development of the statewide plan, the MVP program, vulnerability assessments for state agencies, and aligning spending at EEA with the statewide plan.

- Resilience bonds are a new and emerging finance mechanism, similar to catastrophe bonds that offer a highly flexible approach to funding resilience projects. They combine insurance with a debt instrument, allowing a bond issuer to raise capital to finance measures that reduce risk and

increase resilience to natural hazards.

Resilience bonds can be applied to the full range of hazard mitigation or climate adaptation projects, and they can be applied at various scales, from a single infrastructure asset project to larger regional-scale measures that may combine multiple structural and nonstructural actions to reduce risk and insurance cost.

- Once complete and finalized, the Climate Change Adaptation and Resiliency Policy for the Massachusetts Environmental Protection Act will help the State to address more actively the threats and challenges posed by climate change in major development projects that require State permitting, financial assistance or land disposition.

SELECTED NEIGHBORHOOD, CITY, REGIONAL, AND STATE ACTORS

For further reference, below is a selected list of additional actors for added context. Similar to the discussion of EEA above, we highlight each group's overarching purpose or mission, specific role in addressing climate change, any current challenges, and potential future directions for increasing resilience. Descriptions below were either: (1) drafted by the agency or organization themselves, (2) written by the report authors and approved by the agency or organization, or (3) drawn from publicly available materials (and did not receive the group's review or consent). The abstracts are by no means exhaustive and only begin to suggest the depth and breadth of some of the involved and relevant parties to climate adaptation governance.

Legend

- Written by organization, minimally edited by report authors
- Written by report authors, edited by organization
- Written by report authors, unedited

■ A Better City (ABC)

Purpose/Mission: A Better City (ABC) is a diverse group of 130 business leaders united around a common goal—to enhance Boston and the region's economic health, competitiveness, vibrancy, sustainability, and quality of life. It operates between the private and public sectors using technical expertise and research capabilities to shape key policies, projects, and initiatives in three critical areas—transportation and infrastructure, land use and development, and energy and the environment.

Climate Change Role: The core program areas impact infrastructure, finance, and policy, the Municipal Harbor Plan, public realm planning, driving carbon reduction, and building climate resiliency. ABC has been a key partner with the City of Boston for Climate Ready Boston and Carbon Free Boston, and coordinates the Commercial Real Estate Working Group for the Boston Green Ribbon Commission. It runs the Sustainable Buildings Initiative working closely with member

buildings on energy, waste, water and transportation reductions, and climate adaptation.

Limitations/Current Challenges: Preparing the built environment for climate impacts is a challenging task. Despite ABC's efforts to educate, provide resources and updates on policies and programs that will affect Boston and the region's buildings, results of a survey ABC conducted after the January 4, 2018 winter storm with ABC and Boston Green Ribbon Commission members in close proximity to the harbor found: 1) The intensity of the January 4, 2018 winter storm was a surprise to the majority of the property owners surveyed; 2) Over half of those with assets located in close proximity to the Boston Harbor experienced business disruption either in the form of lost time and productivity and/or facility damage; and 3) As a result, 60% of respondents will be making changes to their planning.

Potential Future Directions: ABC works with multiple stakeholders to monitor climate change projections, educate constituents, and provide adaptation tools and resources so they are able to make the best possible planning and development decisions.

■ Barr Foundation

Purpose/Mission: Based in Boston, the Barr Foundation focuses regionally, and selectively engages nationally, working in partnership with nonprofits, foundations, the public sector, and civic and business leaders to elevate the arts and creative expression, to advance solutions for climate change, and to connect all students to success in high school and beyond. Founded in 1997, Barr now has assets of \$1.7 billion, and has contributed more than \$838 million to charitable causes. Barr's mission is to invest in human, natural, and creative potential, serving as thoughtful stewards and catalysts.

Climate Change Role: The goal of Barr's climate resilience focus area is to increase the capacity of Metro Boston communities to prepare for and adapt to the impacts of climate change. To accelerate climate resilience in the

region, we need informed and mobilized stakeholders, supportive policies and regulatory frameworks, and strong examples of climate resilient design and infrastructure. Barr's efforts to catalyze climate resilience are aligned under the following three strategies: (1) build awareness of climate impacts, risks, and resilience strategies, (2) mobilize key constituencies to advance policy and implement resilience plans, and (3) support demonstration projects that integrate resilience into the fabric of cities.

Limitations/Current Challenges: There are a limited number of other funders supporting climate resilience efforts in the Northeast US.

Potential Future Directions: In 2018, Barr anticipates awarding \$5 million to support grants in alignment with our climate resilience strategies.

■ Board of Building Regulation and Standards (BBRS)

Purpose/Mission: The Board of Building Regulations and Standards (BBRS) monitors Massachusetts building codes and construction supervisor licensing. BBRS also certifies municipal building inspectors. Members serve either ex-officio (State Fire Marshal, Chief of Building Inspections for Office of Public Safety and Inspections), in their professional capacity (town building inspector, city building inspector, local fire department chief) or are appointed to the board to represent relevant interests (building trades, architects, mechanical and structural engineers, contractors, builders). There are five technical Advisory Committees (energy, structural, geotechnical, fire protection/prevention, existing buildings) and four Working Groups (Convention Center Fire protection, Prescriptive Standards for Low-risk Rooftop Solar Installations, Construction Supervisor License Exam Transition, and LNG Storage Facility Standards).

Climate Change Role: The Massachusetts State Building Code (780 CMR) consists of a series of international model codes and state-specific amendments adopted by BBRS. The

BBRS regularly updates the state building codes as new information and technology become available and change is warranted. Climate change impacts from wind, heat, and flooding will require future consideration—though there is a focus on flooding specifically for current limitations and future directions.

Limitations/Current Challenges: Coastal flooding exacerbated by sea level rise will only impact certain towns and cities across the Commonwealth, which makes changing the statewide building code challenging. Furthermore, the benefits of greater resilience (eg. freeboard requirements) must be balanced with the additional costs of construction across the entire state. Climate impacts stretch across a variety of code sections and there are technical issues associated with mitigating uncertain, future risks.

Potential Future Directions: Working groups have historically focused on climate mitigation strategies, specifically around energy efficiency, as opposed to long-range adaptation. There was, however, a recent effort to reintroduce Coastal “A” zone requirements for flood risk into the 9th Edition of base residential and commercial codes. This would have helped mitigate climate risks and promoted climate adaptation, but it did not succeed. Various organizations and quasi-public entities including the American Institute of Architects (AIA), the Metropolitan Area Planning Council (MAPC), and Conservation Law Foundation (CLF) continue to investigate potential paths for incorporating forward-looking building standards into the state code or creating more flexibility for cities and towns to regulate to a higher standard.

■ **Boston Harbor Now**

Purpose/Mission: Boston Harbor Now focuses on maximizing the benefits of Boston Harbor for everyone through quality programming, policy, planning, and design. It is committed to a vision of a future Boston Harbor waterfront that is prepared for and resilient to

climate change. We work collaboratively to realize this vision.

Climate Change Role: Boston Harbor Now works to develop climate resilient open space and infrastructure that sets a new standard for resilient, beautiful, and functional urban design. The organization advocates for both robust site-specific and district-level approaches to resilience planning in waterfront areas targeted for growth by the City of Boston. As part of its ongoing policy and planning efforts, the organization advises on neighborhood redevelopment plans to ensure harbor access and climate resilience are a priority. The organization is part of a team working with the Boston Planning and Development Agency (BPDA) to develop a flood resiliency zoning overlay district and related design guidelines for new construction and building retrofits. As part of its effort to expand awareness and utilization of the Harbor’s open spaces, it is taking a role in the Moakley Park Vision Plan to ensure it prioritizes climate resilience and equitable access for all the surrounding neighborhoods. Recently Boston Harbor Now hosted a symposium to highlight opportunities for great Boston waterfront public spaces and parks and encourage more equitable and innovative development, a strong working port, and long-term climate resilience. The organization also released a Working Port report emphasizing the need to tailor resilient design initiatives to address the vulnerabilities of Boston’s industrial waterfront while understanding their need for continuous access to and dependence on the harbor.

Limitations/Current Challenges: To make the most of a lean staff and resources, the organization does everything through collaboration and partnerships. It focuses on advancing impactful resilience projects and efforts across the Boston Harbor waterfront. The organization is actively working to expand its reach across the Boston Harbor region to other communities that are grappling with employing resilience strategies that are also beautiful and functional urban design.

Potential Future Directions: Boston Harbor Now will continue to be an active member of the Green Ribbon Commission to support the City to implement Climate Ready Boston and other resiliency initiatives like the BPDA Zoning Overlay effort and Moakley Park Vision Plan. Building upon our longtime advocacy for public access, the organization will promote the goals and implementation of Chapter 91 to address access and resiliency on the waterfront and Harborwalk. Boston Harbor Now is also working to implement a pilot project to enhance wave reduction by strategically using the strategically located Boston Harbor Islands.

■ Boston Planning and Development Agency (BPDA)

Purpose/Mission: The Boston Planning and Development Agency (BPDA, formerly the Boston Redevelopment Authority) is the planning and economic development agency for the City of Boston. The BPDA is charged with growing the tax base, cultivating the private jobs market, training the workforce, encouraging new business to locate in Boston and existing businesses to expand, planning the future of neighborhoods with the community, identifying height and density limits, charting the course for sustainable development and resilient building construction, advocating for multi modal transportation, responding to the city's changing population, producing insightful research on our City, and ensuring Boston retains its distinctive character.

Climate Change Role: BPDA's community and resilience planning is guided by the recently completed Imagine Boston 2030 plan, as well as Climate Ready Boston. The document outlined several guidelines for how Boston might envision city governance in the future. It emphasized the inclusiveness of all stakeholders and ethnic groups, responsiveness to the needs and wishes of citizens, and collaboration with citizens, private organizations and businesses and public entities such as other municipalities or the state of Massachusetts as guiding principles for

all planning and decision-making processes. These two plans impact various energy and environment initiatives; for example, they call for zoning regulations, in conjunction with district-scale planning exercises, to prepare buildings for climate-related risks and to mitigate climate change through energy efficiency such as neighborhood-level micro-grids.

Limitations/Current Challenges: The BPDA has a Climate Change and Environmental Planning division, whose primary tools related to resilience are specific to planning, policy, zoning, and development review. Given the BPDA's broad mission and limited resources, the BPDA may require with time additional revenue sources and supplemented powers beyond urban renewal to meet the needs of resilience planning in conjunction with Boston's own and interconnected multi-municipality climate preparedness planning (e.g., the Metro Mayors Coalition).

Potential Future Directions: Under Climate Ready Boston and Imagine Boston 2030, the BPDA in conjunction with the Environment Department is actively engaged in detailed planning and implementation exercises throughout Boston. Most recently, the BPDA has updated its Climate Resilience and Preparedness Checklist along with guidance for design based flood elevations in the Sea Level Rise—Flood Hazard Area. The BPDA seeks to incorporate the advisory information into a zoning overlay district.

■ Boston Public Health Commission (BPHC)

Purpose/Mission: BPHC is a municipal-level agency, whose mission is to protect, preserve, and promote the health and well-being of all Boston residents, particularly the most vulnerable. BPHC is committed to providing and supporting accessible high-quality community-based health and social services, community engagement and advocacy, development of health promoting policies and regulations, disease and injury prevention, emergency services, health promotion, and health education services. BPHC envisions a thriving

Boston where all residents live healthy, fulfilling lives free of racism, poverty, violence, and other systems of oppression. All residents will have equitable opportunities and resources, leading to optimal health and well-being.

Climate Change Role: In 2001, BPHC was the first city agency to purchase hybrid vehicles, which led the way for Boston's current vehicle fleet with a substantial proportion of hybrid vehicles. In pursuit of the Health In All Policies objective, BPHC has worked diligently to integrate public health into larger City discussions around climate change. BPHC also played a significant role in developing the City's first greenhouse gas emissions inventory and climate action plan. Finally, BPHC strives to maintain a world class emergency response and preparedness public health infrastructure able to respond to climate-related and other public health emergencies through the Stephen M. Lawlor Medical Intelligence Center.

Limitations/Current Challenges: BPHC continues to advocate for the importance of ensuring public health considerations and long-term resilience of human health are addressed in climate mitigation and adaptation work.

Potential Future Directions: Because of the widespread impact of climate change and the diverse nature of the agencies and populations that can be affected, BPHC has two broad goals related to climate change. The first is to integrate considerations of public health, environmental justice, and particularly vulnerable populations into all aspects of climate change mitigation and adaptation. The second is to develop and maintain a robust infrastructure for public health response to natural disasters.

■ Boston Water and Sewer Commission (BWSC)

Purpose/Mission: Boston Water and Sewer Commission (BWSC or Commission) operates and maintains the water, sewer and storm drainage systems in the City of Boston. It is New England's oldest and largest water,

sewer and stormwater system. Established in 1977, BWSC provides potable water and sewer services to more than one million people per day. Boston Water and Sewer Commission is overseen by a three-member Board of Commissioners appointed by the Mayor of Boston. The primary responsibility of the Board is to ensure the efficient operation and maintenance of the systems to ensure the highest quality services to the City of Boston. The Board of Commissioners is also responsible for setting clear financial and operational policy directives.

Climate Change Role: BWSC works with other city agencies to evaluate improvements the City is undertaking to promote resilience in Boston. For example, BWSC's leak detection efforts have set the standard within the industry for keeping unaccounted-for water at a minimum. BWSC also examines its systems to assure the BWSC infrastructure does not have a detrimental impact on planned improvements and that wherever possible, its efforts compliment other measures to mitigate sea level rise. BWSC has a comprehensive, three-year Capital Improvement Plan that identifies needed repairs or rehabilitations, establishes a planning process and implements construction.

Limitations/Current Challenges: BWSC is limited by its jurisdiction to that of the water, sewer and storm drainage systems of Boston and must coordinate with not only the Massachusetts Water Resources Authority (MWRA), but also with private land and infrastructure owners.

Potential Future Directions: BWSC is working with other City Agencies to coordinate improvements to the Commission's infrastructure to address climate change. It was one of the first city agencies to model worst-case scenarios for stormwater flooding and to analyze the best options for keeping sewage from overflowing into the harbor or backing up into buildings. The Commission currently models a 10-year, 24-hour rain event to identify what parts of the city would be affected and how to evacuate vulnerable residents,

such as hospital patients. BWSC is also working with flood-prone institutions to ensure that their properties are not damaged during extreme weather.

■ Coastal Zone Management (CZM)

Purpose/Mission: The Massachusetts Office of Coastal Zone Management (CZM) is the lead policy, planning, and technical assistance agency on coastal and ocean issues within the Executive Office of Energy and Environmental Affairs (EEA) and implements the state's coastal program under the federal Coastal Zone Management Act. The mission of CZM is to balance the impact of human activities with the protection of coastal and marine resources through planning, public involvement, education, research, and sound resource management. CZM provides technical assistance and support—primarily to local officials, marine businesses, environmental groups, and coastal homeowners—as well as information to people who visit and volunteer for the coast.

Climate Change Role: As the lead policy and planning agency on coastal issues for the Commonwealth, natural hazard mitigation and climate change adaptation are fundamental to CZM's mission and program areas. CZM works with project proponents to address sea level rise and coastal flooding and provides coastal communities technical assistance and support on these issues. CZM also administers the Coastal Resilience Grant Program, which funds local efforts to increase awareness and understanding of climate impacts, identify and map vulnerabilities, conduct adaptation planning, redesign vulnerable community facilities and infrastructure, and implement non-structural (or green infrastructure) measures to provide flood and erosion control and improve community resilience.

Limitations/Current Challenges: Projected climate impacts, including higher tides, greater storm surges, and more intense precipitation will likely exacerbate current erosion and flooding issues to homes, businesses, critical

facilities and infrastructure, and natural resources. By incorporating climate projections into existing plans, programs, and policies, communities can start to gradually transition vulnerable assets toward a more resilient future. Improving resilience requires ongoing attention and action, and often the challenges associated with adapting to a changing climate include a need for: project funding, local capacity to plan for and implement risk reduction measures, technical expertise to properly evaluate and advance innovative approaches, and monitoring data and analysis to help inform future adaptation projects.

Potential Future Directions: CZM actively supports coastal communities in climate adaptation and coastal resilience efforts through technical assistance and information sharing, providing strategies and tools to help address local challenges. With continued capital funding, CZM will support additional local resilience efforts through the Coastal Resilience Grant Program, which has provided over \$14.4 million in funding over the past five years for 105 projects in 47 coastal communities. CZM participates in state interagency coordination efforts related to the development, review, and implementation of plans, projects, and policies for such issues as coastal erosion, flooding, and climate change. CZM collaborates with Federal partners and other state coastal programs across New England and the country to facilitate knowledge sharing and advance coastal resilience planning and policies. New England regional efforts are currently focused on advancing the construction of living shorelines and coastal green infrastructure projects to provide coastal storm damage protection.

■ Conservation Law Foundation (CLF)

Purpose/Mission: Conservation Law Foundation (CLF) is a non-profit, member-supported advocacy organization founded in 1966. CLF uses the law, science, and the market to create solutions that preserve natural resources, build healthy communities, and sustain a vibrant regional economy. CLF's

approach to environmental advocacy is distinguished by its close involvement with local communities; ability to design and implement effective strategies; and capacity for developing innovative and economically sound solutions to our region's most critical environmental challenges.

Climate Change Role: CLF's work on climate adaptation is centered on research, laws, and policies to hold private actors who fail to adapt accountable; modernize our building and land use codes; promote health and safety of all Massachusetts residents in the face of extreme weather; and address disparate burdens for environmental justice communities. CLF has also spearheaded cutting-edge research on potential liability for public and private decision makers for failing to adapt to climate change and cited it as a lever for action.

Limitations/Current Challenges: Climate change poses an entirely new reality that existing laws and regulations do not adequately account for. To address climate impacts comprehensively and cohesively, changes need to be made to the statutory and regulatory frameworks to incorporate the best available science and data on future impacts. There is also a need for coordination between a variety of actors at different levels of government, political will, subject matter expertise, and more—all of these things can be barriers to progress. While CLF is actively working toward these changes, it is difficult to compel action when climate adaptation is optional and not mandatory.

Potential Future Directions: CLF is uniquely positioned to devise and advocate for more stringent and up-to-date laws, codes, standards and more to ensure that the City of Boston and all of Massachusetts can endure and recover from climate impacts. With a focus on regulations, policies, legislation, and science—CLF will continue to work with city and state officials, community organizations, residents, and other stakeholders on important issues like wetland bylaws, building code reform, procurement policies, opportunities

for open space and nature-based solutions, and updates to zoning and land use policies.

■ Department of Conservation and Recreation (DCR)

Purpose/Mission: The Massachusetts Department of Conservation and Recreation (DCR) manages over 450,000 acres of parks, forests, watersheds, beaches, parkways and roads, long distance bike corridors, dams and other public infrastructure throughout Massachusetts on behalf of the people of the Commonwealth.

Climate Change Role: DCR protects and manages a diversity of properties, and is a human-centered service agency that connects people to natural, cultural, historic, and recreational resources which are impacted by climate change. As DCR facilities/properties are altered over time, climate change impacts are considered in engineering and design alternatives, including such assets as flood control facilities/equipment, cultural and historic assets, invasive species, and forestry management practices. DCR has been an active participant in the development of the state's new Climate Adaptation Plan, and the agency will continue to explore climate change impacts and solutions.

Limitations/Current Challenges: A major limitation in DCR's response to climate change will be limited resources, especially the funding required to address vulnerable structures or critical natural areas. The public's understanding and acceptance of climate change and its impacts is critical to the agency's ability to implement some of the best alternatives and policies. Also, DCR will need assistance to understand the complexities of sea level rise and gain comprehensive information about climate change impacts statewide.

Potential Future Directions: DCR has taken a number of steps to address climate change; as part of Governor Baker's climate change initiative DCR has been exploring new strategies for the future. Examples of DCR climate adaptation actions include a 10-year watershed land management plan for critical

drinking water supplies; resource management plans that include climate resilience measures; an inundation assessment and mitigation design for the New Charles River and Amelia Earhart Dams; assessment of 1,462 coastal protection structures; the systematic evaluation of accretion and erosion on coastal beaches; a regional sediment management study on the Upper North Shore; and archeological site stabilization due to coastal erosion.

■ Department of Environmental Protection (DEP)

Purpose/Mission: The Department of Environmental Protection's (DEP) statutory obligations and responsibilities are to provide effective stewardship of the Commonwealth's trustlands, which include a mission to protect and promote the public's interest in tidelands in accordance with the Public Trust Doctrine. This mission provides a duty to ensure that tidelands are used for water-dependent purposes or otherwise serve a proper public purpose, and to protect the public health, safety, and general welfare as it may be affected by any project in tidelands.

Climate Change Role: The Department fulfills this role by requiring approval by licensure of any proposed construction, placement, excavation, addition, improvement, replacement, construction reconstruction, demolition or removal of any fill or structures in tidelands.

Limitations/Current Challenges: The current challenge to addressing climate adaptation in tidelands is that the current regulatory standard is based on a retrospective analysis of historic sea level rise, as opposed to a prospective one. Another challenge is that the regulations have a clear interest in keeping the placement of fill and structures in tidelands limited to only previously filled tidelands, unless a project can be expressly deemed to be water-dependent and cannot achieve its purpose without being located in flowed tidelands. The understanding of climate change and the adaptive strategies

were never at the forefront of the Chapter 91 regulatory framework.

Potential Future Directions: Nonetheless, given the statutory obligation of the Public Waterfront Act, regulating all work in filled and flowed tidelands, it will necessarily play a key role going forward. The Department would expect that through potential regulatory changes or through policy interpretation of the existing regulatory framework, it will work closely with state and federal agencies, municipalities, and the regulated community to address sea level rise and climate adaptation.

■ Environment, Energy, and Open Space (EEOS)

Purpose/Mission: Environment, Energy, and Open Space (EEOS) is municipal-level cabinet agency that maintains Boston's historic sites, buildings, and landscapes, and waterways through protective designation and review processes. The cabinet reviews environmental impact assessments, issues permits, and provides information and referral services on environmental issues.

Climate Change Role: EEOS implements the Mayor's commitment to sustainable development, climate protection, and the environment. Most recently, the Environment Department completed Climate Ready Boston, a detailed plan to increase the city's climate resilience. Through extensive stakeholder outreach, this plan provided a consensus of local climate change projections, a city-wide climate vulnerability assessment, and recommended resilience strategies. The department is currently focused on planning and implementing neighborhood resilience strategies, community engagement through the Greenovate Leaders program, and launching cross-departmental resilience efforts such as the Public Works Resilient Infrastructure Standards, BPDA climate-ready zoning, and BPHC extreme temperatures operations plan.

Limitations/Current Challenges: The Environment Department, for example, is limited

in its ability to apply enabling environmental regulations to the challenges of climate change. For example, the Boston Conservation Commission lacks regulatory authority over certain resource areas not currently protected under the Wetlands Protection Act, such as Land Subject to Coastal Storm Flowage.

Potential Future Directions: The Environment Department is implementing the Climate Ready Boston plan by developing neighborhood coastal resilience strategies for critical focus areas such as East Boston, Charlestown, South Boston, and Moakley Park. EEOS also recently hired a Director of Climate and Environmental Planning and Climate Ready Boston Coordinator, increasing its staffing capability and capacity.

■ Boston Green Ribbon Commission (GRC)

Purpose/Mission: The Boston Green Ribbon Commission (GRC) is a voluntary CEO network committed to supporting the development and implementation of the City of Boston's Climate Action Plan. The GRC has strong leadership representation from key sectors of the economy, including commercial real estate, health care, higher education, cultural institutions, finance, and non-profit.

Climate Change Role: The Commission played a leadership role in helping the City launch the Climate Ready Boston initiative and plan, and has sponsored several follow-on projects, including the harbor barrier feasibility assessment, and reports by UMass Boston on resilience finance and governance. GRC members have also been directly involved in district scale resilience planning in East Boston, Charlestown, and South Boston.

Limitations/Current Challenges: The Commission has no legal authority or mandate, so is limited in actions it can advance on behalf of climate adaptation. Its primary strength is to mobilize its members to advance best practice, engage with the City on planning, and push for aggressive action on near term risks.

Potential Future Directions: The GRC anticipates future engagements to support a coordinated municipal, regional and state approach to climate resilience financing and governance. Institutions capable of identifying, designing, financing and implementing major resilience investments are needed at all three scales.

■ Metropolitan Area Planning Council (MAPC)

Purpose/Mission: The Metropolitan Area Planning Council (MAPC) is the regional planning agency that serves the people who work and live in the 101 municipalities of Metropolitan Boston. MAPC's mission is to "promote smart growth and regional collaboration." MAPC's regional plan for Greater Boston, MetroFuture, guides the agency's work as it engages the public in responsible stewardship of the region's future.

Climate Change Role: MAPC is guided by a set of four strategic priorities, including to "help the region reduce greenhouse gas emissions and adapt to the physical, environmental, and social impacts of climate change and natural hazards." The agency takes a comprehensive and interdisciplinary approach to climate work across the Clean Energy, Environment, Public Health, Government Affairs, and Data Services Departments, among others. Climate adaptation is one piece of MAPC's overall climate strategy and to meet this goal, the agency:

- Manages and supports the Metro Mayor's Coalition Climate Preparedness Taskforce and coordinates actions at a regional level;
- Helps municipalities connect with state agencies around key issues and critical infrastructure;
- Advocates for state legislation and state policy;
- Conducts climate vulnerability assessments and action plans for municipalities, including as a provider for the Massachusetts Municipal Vulnerability Preparedness (MPV) program;

- Incorporates climate change into local planning processes, such as open space plans and comprehensive plans;
- Provides targeted research and technical assistance to municipalities on issues related to climate mitigation, adaptation, and preparedness; and
- Provides data services, mapping, and digital tools to understand climate impacts and plan for resilience.

Limitations/Current Challenges: As a regional planning agency, MAPC provides guidance and technical assistance to municipalities. It is up to each municipality to determine which policies to enact and projects to undertake. Capacity and funding/financing remain challenges for both local municipalities and MAPC in implementing climate adaptation projects. Additionally, often the communities that are the most vulnerable are also those that have the fewest resources to address that vulnerability. As an agency, MAPC strives to support these communities, and works to find ways the region and state can support them, as well.

Potential Future Directions: In fall 2018, MAPC is launching an update to MetroFuture, the region's 2008 long-term plan. Climate change, including adaptation and resilience, will be a critical component of the planning process. MAPC is continuing to support municipalities, identify partnerships and funding, and coordinate with state agencies on these topics.

■ Massachusetts Emergency Management Agency (MEMA)

Purpose/Mission: The Massachusetts Emergency Management Agency (MEMA) is the state agency charged with ensuring the state is prepared to withstand, respond to, and recover from all types of emergencies and disasters, including natural hazards, accidents, deliberate attacks, and technological and infrastructure failures. MEMA is committed to an all hazards approach to emergency management. By building and sustaining effective partnerships with federal,

state and local government agencies, and with the private sector—individuals, families, non-profits and businesses—MEMA ensures the Commonwealth's ability to rapidly recover from large and small disasters by assessing and mitigating threats and hazards, enhancing preparedness, coordinating response operations, and strengthening our capacity to rebuild and recover.

Climate Change Role: Massachusetts Executive Order (EO) 569, *Establishing an Integrated Climate Change Strategy for the Commonwealth*, directs executive agencies to develop and implement a statewide Climate Adaptation Plan, and to build a framework for each state agency to assess their vulnerability to climate change and implement resiliency measures. Historically, MEMA is responsible for updating and implementing the Massachusetts State Hazard Mitigation Plan. As a result of EO 569, the Commonwealth resolved to integrate climate change planning into the State Hazard Mitigation Plan, now known as the State Hazard Mitigation and Climate Adaptation Plan (SHMCAP). MEMA, in partnership with the Executive Office of Energy and Environmental Affairs (EEA), is the lead agency for the creation and maintenance of the SHMCAP.

Limitations/Current Challenges: MEMA faces similar challenges with respect to infrastructure that all state agencies face. But because MEMA is a lead agency in the Commonwealth's effort to effect resilience solutions, the greater challenges relate to this mission. MEMA traditionally takes a lead in identifying regional and local resilience projects that would mitigate future climate related impacts, however, implementing these projects is hampered by the availability of funding. Federal, state and other mitigation grants are available, however, the identified need vastly paces the available funding.

Potential Future Directions: In its lead role, MEMA continues to plan for climate change adaptation and identify resilience projects that will mitigate future effects. To those ends, the SHMCAP includes Goal

Statements that guide the Commonwealth's current and future resilience planning and implementation efforts. These goals include building institutional capacity, encouraging the adoption of forward-looking policies, plans, and regulations, developing risk reduction strategies using the best available science, investing in performance-based solutions, and supporting implementation through increased education, awareness, and incentives.

■ **Massachusetts Port Authority (Massport)**

Purpose/Mission: The Massachusetts Port Authority (Massport) has a long history with serious responsibilities and an unwavering mission: to connect Massachusetts and New England to the world safely, securely and efficiently, never forgetting its commitment to its neighbors who live and work around its ports and facilities.

Climate Change Role: Massport's climate adaptation effort is focused on protecting the transportation infrastructure that it is responsible for, and specifically anticipating possible climate impacts, developing and evolving plans to respond to those impacts, and enabling the recovery of the region by restoring operations as quickly as possible.

Limitations/Current Challenges: Although Massport is trying to protect its own infrastructure, the transportation system as a whole would benefit from a comprehensive review and approach to resilience challenges, with a holistic solution developed for addressing a changing climate.

Potential Future Directions: Massport has undertaken an extensive resilience program based on an assessment of potential climate vulnerability and resulting consequences to its infrastructure and operations. An adaptation program that includes planning and design guidelines, flood operations plans for Logan Airport and Maritime facilities, and permanent enhancements to protect critical assets is overseen by a Climate Mitigation

and Resiliency Manager, who also collaborates with district, city and state partners.

■ **Massachusetts Water Resources Authority (MWRA)**

Purpose/Mission: The Massachusetts Water Resources Authority (MWRA) is a Massachusetts public authority that provides wholesale water and sewer services to 3.1 million people and more than 5,500 large industrial users in 61 metropolitan Boston communities. MWRA's mission is to provide reliable, cost-effective, high-quality water and sewer services that protect public health, promote environmental stewardship, maintain customer confidence, and support a prosperous economy.

Climate Change Role: MWRA has a pragmatic approach to climate change adaptation, and efforts have focused on the evaluation and implementation of measures to allow MWRA facilities to withstand a significant storm event that could occur in Eastern Massachusetts. Staff have looked at potential impacts on water supply, wastewater transport, and treatment facilities. Most water facilities are located inland and were found to have very limited exposure to coastal flooding. Wastewater facilities are, however, generally located closer to the coast and were the focus of staff investigations. MWRA staff recently generated vulnerability assessments for 30 coastal or near-coastal wastewater and administrative/operational facilities for potential impacts of sea level rise, and regularly assess equipment and facility envelopes for repair and rehabilitation needs. The most current information available on climate change scenarios and sea level rise has been and will continue to be incorporated into design and construction contracts to ensure hardening against potential impacts.

Limitations/Current Challenges: Upon completion of MWRA's site-specific vulnerability assessment, 16 facilities were determined to be within the most recent 100-year flood elevation as set by the Federal Emergency Management Agency (FEMA) when 2.5 feet

of sea level rise were added to the analyses. This benchmark appears to provide protection to a little beyond 2070 even for the highest CO₂ emissions scenarios, and staff are using it as an appropriately conservative measure of vulnerability, addressing issues of both storm intensity and sea level rise. MWRA will continue to monitor the evolving science and consensus on sea level rise and change benchmarks as appropriate.

Potential Future Directions: Where major rehabilitation is not occurring in the short-term, staff have identified immediate needs for flood proofing improvements; short-term measures have already been made at ten of the highest priority facilities, and three additional sites are in the process of design or procurement of materials. Evaluations of the impact of climate change on the water supply system indicate that MWRA's safe yield will likely increase slightly, while many neighboring communities will see reductions in reliability due to the more variable future precipitation patterns. MWRA will be able to provide both emergency and regular supply to more surrounding communities in the future.

■ Mayor's Office of Resilience and Racial Equity (MORRE)²

Purpose/Mission: The Mayor's Office of Resilience and Racial Equity (MORRE) works to develop and implement Boston's Resilience Strategy, which plans for and deals with catastrophes and slow-moving disasters.

Climate Change Role: Initially funded by a Rockefeller Foundation grant as a part of the 100 Resilient Cities initiative, Boston had a pioneering focus on social and economic resilience to address historic and persistent divisions of race and class.

Limitations/Current Challenges: As a cross-cutting, MORRE must rely upon coordinating initiatives, capabilities, and capacities from other cabinets and departments.

Potential Future Directions: MORRE's strategy is a transformative, healing journey to ensure all of us have access and support

to thrive from childhood to retirement in our daily lives and during major emergencies.

■ Neighborhood of Affordable Housing (NOAH)

Purpose/Mission: Neighborhood of Affordable Housing (NOAH), is an East Boston-based community development corporation structured to collaborate with and support residents and communities in their pursuit of affordable housing strategies, environmental justice, community planning, leadership development, and economic development opportunities. NOAH eagerly partners with those residents, neighborhood entities, municipalities or groups that share similar values and goals in order to improve standards of living, build community, and create social/economic opportunities, especially for low and moderate-income persons, families and disadvantaged groups or areas. NOAH's goals and programs are built on a commitment to equality, fairness, diversity and respect for all people.

Climate Change Role: NOAH is helping make the community more resilient to climate change. Over the last three years, it has established ClimateCARE—an initiative with three main elements: a) strengthening and expanding community engagement, b) partnering with the City of Boston to develop effective programs and models for selected elements of the Climate Action Plan, and c) convening and facilitation of an Adaptation Planning Working Group—a consortium of community delegates and state and city agencies with assets in East Boston.

Limitations/Current Challenges: Socio-demographic characteristics, geographic, and language characteristics, together with social isolation, and high poverty rates make it challenging for local residents to participate in civic engagement efforts to become more resilient. In addition, for those who are able to prioritize such engagement, resources and information are not always accessible—whether because the information is only in English, is highly technical, or because a

service requires interacting with governmental bodies that residents do not trust.

Potential Future Directions: NOAH's ClimateCARE program has enabled a culture change for East Boston toward a new urban environmentalism, with deep and broad engagement, so that that people are taking action, engaging in climate conversations, and using their power—individually and collectively—to increase their climate resilience. NOAH has had the extraordinary opportunity to work closely with the Mayor and the City of Boston to protect the physical assets and human capital of our vulnerable neighborhood. NOAH is currently looking at expanding its leadership development and, therefore resilience, through analysis of social cohesion.

■ Watershed Associations (e.g. Mystic River Watershed Association, MyRWA)

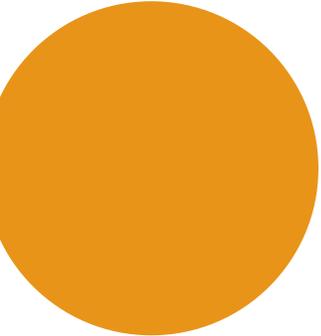
Purpose/Mission: There are three major regional watershed associations affiliated with the Charles, Mystic, and Neponset Rivers. For example, the Mystic River Watershed Association (MyRWA) was founded in 1972 to protect and restore the Mystic River, its tributaries and watershed lands for the benefit of present and future generations and to celebrate the value, importance and great beauty of these natural resources. The 22-community Mystic River Watershed flows to Boston Harbor from Woburn through Revere.

Climate Change Role: The Mystic is facing significant climate-related challenges: coastal and stormwater flooding, extreme storms, heat, and drought. The watershed is relatively

low-lying and extensively developed, making it prone to both freshwater and coastal flooding. Its 22 communities are home to major commercial areas and a half-million residents, including many who are disproportionately vulnerable to extreme weather due to health, language, and/or economic limitations. As a watershed association with nearly a half-century of work in the Mystic, MyRWA has long focused on regional strategies to improve water quality, riparian habitat, and access to a clean, healthy, beautiful river. In recent years, its mission has evolved to include enhancing and connecting waterfront parks and decreasing risk of harm from flooding, heat and drought.

Limitations/Current Challenges: New England states lack the strong county governance and finance structures that other regions of the country rely on for regional initiatives. Massachusetts' "Home Rule" regulations strictly limit municipalities' abilities to raise and pool local revenues.

Potential Future Directions: As climate change increases the risk of flooding and drought, Greater Boston communities are increasingly aware of the limitations of trying to manage risks within municipal boundaries. Mystic River Watershed communities will need to collaborate to protect key regional assets and avoid spending more money for less-effective, less-equitable strategies. MyRWA is in the process of launching a regional coalition focused on implementing climate resilience projects of regional importance to Mystic River communities.



APPENDIX B

TOOL BOX REFERENCES

This report refers to many different laws, ordinances, regulations, policies, and plans that make up our governance tool box. Below are links to learn more about them and, in some cases, read them in their entirety. Some of the tools mentioned in the report are not publically available or are in formation and, as a result, are not listed below.

LOCAL GOVERNMENT

[Zoning Code](#)
[Article 80 Development Review and Approval](#)
[Article 25 Flood Hazard Districts](#)

Policies

[Article 37 Climate Change Preparedness and Resiliency Policy](#)

Plans

[Imagine Boston 2030](#)
[Climate Ready Boston](#)
[Municipal Harbor Plans](#)
[Resilient Boston: An Equitable and Connected City](#)

Regional Governance

[Charles River Watershed Association—Climate Change Adaptation](#)
[Mystic River Watershed Association](#)
[Neponset River Watershed Association](#)
[Massachusetts Port Authority Floodproofing Design Guide](#)
[Metropolitan Area Planning Commission \(MAPC\) Regional Climate Change Strategy](#)

STATE GOVERNMENT

Laws

[Chapter 91, The Massachusetts Public Waterfront Act Wetlands Protection Act](#)
[Executive Order No. 569, “Establishing an Integrated Climate Change Strategy for the Commonwealth”](#)
[Environmental Bond Bill, “An Act Promoting Climate Change Adaptation, Environmental and Natural Resource Protection, and Investment in Recreational Assets and Opportunity”](#)

Policies

[The Massachusetts Environmental Policy Act—Draft Climate Change Adaptation and Resiliency Policy](#)

Regulations

[The Massachusetts Building Code](#)

Plans

[Commonwealth of Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan \(SHMCAP\)](#)

FEDERAL GOVERNMENT

Laws

[Rivers and Harbors Act—Section 10](#)
[Clean Water Act—Section 404](#)
[National Flood Insurance Act](#)

Policies

[US Army Corps of Engineers Procedures to Evaluate Sea Level Change: Impacts, Responses and Adaptation \(Engineer Technical Letter No. 1100-2-1\)](#)

APPENDIX C

ACRONYMS

ABC	A Better City	FROD	Flood Resilience Overlay District
ADA	Americans with Disabilities Act	GOSR	New York Governor's Office of Storm Recovery
BBRS	Board of Building Regulation and Standards	GRC	Boston Green Ribbon Commission
BFE	Base Flood Elevation	GWSA	Massachusetts Global Warming Solutions Act
BH-FRM	Boston Harbor Flood Risk Model	ICC	Infrastructure Coordination Committee
BPDA	Boston Planning and Development Agency	IGBC	Interagency Green Building Committee
BPHC	Boston Public Health Commission	IPCC	Intergovernmental Panel on Climate Change
BTB	Boston Transportation Department	ISD	City of Boston Inspectional Services Department
BWSC	Boston Water and Sewer Commission	LSCSF	Land Subject to Coastal Storm Flowage
CLF	Conservation Law Foundation	MGL	Massachusetts General Law
CMR	Code of Massachusetts Regulations	MAPC	Metropolitan Area Planning Council
CRB	Climate Ready Boston	MEMA	Massachusetts Emergency Management Agency
CRWA	Charles River Watershed Association	MEPA	Massachusetts Environmental Policy Act
CSO	Combined Sewer Overflows	MHP	Municipal Harbor Plan
CWA	Clean Water Act	MHW	Mean High Water
CZM	Massachusetts Office of Coastal Zone Management	MORRE	Mayor's Office of Resilience and Racial Equity
DCR	Massachusetts Department of Conservation and Recreation	MOU	Memorandum of Understanding
DEP	Massachusetts Department of Environmental Protection (also known as MassDEP)	MSSP	San Francisco's Mandatory Soft Story Retrofit Program
DOA	Determination of Applicability	MVP	Municipal Vulnerability Preparedness Program
DoD	Department of Defense	MWRA	Massachusetts Water Resources Authority
DPA	Designated Port Area	MyRWA	Mystic River Watershed Association
DPW	Department of Public Works	Nep-WRA	Neponset River Watershed Association
EEA	Massachusetts Executive Office of Energy and Environmental Affairs	NFIP	National Flood Insurance Program
EEOS	City of Boston Environment Energy and Open Space Cabinet	NOAH	Neighborhood of Affordable Housing
EIR	Environmental Impact Reports	OOC	Order of Conditions
ENF	Environmental Notification Forms	ORAD	Order of Resource Area Delineation
EO	Executive Order	OSD	Office of the Secretary of Defense
EOPSS	Massachusetts Executive Office of Public Safety and Security	RFP	Request for Proposals
ETL	Engineer Technical Letter	ROI	Return on Investment
FAR	Floor Area Ratio	SFHA	Special Flood Hazard Area
FEMA	Federal Emergency Management Agency	SHMCAP	Commonwealth of Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan
FFE	Finish Floor Elevation	SLR-DFE	Sea Level Rise Design Flood Elevation
FIRM	Flood Insurance Rate Map	SLR-FHA	Sea Level Rise Flood Hazard Area
FPA	Facilities of Public Accommodation	USACE	United States Army Corps of Engineers
		WPA	Wetlands Protection Act
		WYO	"Write Your Own" Insurance company
		ZBA	Zoning Board of Appeal

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