Wharf District Council

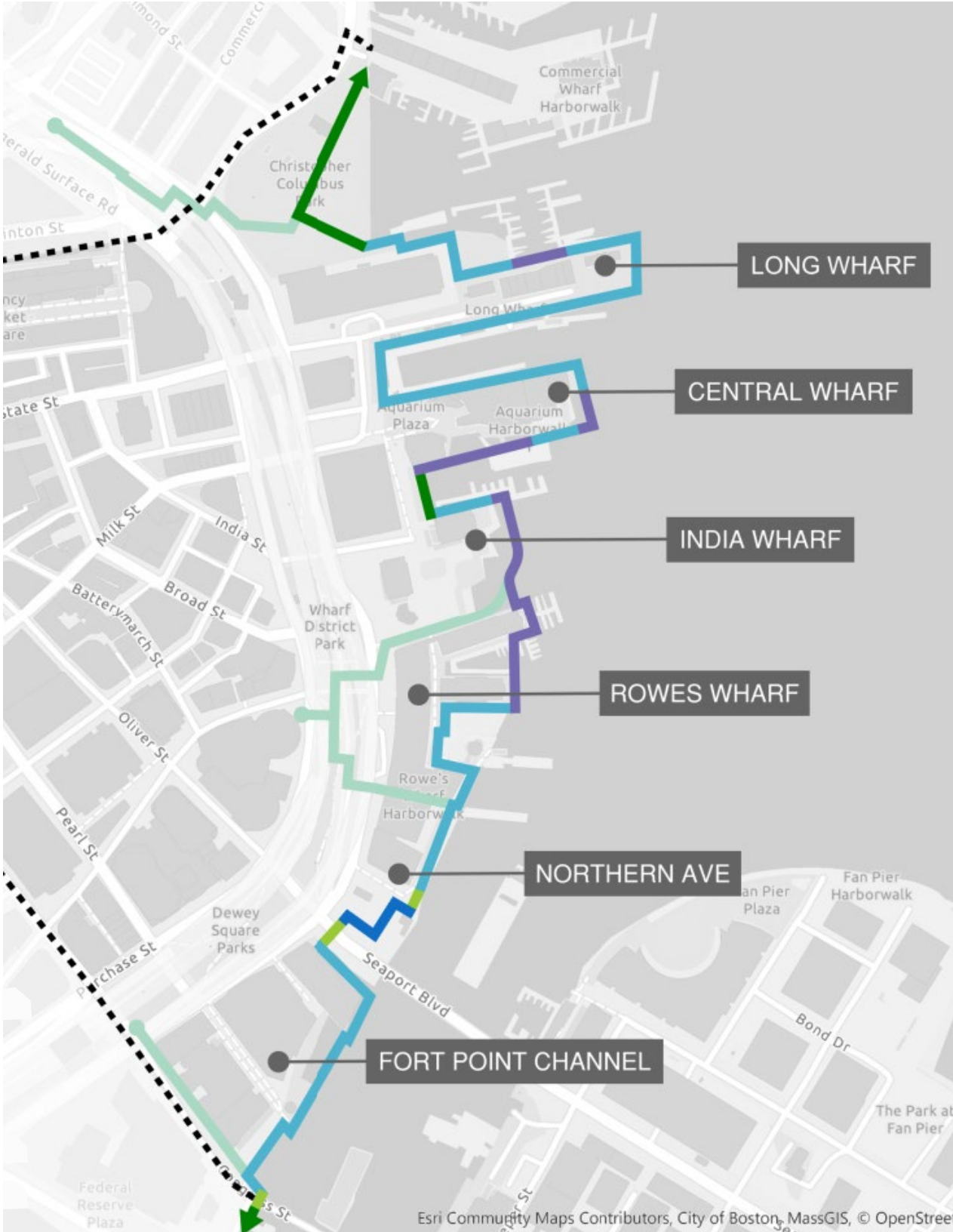
Neighborhood Resiliency Project Handbook

Guidelines to help communities organize & lead neighborhood-scale flood protection projects

May 2025

ARUP

WHARF DISTRICT COUNCIL
BOSTON



Intent of the Handbook

This Neighborhood Resiliency Project Handbook aims to serve as a step-by-step guideline of best practices for waterfront communities interested in creating, influencing, accelerating, or building consensus for resiliency plans to protect their neighborhoods from flooding. It also demonstrates the effectiveness of establishing a public-private partnership to work together to develop the critical information necessary for city, state, and federal entities to make decisions and establish programs necessary to protect a community.

Part 1 and **Part 2** of this handbook provide detailed strategies and frameworks for local community advocacy organizations, non-profits, and citizens to lead and build support for neighborhood-scale resiliency projects in their own communities. **Part 3** provides recommendations for public agencies interested in facilitating the creation of such community-led resilience initiatives.

This handbook provides a comprehensive summary of key insights and lessons learned from the development of the Wharf District Council's 2023 Climate Resiliency Plan, which represents a uniquely successful exercise in generating a shared vision amongst stakeholders and community members for a district-wide protection and resiliency plan.

By preparing this handbook, we hope to support and foster the propagation of similar community-led approaches, encouraging local organizations and citizens to accelerate and complement broader efforts to make communities more resilient.

Acknowledgements

The Wharf District Council wishes to acknowledge and thank the many individuals and organizations who contributed their support and time to developing and to continuing to advocate for the district's resiliency plan.

The Wharf District Council thanks the numerous City of Boston individuals for their time and attention throughout the project.

The Wharf District Council would also like to thank the Commonwealth of Massachusetts for their continued generous support.

The Wharf District Council's resiliency plan and this handbook would not have been possible without the neighborhood's many volunteered hours, shared knowledge, and financial support.

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About the Wharf District

The guidance in this handbook is based on the lessons learned from the Wharf District Council's experience developing a public-private partnership, leading a neighborhood flood protection project, and building support within their community.

As communities consider delivering their own neighborhood flood resiliency projects, they must take into consideration the similarities and differences between those neighborhoods and the Wharf District.

The Wharf District is a historical waterfront neighborhood with a vibrant mix of businesses, hotels and restaurants along with residential buildings & non-profits such as the Rose Kennedy Greenway & New England Aquarium. Contextual information about the Wharf District's major land uses and infrastructure is provided in **Figure 1**. An overview of the Wharf District Council's flood protection project is provided in **Part 2** of the handbook.

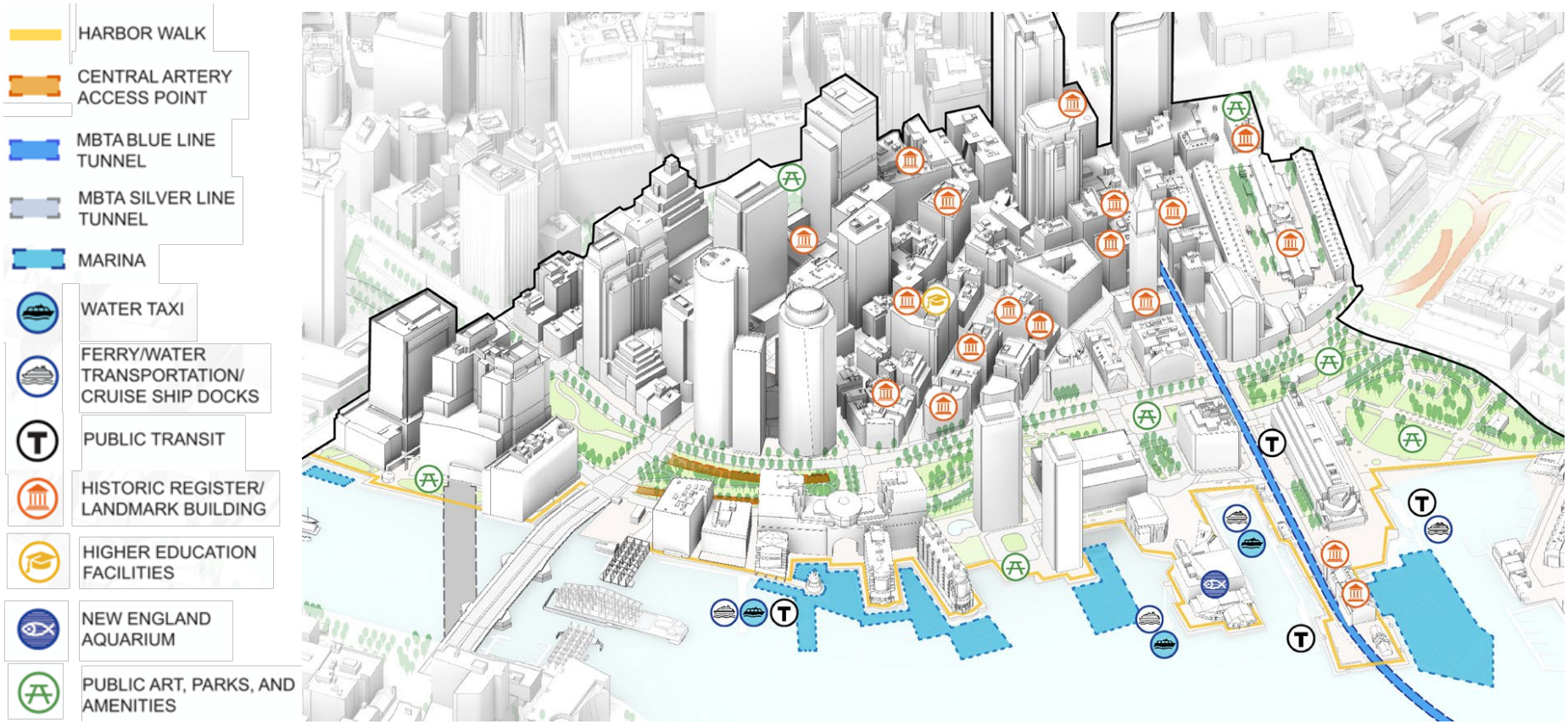

Figure 1. The Wharf District

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Part 1: Guidelines for Leading a Neighborhood Resiliency Project

Part 1.1 – Setting up the Project

This section outlines recommended steps, summarized in **Figure 2**, for communities to consider when setting up a neighborhood resiliency project.

Guiding questions and recommendations are provided to help communities identify key considerations for:

- deciding if a community-led project would be productive;
- establishing a project leadership team;
- setting goals and defining key tasks;
- securing financial and technical resources.

Lessons learned from the Wharf District Council's project are also included as narratives throughout this section to provide additional context for communities to consider as they set up their own projects.

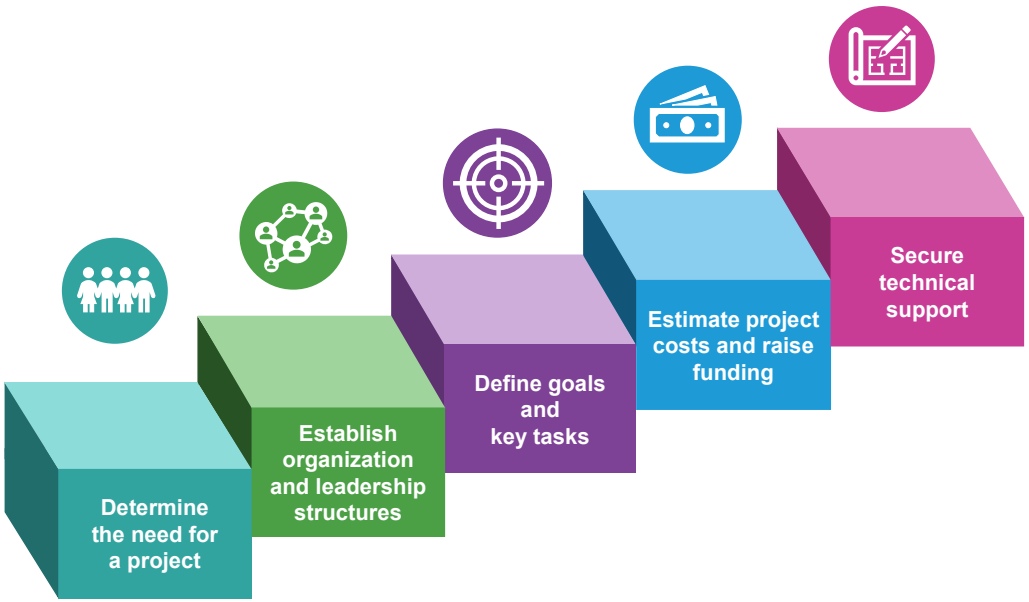


Figure 2. Setting up the Project

Step 1: Determine the need for a community-led project

Determine the Need for a Community-Led Project

Answering the following questions can help determine if a community-led resiliency project would be productive in advancing a neighborhood's resiliency planning:

- Is a city, state, or federal public agency currently leading resiliency planning efforts, and if so, do they want or need community support?
- Are government resources sufficient to adequately tackle a community's climate risk within an appropriate timeframe?
- What support can residents, businesses, non-profit groups, and other private sector stakeholders in the community provide to existing public agency resiliency planning efforts?
- Would the community like to propose an alternative plan not currently being considered by public agencies, or advocate for design and implementation of a plan that respects neighborhood-specific context?
- Will the construction of flood protection systems require private property owner support?

Figure 3. Determining The Need for the Project

Would a community-led resiliency project be helpful?

Not every neighborhood needs a community-led resilience planning project. For some places, governmental and community leadership may be one and the same.

However, in larger urban areas, sub-districts like the Wharf District can greatly benefit from localized consensus.

Some communities may also not have governmental leadership involved in climate resilience planning, or those governmental entities may lack the resources to advance resiliency planning for all its neighborhoods simultaneously.

Be aware that not all property owners are willing to share their development plans and engineering reports with the public or public agencies, and they have no obligation to do so. A community-led initiative is in a position to provide confidentiality for these property owners by creating a secure data repository for privately-held plans and information that are useful for developing a resiliency plan.

What other benefits can a community-led project provide?

Another advantage of a community-led partnership is the ability to work in concert as a group on legal issues of common concern.

For example, conducting field investigations and building flood protection systems on private property requires access agreements between the investigating entity and each property owner. Negotiating individual legal agreements with each property owner can be expensive and time consuming. The community-led partnership can develop a standard access agreement that all the members can accept, that can shorten the time required to get planning underway.

Another important role a local partnership can play is to help identify existing regulations that apply to their district and engage with the agencies having jurisdiction.

In Massachusetts, current environmental protections were not necessarily established with climate resilience in mind and are often antithetical to it, particularly for densely developed urban areas. A vital role is identifying if regulatory or legislative changes are needed to protect a community from flooding and how to influence those in positions of power to enact those changes.

Step 2: Identify or establish a 501(c)(3) organization and project leadership structure.

Identify or Establish a 501(c)(3) Organization and Project Leadership Structure

Consider the following when determining how to lead and fund the project:

- Does a representative organization for the neighborhood already exist?
- Who in the community might be willing to help create or lead a representative organization?
- Will public or private funds need to be raised to deliver the project?
- Are there engineering, landscape design, and permitting experts in the community who might be willing to provide support?
- Who in the community can help cultivate relationships and build influence with key stakeholders, such as private property owners, public agencies, and government representatives?

Figure 4. Establishing an Organization and Leadership Structure

Who should be involved in leading the project?

In addition to the many essential engineering, permitting, funding, and myriad other issues that must be addressed to develop a community's climate resilience plan, **the question of stakeholder involvement in the project is paramount.**

If a neighborhood already has a representative organization willing and able to spearhead the conversation about how best to develop consensus around a climate resilience plan, that is likely ideal.

Many neighborhoods do not have such an entity in place, in which case the challenge becomes how to best create such an entity. While local real estate developers may have both the capacity and incentive to be the organizers, often there is a perception of conflict of interest that may work to the disadvantage of their leadership. Governmental agencies can serve as conveners, but they may be bound by existing regulatory structures, limiting their capacity to meet the community's aspirational goals.

Ideally, a group of concerned citizens would coalesce around the idea of creating a resiliency plan that feels less constrained by existing property lines, out-of-date regulations, or funding hurdles.

This group would move forward to form an independent public-private partnership. This is one structure that has the capacity to elicit feedback from multiple sources, share confidential information about existing conditions, and hire engineering support without the constraints of public processes and procurement policies.

How should the project's leadership be organized and funded?

A 501(c)(3) establishes a framework for leadership, in that it requires officers who presumably become the leaders and managers of the resilience planning effort.

The roles of officers for the project should be clearly defined, and should primarily include:

- scheduling community meetings;
- establishing and managing funding;
- identifying stakeholders and government support;
- advocating for an inclusive process.

With a clear definition of the leaders' roles, it becomes easier to recruit people who have the interest without intimidating them with an unlimited time commitment.

Establishing funding sources is also essential. Most resilience plans will require some level of engineering or landscape design. **Formation of a 501(c)(3) is inexpensive and simple, and provides a format for collecting and disbursing money to fund the project**.

501(c)(3) Nonprofit

A 501(c)(3) nonprofit is an organization the IRS recognizes as tax-exempt (excused from paying federal income and unemployment taxes) because it is organized or operated primarily for religious, charitable, scientific, educational, or similar purposes. **These organizations are eligible to receive government and private grants to help with funding and to further their mission**.

Figure 5. Benefits of Establishing a 501(c)(3)

With a 501(c)(3) established, funding to deliver the project can be secured by applying for public and private grants. City and State representatives may also be helpful in identifying potential funding sources.

It is also helpful to discuss the benefits of the project with the property owners most affected by climate hazards, who may be convinced to contribute to the new non-profit. It is often the case that having a financial stake in the effort will also increase the likelihood of their meaningful involvement.

Private property owners may find the following reasons to participate and financially contribute to the project compelling:

- Once constructed, the project will reduce flood risks to their property and may help avoid increased costs of flood insurance.
- They will be empowered to decide if and how neighborhood flood protection systems will impact their property.
- The project can identify opportunities to reduce their own costs to protect their property from flooding.
- The project will develop engineering analyses that can inform their own resiliency efforts.
- A neighborhood-wide plan will give them confidence that their own resiliency efforts are aligned with those of their neighbors.

Once a 501(c)(3) is funded and a leadership structure is established, a broader discussion can get underway about both how vulnerable the community is to climate risks, and what the appetite is for broader engagement.

Step 3: Define project goals and key tasks

Define Project Goals and Key Tasks

Steps to defining project goals and tasks:

1. Establish goals and desired outcomes of the project
2. Identify roles and responsibilities for individuals or groups assisting with the project delivery
3. Outline tasks necessary to achieve the project's objectives

Figure 6. Defining Project Goals and Tasks

What should be considered when establishing project objectives & goals?

Perhaps the most important starting point is the definition of objectives. For example, preventing flooding may be the sole intent, but does everyone agree that is sufficient? Are there associated opportunities that should also be pursued?

Each community will have its own objectives for a resilience endeavor, and for it to succeed they must be clearly stated in quantifiable terms and be supported by the community.

The Evaluation Criteria matrix provided in **Part 2** of this handbook was the result of extensive discussion and introspection and is offered as a way to jump-start the development of a project's goals, and to offer an approach to evaluating options.

One advantage to this strategy is that it separates the question of "cost" from the question of "value". A low-cost solution that is ineffective or unadaptable to future plans may not provide the highest value, and that becomes clear using this method.

Is the project setting out to directly construct a flood protection system, or to provide advice and advocacy to support those who will?

Another component to the definition of goals is identification of responsibilities for project design, funding, ownership, construction, and operations.

If a community-led group is to lead the full spectrum of work through final design and construction, its goals and approach to project tasks will be different than if it has only an advisory and advocacy role – which may conclude with the development of a conceptual plan and building support within the community and key stakeholders.

It will be important to consider what other partners will be needed along the way – from agencies to neighbors to non-profits. It will also be critical to consider how residents, businesses, institutions, and governmental agencies can be best engaged, and by whom.

What are the typical tasks for a resiliency project?

Once the project's objectives and roles are established, it will be helpful to develop an outline of major tasks the project will need to undertake to achieve those objectives. Typical flood resiliency projects will likely include the tasks described in **Figure 7**.

It will be important that these tasks be set up to entertain ALL options and their consequences, including doing nothing. **A community-led process that is honest, transparent, inclusive, and open-minded is key to success.**

Figure 7. Typical Neighborhood Resilience Project Tasks

Step 4: Estimate project delivery costs and raise funding

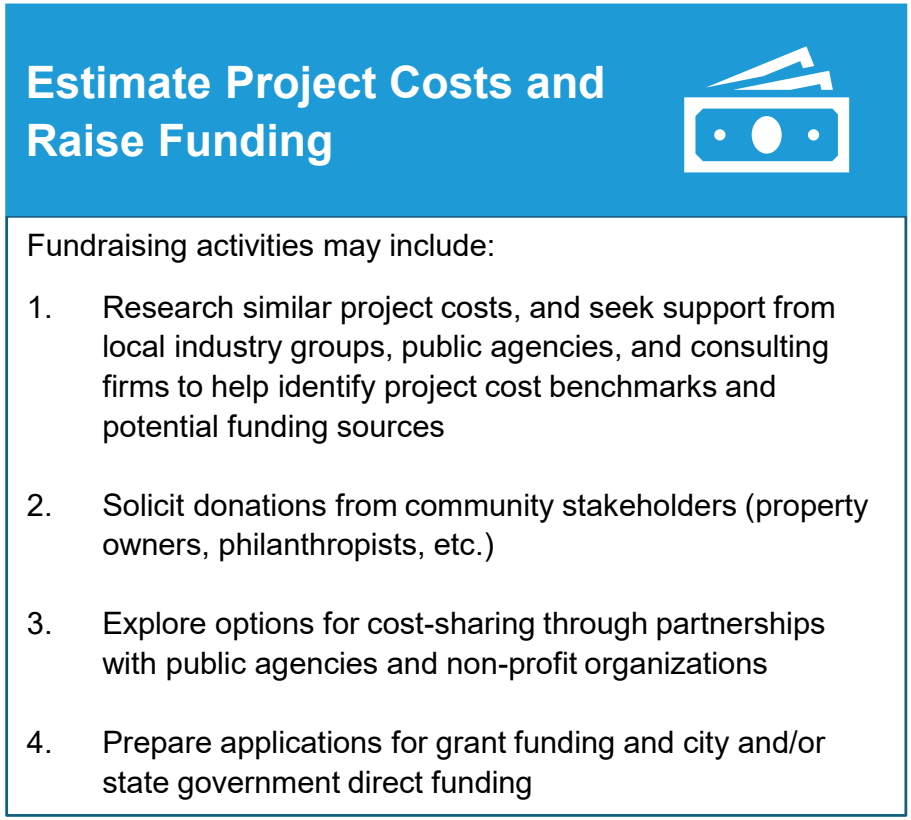


Figure 8. Estimating Costs and Raising Funds

The WDC Climate Resilience Task Force received funding via two sources: contributions from most (not all) of the waterfront property owners, and grants from the Commonwealth of Massachusetts. The latter, “earmarked” for climate resilience planning/design, were invaluable to the effort.

The bulk of the engineering design, stakeholder engagement, and documentation of the plan occurred within the first two years of the project, and cost approximately $500,000. At the time, there did not seem to be precedents for this kind of community-lead climate study, so many of the processes needed to be invented (and herein shared).

The WDC hopes that much of that work can be leveraged by other communities to reduce their costs. In fact, the North End/Waterfront Climate Alliance has recently undertaken a similar project for Boston's North End, leveraging the work of the WDC resiliency project to more cost effectively deliver their project after raising $250,000.

Step 5: Secure technical support to deliver the project

Secure Technical Support to Deliver the Project

Steps for obtaining technical support:

1. Prepare a Request for Proposals (RFP) for engineering, permitting, and stakeholder engagement professional services to deliver the project
2. Seek support from local industry groups, public agencies, and consulting firms to review and refine the RFP
3. Issue RFP, and interview and hire a professional consultant

Figure 9. Securing Technical Support

One advantage of a public-private partnership is the ability to raise private money and to engage technical support within an established budget. A public RFP process has its place but has the disadvantage of limited flexibility in negotiating the scope of work to suit available funding.

The WDC was able to get voluntary contributions toward its 501(c)(3), but even then had to work with its chosen engineering firm, ARUP, to tailor the approach and scope to suit the funding limitations. As the project progressed, some tasks were eliminated in favor of extending the scope of others, and additional tasks were added to address previously unanticipated requirements.

Choosing a firm with the technical capacity and local experience is essential to successful and speedy delivery of a resilience plan. The ability to benchmark the approach against other, similar projects is key to credibility.

The WDC hopes that the investment made in its project will accrue to the benefit of other communities, who are all welcome to use any part of its documentation to aid with their effort. Ultimately there will have been enough separate technical analyses such that starting from scratch each time will be unnecessary; building upon what everyone learns along the way will help us all. There will eventually be a wealth of technical expertise, and the design process will be swifter and less costly.

Part 1.2 – Delivering the Project

Once a neighborhood resiliency project is set up, the next step is delivering the project. This section provides a step-by-step approach for delivering a resiliency project based on our lessons learned delivering the Wharf District Council resiliency project, and is intended to help communities efficiently develop flood resiliency designs and gain the support of key stakeholders.

Steps are laid out in a recommended sequential order, indicated in **Figure 10**, to demonstrate how stakeholder and community input is intentionally integrated throughout the entire process with a goal of establishing trust and support for both the process and the final plans.

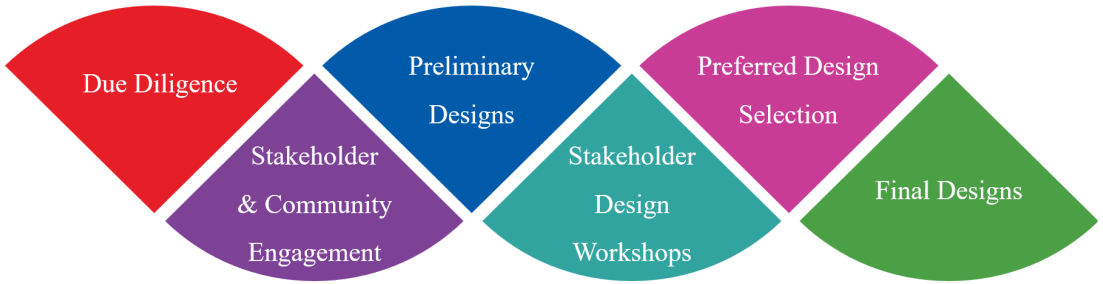


Figure 10. Delivering the Project

Step 1: Due Diligence Assessment

1. Establish a confidential data repository to provide confidence to private property owners that sensitive information, such as proposed site plans, will not be shared. Consider limiting access to the repository to individuals that property owners can trust with sensitive information (such as the design consultant), and restricting the project's leadership team from accessing the data repository. This may require establishing confidentiality agreements between the design consultant and property owners.
2. Collect, catalogue, and review existing conditions data, property data, prior planning, technical and regulatory information, and access considerations.
3. Identify the level of protection the flood resiliency system needs to provide to meet the project's goals. The elevation of flooding a resiliency system needs to protect against is referred to as a Design Flood Elevation (DFE). Coordinate with public agencies to ensure consistency between the project's DFE and any public resiliency planning efforts.
4. Identify a range of potential flood adaptation strategies to study.
5. Conduct site visits to all properties potentially impacted by the flood protection system to observe and document existing conditions and key considerations for assessing and designing the flood adaptation strategies.
6. Develop a preliminary set of Evaluation Criteria for ranking and prioritizing resiliency strategies. Refer to Part 2 for a set of recommended Evaluation Criteria.

7. Perform a preliminary regulatory analysis and identify permitting obligations that may influence decisions on specific design approaches for individual properties.
8. Document relevant information, assumptions, and findings of the due diligence assessment in a Basis of Design document.

Figure 11. WDC Due Diligence Site Visit by Arup's Engineering Team

Step 2: Initial Stakeholder & Community Engagement

1. Meet with stakeholder groups (e.g. public stakeholders, private stakeholders, municipal planning and development agencies, city and state elected officials, and representatives from local community groups that may serve as social equity and inclusion stewards) to review project goals and key assumptions, identify stakeholders who should be included in the design process, and build consensus for using the preliminary Evaluation Criteria to rank and prioritize flood adaptation strategies.
2. Hold initial 'Discovery' Workshops with public and private property owners whose land would be impacted by the proposed resiliency plan to share knowledge of flood hazards, prior resiliency initiatives, site-specific considerations, priorities and preferences for design, and to build further support for using the preliminary Evaluation Criteria to rank and prioritize flood adaptation strategies. These workshops may be held individually with each property owner or may be a group workshop with multiple property owners.

Step 3: Preliminary Design Development

1. Develop a Multi-Criteria Assessment (MCA) approach based on the project's Evaluation Criteria to rank and prioritize the potential flood adaptation strategies. The MCA approach should screen out strategies that are unlikely to be implemented to focus on strategies that are most likely to be supported by the community and public agencies. This approach should vary to reflect the community's priorities, which may include issues associated with social equity, preservation of unique community characteristics, or environmental impacts. The Multi-Criteria Assessment should include an evaluation of relative costs, maintenance requirements, and impacts on public access and views, among other considerations necessary for informing the selection of a preferred strategy.
2. Use the MCA to rank potential strategies and prioritize those that provide the best balance of benefits and tradeoffs for the project's Evaluation Criteria.
3. Use the results of the MCA to inform the development of preliminary design plans for each property. The designs should also be informed by findings of the Due Diligence Assessment, input from Stakeholder Engagement activities, and applicable design guidelines and engineering best practices.

   Recommendations for preparing the preliminary designs include:

   a. Develop multiple alternative designs if the following scenarios apply:
      i. Where property owner preferences are unclear.
      ii. Where property owner preferences are likely to trigger a significant risk to eventual implementation (e.g. unlikely to receive permits, project costs exceeding anticipated value of losses associated with inaction, or likely government or community opposition).
      iii. Where property owner preferences may preclude abutting properties from protecting themselves.
   b. Identify alternative designs that do not require the property owner to take action (e.g. flood protection systems located outside of the property), enabling the property owner to decide if they want to participate in the project.

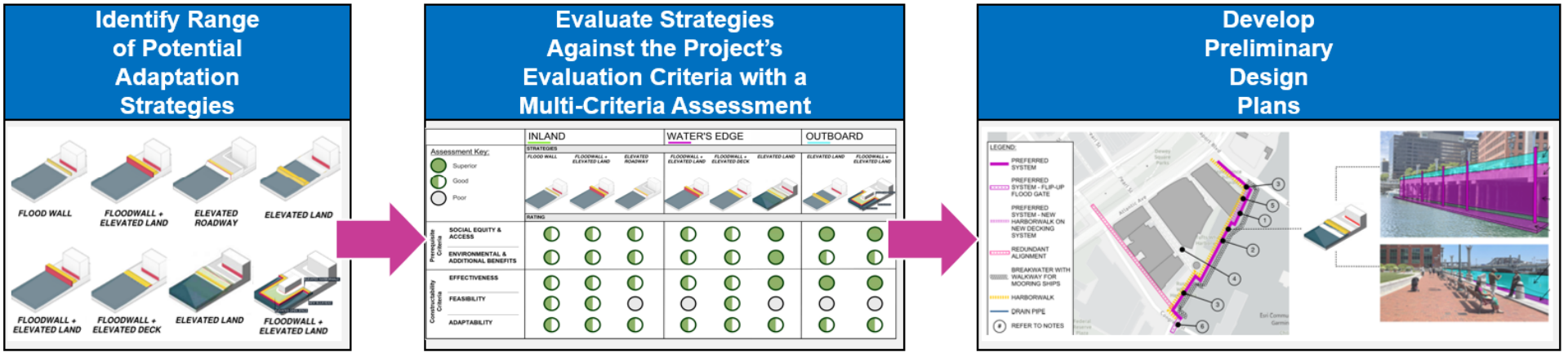


Figure 12. Using an MCA to Identify a Preferred Strategy for Inclusion in the Preliminary Design Plans

Step 4: Stakeholder Design Workshops

1. Review the preliminary design plans individually with each property owner. Project team attendees at these workshops should be limited to individuals that the property owners can trust with sensitive information. The workshops should be structured to:
    a. Discuss the preliminary design plans in the context of the project's Evaluation Criteria, clearly communicating why specific design strategies are recommended or omitted, and explaining the benefits and tradeoffs of the design (and alternative designs, if applicable).
    b. Enable the property owners to identify changes necessary to secure their support.
    c. Discuss considerations associated with not constructing any flood protection system on the property, such as:
        i. Flood risks to property in a 'do nothing' scenario.
        ii. Alternative designs that public agencies may undertake if the property owner is not interested in a flood protection system being built on their property.

Figure 13. WDC Community Engagement Workshop

Step 5: Preferred Design Selection & Development

1. Select and refine a single preferred design plan to advance to final design, reflecting input from the stakeholder engagement activities.
2. Where a preferred option would require regulatory modifications, such modifications should be identified and an alternative option, consistent with the existing regulatory framework, should also be selected to progress to final design.
3. Develop typical cross-sections of the designs.
4. Identify options to transition between properties, such that a continuous flood protection system spanning all properties in the project area can be provided.
5. Identify and assess permitting considerations for the design, considering the nature, jurisdiction, process and schedule of applicable permits, as well as identifying regulatory changes necessary to enable specific design approaches.
6. Develop a prioritized phased implementation timeline.
7. Perform a high-level cost effectiveness assessment to compare the project's potential costs (design, construction, and operations and maintenance costs) to its anticipated benefits (e.g. losses associated with flooding if no action is taken). If the project's documentation is to be used to apply for public grant funding, a comprehensive Benefit Cost Analysis, such as a FEMA-approved process, should be considered.

Step 6: Final Design

1. If an individual property's preferred design precludes an abutting property from implementing their own preferred design, meet with each property owner individually to identify shared goals, minimum requirements required for support, and potential opportunities to achieve the minimum requirements of each stakeholder. If consensus cannot be achieved, the project's leadership team should identify a solution that maximizes stakeholder support and meets the overarching project goals.
2. Meet with stakeholder groups (e.g. public stakeholders, private stakeholders, city and state elected officials, and representatives from local community groups that may serve as social equity and inclusion stewards) to seek feedback on the preferred designs.
3. Meet with regulatory agencies having jurisdiction to seek preliminary feedback and identify potential regulatory pathways.
4. Update the Preferred Designs based on feedback from stakeholder groups, regulatory agencies, and property owners, and request confirmation of support from each property owner.
5. Prepare final deliverables to communicate the plans to diverse groups of stakeholders.

Part 1.3 – Building Support

Once a plan is developed and endorsed by a neighborhood, building support with the broader community and entities responsible for implementation becomes the next, potentially final major step. In some cases, private property owners may be responsible for subsequent detailed design and construction of resilience work, but in many situations that responsibility falls to City, State, or Federal agencies, or a public-private partnership of multiple entities. Each may have its own prescribed policies, processes and procedures, and may not be in a position to simply adopt the locally preferred scheme. At that point, the community's goals should be:

1. Position itself to be a constructive part of the agencies' design processes, to advocate that the best parts of the community's plan be incorporated in the final design.
2. If both short- and longer-range plans are proposed, work to ensure the more immediate solutions are consistent with long-range objectives and resources are not wasted on them in a way that precludes the preferred design.
3. Help communicate the importance of becoming involved in resilience efforts to those who are not immediately affected by its impact. Large projects require funding from sources beyond those immediately affected (such as State matching of Federal funds) and those better protected must see the value TO THEM of ultimately needing to contribute their share. Helping legislators who already appreciate this dilemma explain this message to their constituents is a valuable support role the community can play. Informing legislators who don't yet appreciate the reason for everyone to be engaged and supportive of the necessary investments is also key.

WDC's Lessons Learned About Building Support

The value of stakeholder and community engagement:

Like any substantial change to a community's infrastructure, consensus and broad support is essential to a plan's acceptance. It is unlikely that the best approach is to develop a plan and then ask for endorsement without having had a conversation with a wide audience along the way. Ideally, everyone involved acknowledges that ALL of the relevant alternatives have been fully explored (including doing nothing) and that the option(s) selected represent the best of those alternatives. There will invariably be those who do not want to address climate change challenges; their voices need to be respected while identifying both the vulnerabilities and opportunities associated with any course of action.

Communicating risk:

It is unlikely that there will be much eagerness to spend the resources necessary for climate resilience, but the significantly higher cost of waiting for damage to be inflicted, repaired, and THEN creating the appropriate resilience must be made apparent. It is often difficult to quantify the regional cost to localized damage, but interruptions to business, transportation, tourism, infrastructure, emergency services, and residents can be substantial and even permanent.

It turns out that risk evaluation can be communicated differently with the same data. For example: engineering studies often identify the danger associated with a one percent storm, meaning the likelihood of a "100-year storm" in any one year. Real estate professionals on the WDC team

expressed their inability to elicit much concern over a one percent event. What failed to come across until expressed differently is that a one percent possibility, over twenty years, is more than an 18% likelihood. Insurance companies and investors are invariably concerned at a completely different level with an 18% possibility over the length of a property's ownership than with a 1% possibility. Same data, different implications.

Communicating benefits:

While a plan for resilience may address just the most straightforward concerns, there may also be an opportunity to transform the affected areas in a positive way. The Wharf District plan is intended to not only protect the area from sea level rise, heat islands, stormwater flooding, and tidal storm surges, but simultaneously provides an improved public realm. The vision was to protect Boston AND to transform the District's waterfront into a more inclusive, accessible harborwalk for everyone to enjoy its adjacency to the historic harbor's edge. Cities all over the world have modified their waterfront in ways that become regional and global tourist destinations. Those examples should provide inspiration for any community with aspirations for doing more than just the minimum protection necessary.

Figure 14. Wharf District Council CRTF Members Meeting with State Legislators to Discuss the District's Resiliency Plan

Helping everyone appreciate the opportunities an ambitious plan may offer has to be one of the communications and outreach objectives. The WDC created a series of renderings, provided in **Part 2** of this handbook, and a video intended to educate the public, bolstering support for the initiative, which is available on the WDC's website. The renderings are particularly useful in that they contrast existing with proposed conditions. Many come to accept existing conditions without unbiased scrutiny. Illustrating both strengths and weaknesses while contrasting the familiar with what is possible helps build enthusiasm for change and are far easier to digest than engineering diagrams and reports.

Anticipating and addressing objections:

In the quest to build support, all objections need to be anticipated and addressed. Some of those include concerns about property/leasehold ownership, existing regulations and agency objections, operations responsibilities and costs, short versus long-term plans, and consequences to unprotected properties adjacent to those that are protected. The answer to each of these questions will be unique to each community, but they can NOT be ignored or trivialized.

Part 2: Reference Materials from the Wharf District Council Resiliency Project

This section provides an overview of the Wharf District Council's project, and describes the successful approaches used by the WDC to create a project leadership structure and engage stakeholders in the design project.

This section also provides a summary of best practices and examples of the deliverables from the WDC project. **We hope this information will serve as useful precedents for other communities who wish to lead their own neighborhood resiliency projects.** Additional information about the Wharf District Council's Flood Resiliency project can be downloaded at: https://www.wharfdistrictcouncil.org/

Part 2.1 – Overview of the WDC Project

Flood hazards facing the Wharf District

On January 4, 2018, Winter Storm Grayson pushed the waters of Boston Harbor hundreds of feet inland into the Wharf District. Inundating State Street, Atlantic Avenue, and numerous properties, the storm surge caused millions of dollars in damages. Grayson also provided a clear indication of the magnitude of flood risk facing the Wharf District: the extents of flooding anticipated if a similar storm occurs in 2030 are indicated in **Figure 15**.

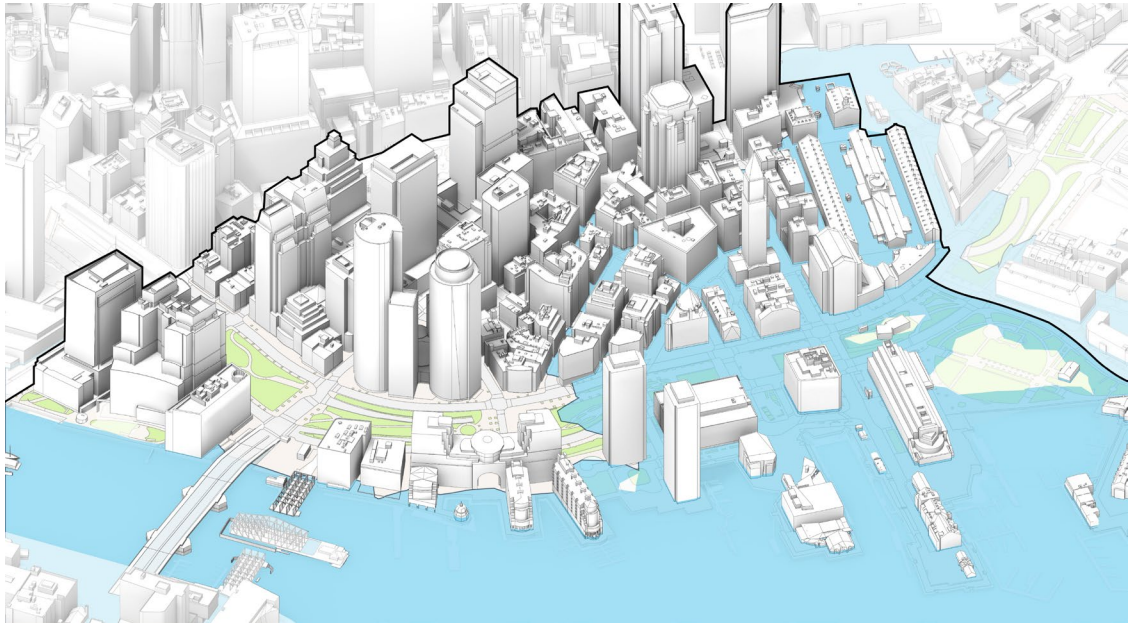


Figure 15. 2030 1% Flood Extents in the Wharf District

In concert with city, state, and federal agencies, and supported by engineering consultant Arup, the Wharf District Council engaged with property owners and community stakeholders to deliver a conceptual flood resiliency plan in 2023 that protects over 60 acres of land in the heart of Boston.

To our knowledge, **this was the first effort of this scale in the nation led by local community members to protect their community from flooding**.

The Wharf District Council also achieved a notable milestone in community engagement by securing the **unanimous support of all sixteen public and private property owners** whose land would be affected by the proposed resiliency plan.

Project Purpose

To prevent such flooding from impacting the community, the Wharf District Council set out to create an equitable and inclusive conceptual resiliency plan that:

i. defines an engineering approach that provides effective protection at 2070 sea levels;
ii. integrates and advances previous resiliency studies by the City of Boston and individual property owners;
iii. thoughtfully addresses connection points between properties to produce a connected barrier along the harbor's edge that protects the entire Wharf District, and which can be integrated into a larger city-scale flood protection system;
iv. identifies the costs, process and priority of actions and strategies for achieving those solutions.

The project aimed to define the engineering components of a preferred flood resiliency system along the Wharf District's waterfront and build support from the district's community.

The plan did not set out to prescribe the public realm land improvements of areas impacted by the proposed flood resiliency system. The project team worked from the assumption that the selection of surface materials and landscaping that would sit atop this engineered infrastructure would need to happen with subsequent community engagement and design, likely led by the City of Boston or Army Corps of Engineers**. The project therefore aimed to support meaningful conversations about what waterfront resilience, access, equity, and inclusion look like for reference by those subsequent resiliency and land improvement design efforts.**

Project Process

The project team consisted of the Wharf District Council Climate Resilience Task Force Management Team and an interdisciplinary consultant team led by engineering consultant Arup. The project approach centered the direct involvement of Wharf District stakeholders in the planning and design process, with a goal of developing a resiliency plan that would be broadly supported by the Wharf District Community. This process is illustrated in **Figure 16**, and included:

- *Task 1: Discovery & Due Diligence*
  A due diligence assessment was performed to collect, catalogue, and review prior planning, technical and regulatory information, and access considerations. Resiliency strategies previously developed by the City were updated to incorporate findings and stakeholder feedback.

- *Task 2: Stakeholder Outreach & Engagement*
  Wharf District stakeholders were engaged to: share knowledge of flood hazards, prior resiliency initiatives, and site-specific considerations; develop a set of Evaluation Criteria for ranking and prioritizing resiliency strategies; assess the impacts of the resiliency strategies; and identify preferred strategies.

- *Task 3: Resiliency System Conceptual Design*
  A preferred district-scale flood protection system was designed, along with resiliency guidelines for individual buildings, permitting considerations, cost estimates, a Cost Benefit Analysis, an implementation timeline, and a list of potential funding sources.

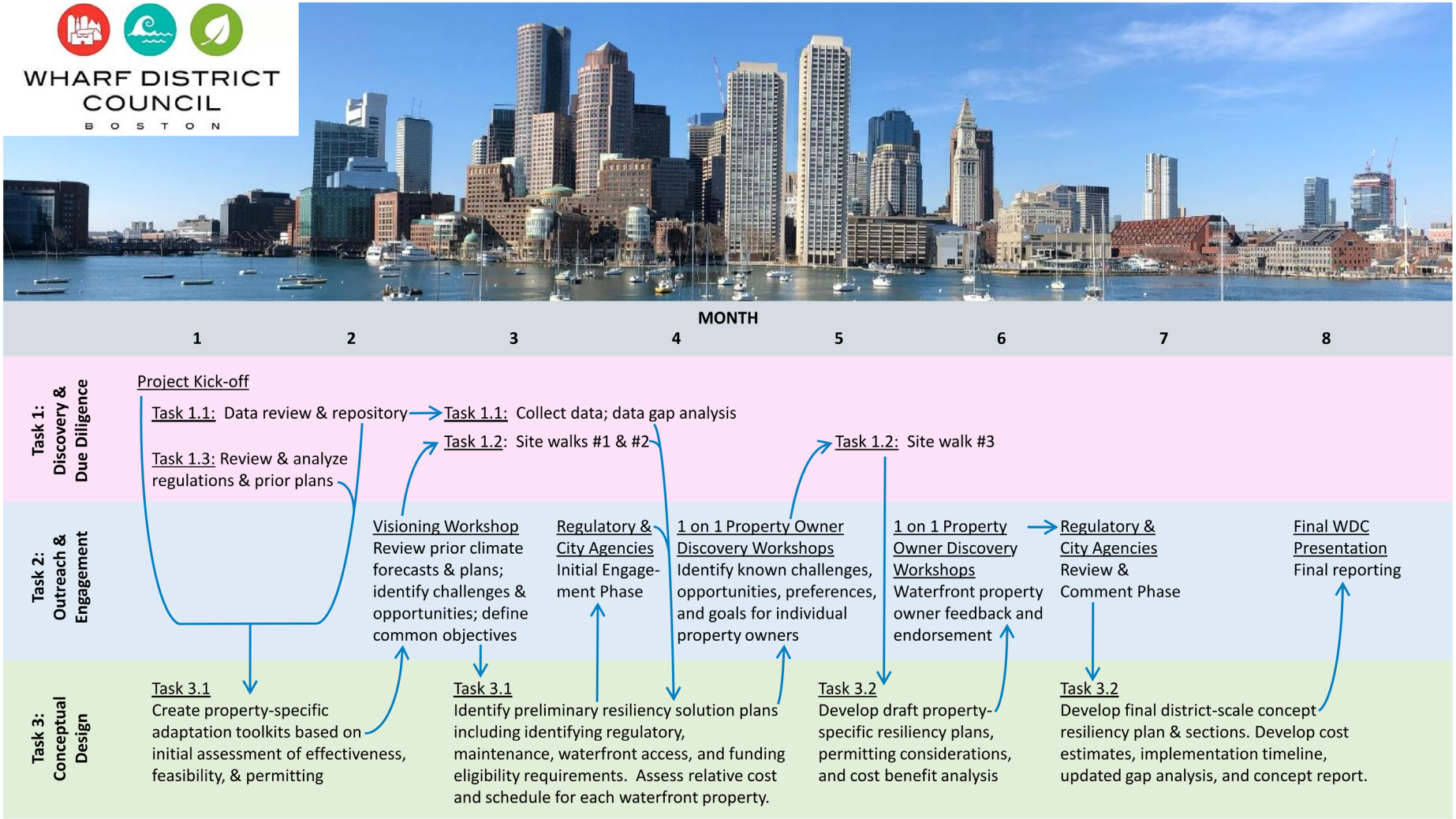


Figure 16. Wharf District Project Process: Task Chart Identifying Interconnections and Flow of Information Between Tasks

The Wharf District Flood Resiliency Plan

The Wharf District Council's flood resiliency plan defines a contiguous line of protection along the district's entire waterfront. This plan also creates three Resiliency Zones within the district to protect all Wharf District properties from flood pathways originating outside the district while mitigating wide-spread flood risks associated with single points of failure.

The flood protection system protects the Wharf District from flooding from the three major potential flood pathways of: (1) coastal storm surge, (2) extreme rainfall, and (3) rising groundwater.

The proposed flood protection system is illustrated in **Figure 17**, and consists of:

- Elevated seawalls and Harborwalks.
- New publicly accessible open spaces on elevated flood protection landforms.
- Flood walls.
- New living shorelines, flood protection islands, floating wetlands, and floating breakwaters designed to reduce wave heights and provide ecological benefits and protect water transportation and recreation.

Figure 17. Wharf District Council Proposed Flood Resiliency Plan

Part 2.2 – Project Leadership Organizational Framework

Nonprofit Organizational 501(c)(3) Structure

WHARF DISTRICT COUNCIL
BOSTON

The Wharf District Council (WDC) is a 501(c)(3) non-profit neighborhood organization, recognized by the Mayor's Office and the City of Boston as representing the community on matters relating to planning, development, construction, programming events, and transportation in the District. The Wharf District Council membership is made up of residents, hotels, non-profit institutions, small businesses and A Better City, representing the major businesses in the District. It serves as the neighborhood's voice in matters that require a community opinion and/or action.

By gaining recognition from the City as representing the Wharf District community, the WDC held the credibility needed to entice property owners and other stakeholders to participate in the WDC's resiliency project.

The WDC's non-profit status also makes it eligible to receive funding from the state and various grants which would not be available to community groups that are not organized as a 501(c)(3) organization. Waterfront property owners and the Commonwealth of Massachusetts provided funding to the WDC to develop their resiliency plan.

Climate Resilience Task Force (CRTF)

The Wharf District Council formed a public-private partnership called the WDC Climate Resilience Task Force (CRTF), chartered to create a conceptual district-scale flood resiliency plan for the Wharf District. The CRTF consisted of:

Figure 18. WDC Climate Resilience Task Force (CRTF)

The WDC Climate Resilience Task Force was responsible for identifying the goals of the project; developing bid documents to secure the services of an engineering consultant; and reviewing and commenting on project deliverables for consistency with community priorities.

Project Management Team

The Wharf District Council was fortunate to have many volunteers interested in joining the CRTF.

However, the CRTF determined that it would be most efficient to task a smaller subset of CRTF members with the day-to-day management of the WDC resiliency project. This group, named the CRTF Management Team, was responsible for tracking project progress, budget, and schedule, and for taking a proactive role in coordinating meetings between the engineering consultant and community stakeholders. The CRTF Management Team was also responsible for providing day-to-day direction as needed to the engineering consultant, and for engaging the larger CRTF and other stakeholders at appropriate stages of the project.

The CRTF Management Team consisted of:

- Wharf District Council Leadership
- Property Owners Within the District
- Representatives for Businesses in the District

Part 2.3 – Stakeholder Engagement Model

Given that a significant majority of the property required for constructing a flood protection system in the Wharf District is privately owned, gaining the support of those private property owners was identified as being critical to the success of the WDC's resiliency plan.

It was also important that the plan be supported by the City and have broad support within the local community, as portions of the flood protection system would be located on public land and the final design and construction of the project is expected to require the City's direct involvement. The WDC therefore adopted a model of stakeholder engagement, described in the following sections, that is particularly effective in building consensus across a diverse set of stakeholders.

Organizational Framework

The organizational structure used to deliver the project, illustrated in **Figure 19** enables property owners to select a preferred design for their properties from a set of design alternatives that each conformed to priorities established by key stakeholders and the broader community.

The roles and responsibilities of each group in this framework includes:

- The **CRTF Management Team**: responsible for encouraging stakeholders to participate in the project, scheduling meetings, supporting information gathering, and ensuring final deliverables meet the project's goals.
- A **Stakeholder Group:** responsible for identifying requirements necessary for gaining the support of the City and the community, providing guidance on project goals and stakeholder engagement, and commenting on final deliverables. This group includes the CRTF, representatives from local community groups that may serve as social equity stewards, public and private stakeholders, and city and elected officials.
- A **Technical Team:** engineers, permitting consultants, and engagement specialists responsible for developing design strategies that are consistent with the project's goals, leading stakeholder engagement, and developing materials to effectively communicate the plan.
- **Property Owners**: empowered to provide input on the project's Evaluation Criteria, comment on the design options, and select a preferred design for their own property. Property Owners are limited to the owners of land on which the flood protection system will be located.

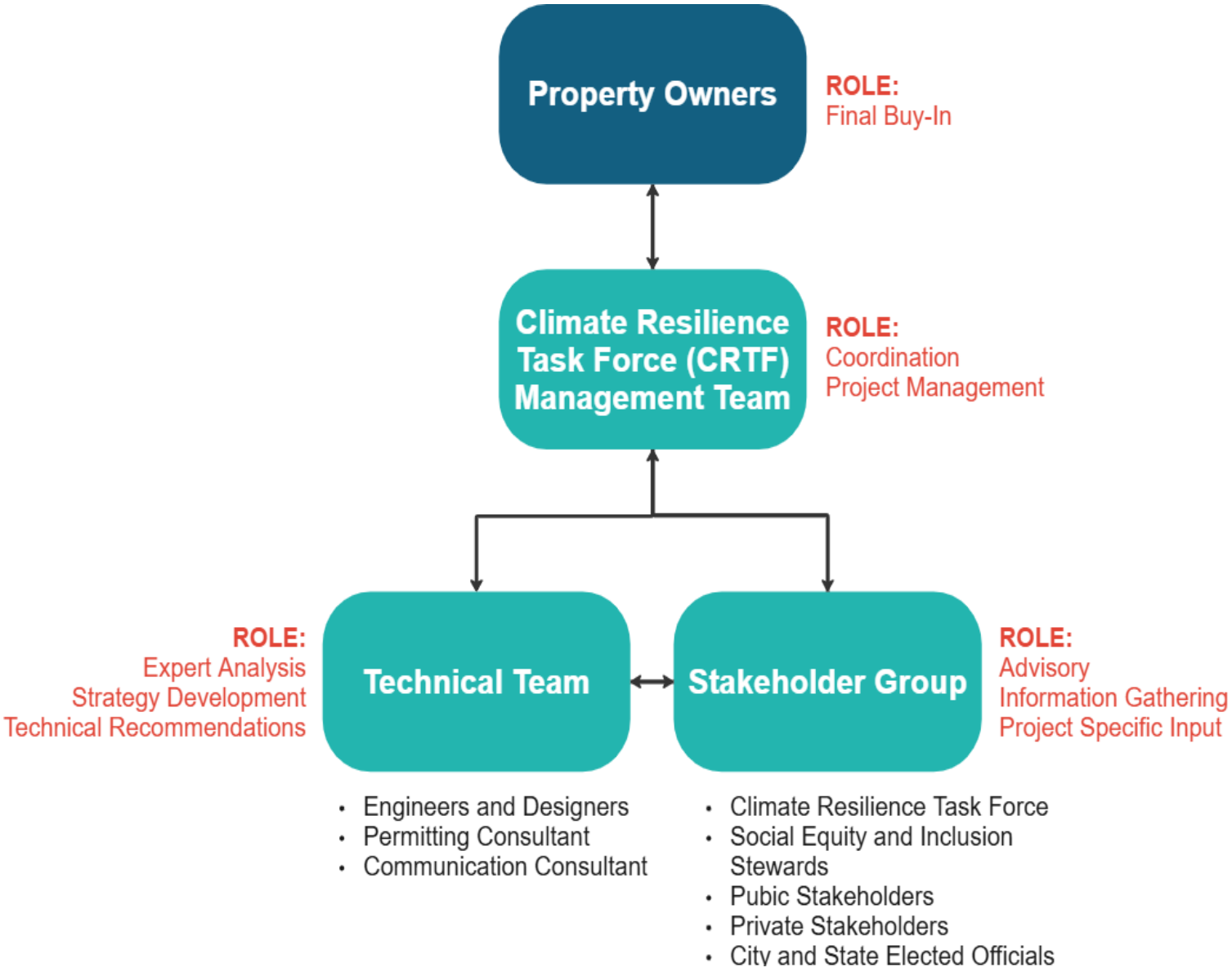


Figure 19. Stakeholder Engagement Model

Stakeholder Engagement

The Wharf District project's approach to stakeholder engagement centers around a series of engagement initiatives and workshops designed to create unique opportunities for key stakeholders to engage in the project side-by-side with the project's Technical Team, empowering stakeholders to make informed decisions and building the trust needed with the community to secure broad support and generate excitement for the project. These engagement activities included:

- *Initial Community and Stakeholder Outreach:*
  An initial Visioning Workshop was held with the CRTF and supplemented with direct outreach to the broader Wharf District community and individual Stakeholder Groups, including city and state elected officials and representatives from local community groups. This initial outreach focused on confirming overarching project goals, identifying community and stakeholder priorities, soliciting feedback on the project's Evaluation Criteria, and identifying strategies to engage with key stakeholders and the community during the project.

- *Discovery Workshops:*
  Following the due diligence phase and identification of potential flood adaptation strategies for the flood protection system, one-on-one Discovery Workshops were held with each property owner whose land could be impacted by the proposed resiliency plan. The objective of these workshops was to share information about site-specific and community-wide flood hazards with the property owners, seek feedback and build support for the project's Evaluation Criteria, identify key considerations for current and potential future use of each property, and discuss each property owner's preferences and goals as they relate to flood protection for their property and the broader community.

  Attendance at these workshops was limited to the Technical Team and the Property Owners. To create a "safe space" for property owners to openly discuss their priorities, members of the CRTF Management Team were not invited to join, and all information shared in the workshops was held confidentially by the Technical Team. The workshops informed the development of site-specific flood protection preliminary design plans for each property.

- *Design Workshops:*
  A second round of one-on-one workshops was then held with the property owners to review preliminary design plans for their property. Similar to the Discovery Workshops, attendance at these workshops was limited to the Technical Team and the Property Owners.

  The goal of these workshops was to use the Evaluation Criteria to explain the benefits and tradeoffs inherent in each option studied, confirm if the plans were responsive to the property owner's priorities, identify a preferred flood protection design option, and identify any design changes necessary to secure the property owner's support.

Building Consensus

In most cases, the preferred design plan selected by each property owner was compatible with those selected by their neighbors. In the limited cases where one property owner's preferred design precluded the preferred design of another owner, additional one-on-one meetings were held between the Technical Team and the impacted property owners to identify opportunities to build consensus. These meetings included discussions to gain a more nuanced understanding of each property owner's preferences, review the benefits and tradeoffs associated with alternative approaches, explain the probable consequences if a mutually agreeable solution was not identified, and explore potential options to find common ground for a design that would be mutually beneficial for the property owners. This approach resulted in an additional round of revisions to the design plans, and yielded plans that were supported by all 16 public and private waterfront property owners in the district.

The plans were then reviewed with all the Stakeholder Groups to confirm alignment with community priorities and the City's plans. Due to the early engagement of these Stakeholder Groups during the Visioning Workshop & Initial Outreach stage, and integration of their feedback into the project approach and designs, the final plans were broadly supported by the Stakeholder Groups.

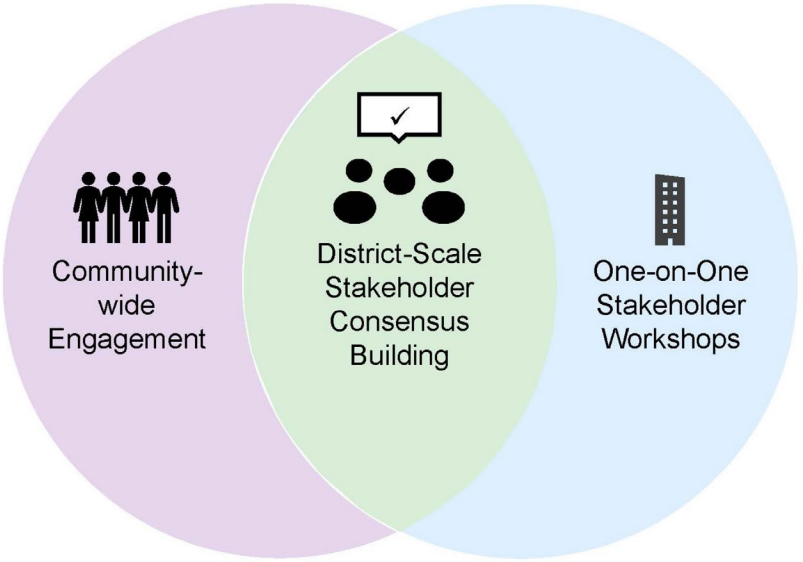


Figure 20. WDC Approach to Building Consensus

Part 2.4 – Planning and Design Best Practice Examples

Examples of deliverables and the planning and design best practices employed by the Wharf District Council are provided in the following sections to serve as precedents for other communities who wish to lead their own neighborhood resiliency projects.

Evaluation Criteria

The Evaluation Criteria in **Figure 21** were created to help guide and rank proposed climate resilience strategies. These criteria are largely based on evaluation criteria initially developed by the City of Boston through comprehensive public outreach and engagement initiatives in Boston including Climate Ready Boston, Coastal Resilience Solutions for Downtown and North End, and Coastal Resilience Solutions for East Boston. Additional information about this work by the City of Boston is provided in **Part 3** of this report. The City's evaluation criteria have since been refined by Arup to reflect subsequent feedback from the Wharf District Council's stakeholder engagement initiatives.

These Evaluation Criteria are generally applicable for use by many coastal communities to assess benefits and tradeoffs of climate resilience strategies, and can be modified to reflect specific priorities of each community. In particular, the last bullet point under the Environmental & Additional Benefits criteria should be revised to require consideration of unique community characteristics that are important to the local community.

Evaluation Criteria Information Cards that may be used to communicate the intent of each criteria are also provided in **Figure 22** and **Figure 23**.

Effectiveness

- Meets Design Flood Elevations (DFEs)
- Facilitates continuous line of protection / resilience across the entire district
- Minimizes deployment complexity
- Protects critical infrastructure
- Avoids increasing rainfall-based flooding at abutting properties

Feasibility

- Minimizes ground settlement & coastal erosion
- Minimizes impacts to seawalls & structural decks
- Minimizes permitting risks
- Minimizes construction cost
- Minimizes long term operations & maintenance costs

Adaptability

- Compatible with existing property-specific plans and land use
- Compatible with district-wide and abutting-property resiliency strategies
- Provides opportunities for phased implementation

Social Equity & Access

- Preserves & enhances the Harborwalk, including welcoming & inclusive access and signage
- Preserves & enhances outdoor public spaces, including welcoming & inclusive access and signage
- Preserves & enhances view of the Harbor
- Preserves & enhances emergency access
- Preserves & enhances non-emergency access to the waterfront, public transportation, & buildings

Environmental & Additional Benefits

- Preserves & enhances environmental resources
- Preserves & enhances docks & water transportation functionality and access
- Minimizes outdoor private land use impacts
- Compatible with the district's architectural & urban context, including the functionality & visibility of wharves and historic resources

Figure 21. WDC Evaluation Criteria

Evaluation Criteria

The Wharf District Conceptual District Protection & Resiliency Plan will use a set of evaluation criteria to assess and rank potential flood resiliency strategies, and to inform the selection of a set of preferred strategies for the Wharf District.

Evaluation Criteria:

- Effectiveness
- Feasibility
- Adaptability
- Social Equity & Access
- Environmental & Additional Benefits

These evaluation criteria are based on community feedback from previous comprehensive public outreach and engagement initiatives, including Climate Ready Boston, Coastal Resilience Solutions for Downtown Boston and North End, and the Wharf District Public Realm Visioning Study.

As this process continues, we are committed to continuing to provide opportunities for stakeholder input as well as providing timely updates on the process and decisions that are reached.

Effectiveness

Mitigating anticipated flood risks for people, homes, businesses, critical infrastructure, and community assets by using reliable flood adaptation strategies.

Considerations:

- ✓ Meets the Design Flood Elevations
- ✓ Facilitates continuous line of protection / resilience across the entire district
- ✓ Minimizes deployment complexity
- ✓ Protects critical infrastructure
- ✓ Avoids increasing rainfall-based flooding at abutting properties

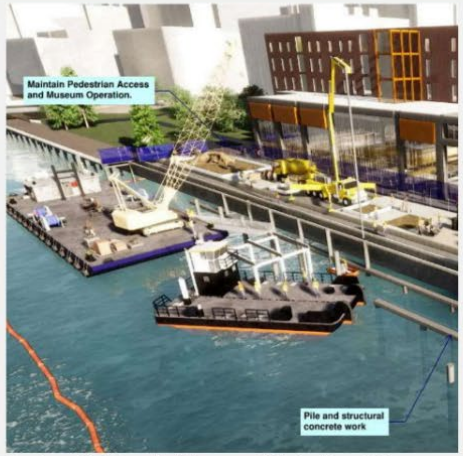
Lady of Lourdes Hospital, Binghamton NY
Image Source: FEMA Media Library

Feasibility

Providing a practical strategy that can be implemented based on construction complexity, cost, and regulatory requirements.

Considerations:

- ✓ Minimizes ground settlement & coastal erosion
- ✓ Minimizes impacts to seawalls & structural decks
- ✓ Minimizes permitting risks
- ✓ Minimizes construction cost
- ✓ Minimizes long-term operations & maintenance costs



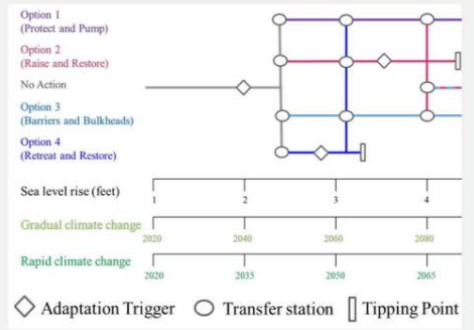
Boston Children's Museum Waterfront Plan
Image Source: Turner Construction

Adaptability

Supporting the phased implementation of district-scale and property-specific resilience strategies over time as sea levels rise.

Considerations:

- ✓ Compatible with existing property-specific plans and land use
- ✓ Compatible with district-wide and abutting-property resiliency strategies
- ✓ Provides opportunities for phased implementation



Kapalama Canal Flood Resiliency Implementation Timeline, Honolulu, Hawaii
Image Source: Arup

Figure 22. WDC Evaluation Criteria Information Cards

Social Equity & Access

Providing equitable access to the waterfront, safe transportation into, out of, and around the waterfront, & creating opportunities for new public recreational & cultural amenities.

Considerations:

- ✓ Preserves & enhances the Harborwalk, including welcoming & inclusive access & signage
- ✓ Preserves & enhances outdoor public spaces, including welcoming & inclusive access & signage
- ✓ Preserves & enhances Harbor views
- ✓ Preserves & enhances emergency access
- ✓ Preserves & enhances non-emergency access to the waterfront, public transportation & buildings

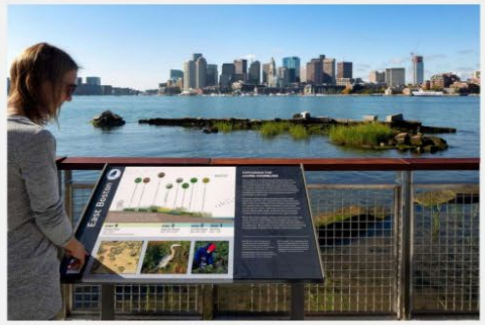
Hunters Point South
Image Source: Arup

Environmental & Additional Benefits

Providing multiple co-benefits in addition to flood adaptation, including preserving or enhancing the function of environmental resources, water dependent uses, private parcel programming, and the Wharf District's architectural & urban context.

Considerations:

- ✓ Preserves & enhances environmental resources
- ✓ Preserves & enhances docks & water transportation functionality and access
- ✓ Minimizes outdoor private land use impacts
- ✓ Compatible with the district's architectural & urban context, including the functionality & visibility of wharves and historic resources



Clippership Wharf, East Boston
Image Source: Ed Wonsek

Figure 23. WDC Evaluation Criteria Information Cards

Multi-Criteria Assessment

The project's Evaluation Criteria should be used as metrics within a Multi-Criteria Assessment (MCA) to qualitatively and quantitatively assess the benefits and tradeoffs of implementing various potential strategies.

The use of an MCA allows for consistent and transparent decision-making based on the Evaluation Criteria agreed upon by project stakeholders for assessing and ranking potential flood adaptation strategies.

This process helps project stakeholders understand reasons for including or dismissing flood adaptation strategies, and is also helpful for designers to identify and mitigate potential adverse impacts of a preferred design strategy.

The MCA approach laid out in this section incorporates lessons learned from the Wharf District Council's project and a similar North End/Waterfront Climate Alliance's North End Flood Resiliency project also led by Arup.

Multi-Criteria Assessment Approach:

1. Confirm the primary types of Adaptation Strategies that could be incorporated into the planned flood protection system. Examples of Adaptation Strategies and their applicability to typical land uses (roadways, inland areas, at water's edge, or outboard of existing seawalls) are provided in **Figure 24**.

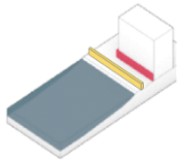
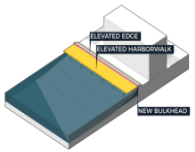
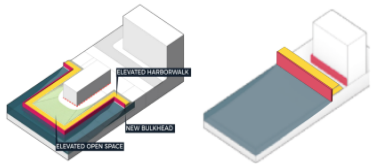
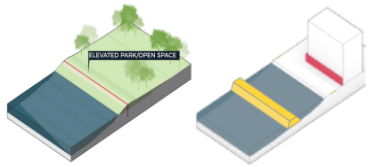
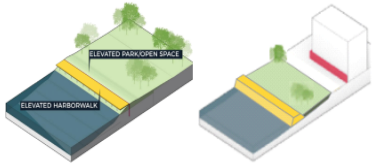
Primary Adaptation Strategy	Description	Examples	Applicability for Each			
			Roadway	Inland	Waters Edge	Outboard
Floodwall	This strategy includes a new or elevated floodwall. If located along the waterfront or outboard alignments, this strategy includes a vertical seawall. Deployable barriers may be included with this strategy to maintain roadway, building, or waterfront access.		✓	✓	✓	✓
Floodwall + Harborwalk	This strategy includes a new or elevated floodwall, and includes a new elevated deck for a harborwalk. The elevated deck may be located inland of the floodwall, or cantilevered over the water. The strategy may include floating docks in addition to an elevated deck.				✓	✓
Floodwall + Elevated Land + Harborwalk	This strategy includes a new or elevated floodwall, and elevates the existing ground or includes an elevated deck for a harborwalk inland of the floodwall. If located along the waterfront or outboard alignments, this strategy includes a vertical seawall. Outboard alignments include filling the existing harbor. The strategy may also include over water decks and floating docks.			✓	✓	✓
Elevated Land	This strategy elevates the existing ground to create a flood protection landform. New harborwalks are not included in this strategy. If located along the waterfront or outboard alignments, this strategy includes a sloped vegetated or rocky shoreline. Outboard alignments include filling the existing harbor. Surface materials vary and may include landscaped or hardscape surfaces.			✓	✓	✓
Elevated Land + Harborwalk	This strategy includes the same features as Elevated Land, and provides space for a harborwalk either inland or outboard of the water's edge.The strategy may also create new open space, and may include new floating docks.			✓	✓	✓

Figure 24. Adaptation Strategies

2. Identify the boundaries of likely individual construction projects within the study area.

   Construction projects should be defined to comprise groups of properties where the flood protection system likely needs to be coordinated and designed together as a single project. Considerations for grouping properties together include:

   a. properties with common site features that will benefit from construction of a single type of flood adaptation strategy;
   b. properties where implementation of the most likely strategies will be dependent on improvements at the adjacent properties;
   c. property ownership and easement boundaries;
   d. considerations for storage and conveyance of rainfall falling on the 'dry' side of the proposed flood protection system during a flood event.

3. Confirm the characteristics the local community believes are essential to the neighborhood's identity and cohesion. Prior community engagement and planning initiatives should be reviewed for context, and additional engagement with community members should be considered. Tailor the MCA description for "Compatible with the neighborhood's identity and supports community cohesion" under the 'Environmental and Additional Benefits' category to reflect the community's key characteristics.

4. Use the MCA to perform a quantitative and qualitative assessment of the Evaluation Criteria for each applicable strategy. Consider the appropriate scale for applying the MCA process to assess individual adaptation strategies. Typically, a single MCA is provided for each identified construction project.

   a. Refer to the Screening Criteria in **Figure 26 - Figure 28**. Remove strategies that do not pass these Screening Criteria from consideration, as they are anticipated to have a 'fatal flaw' such as: an unrealistic permitting pathway, significant life safety risk, negative impacts on abutting properties, irreconcilable differences with existing or planned land uses, or failure to provide the desired level of flood protection.

   b. Quantitatively score strategies that pass the Screening Criteria using the definitions and numerical scores provided in **Figure 26 - Figure 28.** Qualitatively score the strategies using the "superior", "good", and "poor" descriptions indicated in **Figure 25**. Total scores for each Evaluation Criteria can be calculated by averaging the scores of each subcategory under the Evaluation Criteria.

Assessment Score Thresholds		
Description	**Range**	**Plan Symbol**
Superior	1.1 to 3.0	
Good	-1.0 to 1.0	
Poor	-3.0 to -1.1	

Figure 25. MCA Qualitative Descriptions

Criteria Description	Screening Criteria	Assessment Criteria (1)		
		Poor	Good	Superior
Scoring		*-3*	*0*	*3*
Social Equity & Access				
Preserves & enhances the Harborwalk, including welcoming & inclusive access and signage	*Reduces width of Harborwalk, obstructs view of water from Harborwalk, precludes or adversely impacts contiguous harborwalk, or eliminates licensed facilities of public accommodation (FPAs)*	*reduces access points to the Harborwalk*	*enables contiguous harborwalk, does not reduce access to, width of, or water views from the harborwalk, and maintains access to existing facilities of public accommodation (FPAs)*	*increases harborwalk width or views of water, or includes new facilities of public accommodation (FPAs)*
Preserves & enhances outdoor public spaces, including welcoming & inclusive access and signage	*eliminates public access to existing public open space*	*reduces the size of, access to, views/wayfinding to, or signage for public open space*	*no reduction in size of, number of access points to, views/wayfinding to, or signage for public open space*	*increases the size of public open spaces or creates new public open spaces*
Preserves & enhances view of the Harbor	-	*fully or partially obstructed*	*preserves current view quality*	
Preserves & enhances emergency access	*blocks any evacuation route, or blocks all existing emergency access routes to buildings or docks, or results in unnacceptable loss of functionality of existing emergency access as determined by the Boston Fire Department*	*blocks existing emergency access routes to buildings or docks (including for fire boats), but alternative access routes remain and are not impacted*	*no impact on existing emergency access routes to buildings or docks*	*Improves function of existing emergency access, or preferred by Boston Fire Department*
Preserves & enhances non-emergency access to the waterfront, public transportation, & buildings	*eliminates access to the Harborwalk, water transportation, bus/subway facilities, parking garages, or loading areas; no practical alternative access routes identified*	*eliminates access to the Harborwalk, water transportation, bus/subway facilities, parking garages, or loading areas; alternative access routes are available or created*	*no reduction in the number of access routes to the waterfront, and no loss of functionality of existing access program to loading areas, garages, building entrances, or bus/subway facilities*	*creates new public access points to the waterfront (including living shorelines)*

Figure 26. MCA Quantitative Definitions – Social Equity and Access

Criteria Description	Screening Criteria	Assessment Criteria [1]		
		Poor	Good	Superior
Scoring		*-3*	*0*	*3*
Environmental and Additional Benefits				
Preserves & enhances environmental resources	*infills Harbor; no significant flood resiliency benefit associated with infill*	*requires infill of the Harbor that isn't a new living shoreline or wetland*	*does not infill Harbor*	*provides new opportunities for trees, living shorelines, or wetlands (e.g. Elevated Land or Elevated Land + Harborwalk strategies at inland or waters edge alignments), and no other infill of the Harbor is required*
Preserves & enhances docks & water transportation functionality and access	*irreconcilable differences with existing use (e.g. fully eliminates existing dock areas or all access routes to water transportation at any dock); in-kind replacements not identified [3]*	*requires reduction in function or access to docks (e.g. partially reduces existing dock area or the number of access routes to water transportation); in-kind replacements not identified [3]*	*no impact on existing dock area or access routes to water transportation, or in-kind replacements identified for any reduction of existing dock area or water transportation access routes [3]*	*increases dock area, or increases or improves access routes to water transportation, or is preferred by dock owner*
Minimizes outdoor private land use impacts	*eliminates private open space, or eliminates all access to existing private open space*	*reduces private open space size or access points*	*maintains or increases private open space size and access points, or in-kind replacements identified [3]*	
Compatable with the neighborhood's identity and supports community cohesion	-	*impacts the visibility or use of the neighborhood's heritage and historic resources, including impacting the function of wharves, or impacting structures listed in the National Register of Historic Places*	*no impact, or highlights the visibility of the neighborhood's heritage and history, including wharfs or structures included in the National Register of Historic Places*	
Effectiveness				
Meets Design Flood Elevations (DFEs)	*does not meet Target DFE*	*meets Target DFE; cannot be raised to Strategic DFE*		*Meets Target DFE; can be raised to Strategic DFE*
Facilitates continuous line of protection / resilience across the entire study area and abutting properties	*precludes continuous flood protection system for the study area*	*does not protect all buildings in the study area, or precludes extension of the proposed flood protection system to protect buildings or critical infrastructure on abutting properties [2]*	*protects all buildings in the study area, and faciliates extension of the proposed flood protection system to protect buildings and critical infrastructure on abutting properties [2]*	
Minimizes deployment complexity	*fully deployable*	*partially deployable*	*fully passive*	-
Protects critical infrastructure	-	*does not protect all critical infrastructure from storm surge [2]*	*protects all critical infrastructure from storm surge [2]*	-
Avoids increasing rainfall-based flooding at abutting properties	*blocks major rainfall pathway to the Harbor; no practical mitigation strategies identified*	-	*does not block major rainfall pathway to the Harbor, or practical mitigation strategies identified*	*preserves or creates land for rainfall storage & pumping system near the intersection of a major rainfall pathway with the flood protection system*

Figure 27. MCA Quantitative Definitions – Environmental and Additional Benefits & Effectiveness

Criteria Description	Screening Criteria	*Assessment Criteria* [1]		
		Poor	Good	Superior
Scoring		*-3*	*0*	*3*
Feasibility				
Minimizes ground settlement & coastal erosion	*raises ground surface > 2 feet within 30 feet of buildings, tunnels, or large diameter sewers; no practical mitigation strategies identified*	*raises ground surface > 2 feet within 30 feet of buildings, tunnels, or large diameter sewers; practical mitigation strategies have been identified*	*no changes to ground surface exceeding 2 feet within 30 feet of buildings, tunnels, or large diameter sewers*	*mitigates existing known coastal erosion and/or settlement*
Minimizes impacts to seawalls, bulkheads, & structural decks	*raises ground surface > 2 feet within 30 feet of a Coastal Structure; no practical mitigation strategies have been identified*	*raises ground surface > 2 feet within 30 feet of Coastal Structure; practical mitigation strategies have been identified*	*no changes to ground surface exceeding 2 feet within 30 feet of Coastal Structure*	
Minimizes permitting risks	*strategy located outboard of existing seawall / shoreline; no potential permitting strategy identified*	*strategy located outboard of existing seawall / shoreline, or impacts access or views of a structure on the National Register of Historic Places; potential permitting strategy identified*	*strategy located on existing land, with the exception of dock piling*	*strategy located on existing land, and identifies specific opportunties for licensed FPA(s) (Facility of Public Accomodation)*
Minimizes construction cost		*strategy located outboard of seawall / shoreline*	*strategy located on existing land within 30 feet of seawall / shoreline, with the exception of dock piling*	*strategy located on existing land more than 30 feet away from seawall / shoreline*
Minimizes long term operations & maintenance costs		*includes movable or deployable components, pump systems, or other electric components*	*fully passive system with no pump systems, electric components, movable or deployable components*	
Adaptability				
Compatible with existing property-specific plans and land use	*irreconcilable differences with planned land use*	*requires significant reduction in function of planned land use, or not preferred by property owner*	*no impact on planned land use*	*incorporates elements of current redevelopment or resiliency plans, or is preferred by property owner*
Compatible with neighborhood-wide and abutting property resiliency strategies	*precludes continuous flood protection system for the neighborhood*	*precludes protection of buildings or critical infrastructure located immediately adjacent to the study area* [2]	*faciliates protection of buildings and critical infrastructure located immediately adjacent to the study area* [2]	
Provides opportunities for phased implementation	-		*no potential for phased implementation*	*strategy can be implemented progressively as sea levels rise*

Figure 28. MCA Quantitative Definitions – Feasibility & Adaptability

Multicriteria Assessment Notes:

1. Actual benefits and trade-offs of flood resiliency strategies will be subject to numerous site-specific considerations and can be influenced by nuanced detailed design approaches. This process provides simplified Evaluation Criteria definitions for each score to provide a transparent and repeatable high-level assessment of the relative potential benefits and trade-offs for comparing the major components of various flood resiliency strategies.

2. Critical Infrastructure is defined by the Boston Public Works Department 2018 Climate Resilient Design Standard & Guidelines as:

   - Hospitals and health care facilities
   - Emergency Response (Police, Fire, Rescue, Ambulance) facilities and related items (garages, shelters, operations centers, communications, back-up generators, substations, etc.)
   - Correctional facilities
   - Wastewater treatment plants
   - Water storage tanks
   - Operations centers
   - Public works yards
   - Municipal buildings
   - Schools and facilities that may be used as emergency shelters
   - Power transmission facilities, substations, and power generation stations
   - Critical transportation networks (emergency evacuation routes, public transportation, aviation facilities, tunnels, bridges, train and transit maintenance yards and shops, traffic signals)
   - Facilities where residents have limited mobility or ability (such as nursing homes and care facilities)
   - Buildings or structures that contain hazardous waste; waste transfer stations
   - Pumping stations (stormwater and sanitary)
   - Fueling storage and fuel stations
   - Ventilation buildings and fan plants
   - Telecommunications
   - Major food distribution centers

3. In-kind dock replacement includes relocation to an area on the same property with similar or greater footprint, water depth, and protection from wind and waves. In-kind water transportation access route replacement includes relocation to an area on the same property with similar accessibility, connectivity (including distance from connections to public transit), and visibility. In-kind private open space replacement includes relocation to an area on the same property with similar or greater footprint and access points.

4. *Definitions:*
   - Facilities of Public Accommodation (“FPAs”) are qualified under the State's Waterways Regulations (Chapter 91) as “facilities at which goods or services are made available directly to the public on a regular basis, or at which the advantages of use are otherwise open on essentially equal terms to the public at large.” FPA space is located in buildings along the City's waterfront and is required through Chapter 91 licensing for new or redevelopment projects. Examples of interior facilities of public accommodation referenced in the regulations include restaurants, performance areas, hotels, retail establishments, and educational and cultural institutions.
   - A Wharf is a level concrete, stone, or metal platform lying alongside or projecting into water to which a ship may be moored to load and unload. Adequate water depth for ships must exist alongside the structure to be defined as a wharf. The structure must be of adequate size and configuration to allow ships to moore, thereby qualifying it as a wharf.
   - Coastal Structures are seawalls, bulkheads, structural decks over water, or similar structural infrastructure located along the water's edge.

Figure 29. Multicriteria Assessment Notes

5. Findings from the Multicriteria Assessment should be communicated in an easy-to-understand format, such the MCA scorecards illustrated in **Figure 30.**

6. Two of the Evaluation Criteria - Social Equity & Access, and Environmental & Additional Benefits - are identified as 'Prerequisite Criteria'. Any adaptation strategy that receives a 'Poor' score in either of the Prerequisite Criteria should generally not be included in the Flood Protection System plans. Such strategies are recommended to be screened out as they are unlikely to gain the support of key stakeholders, the City, or regulatory agencies, and are therefore unlikely to be fully funded or built.

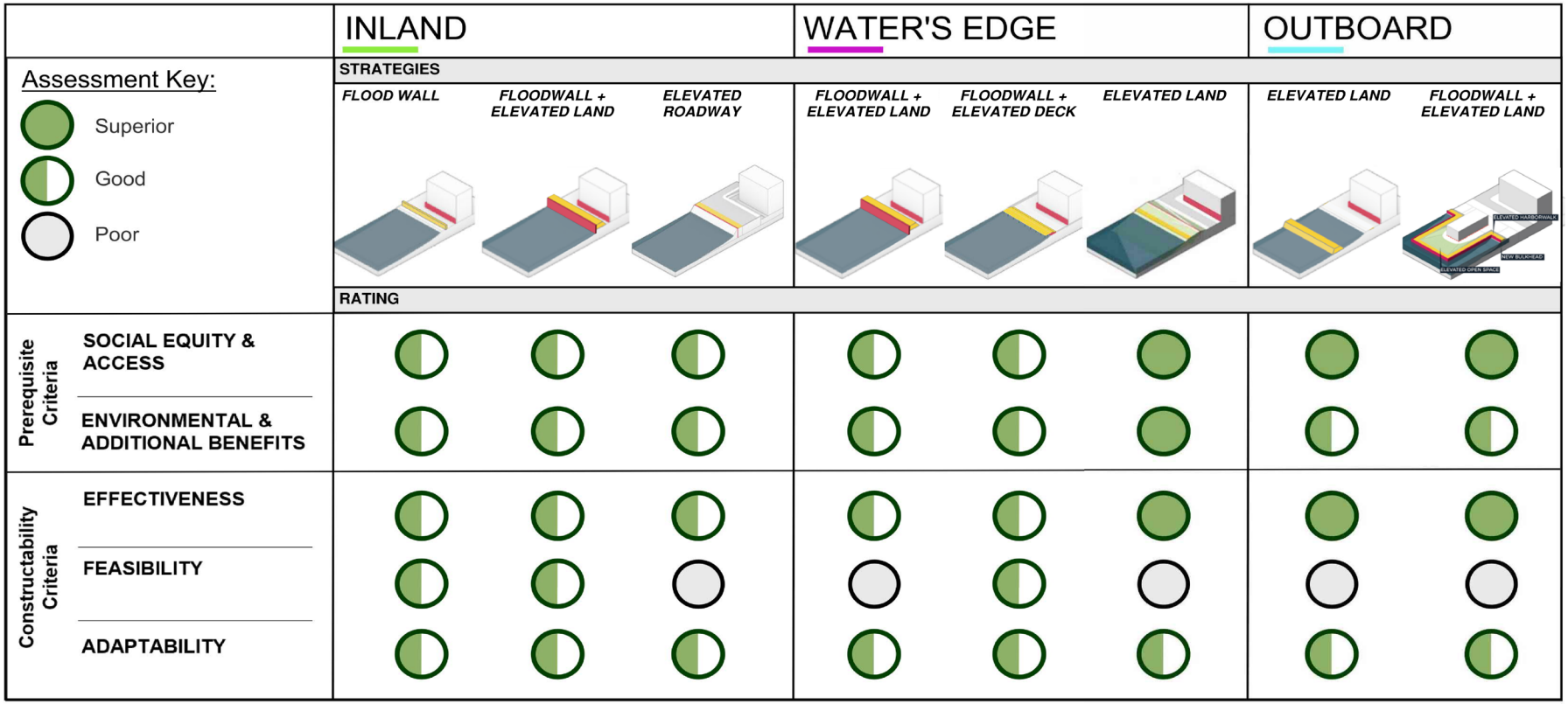
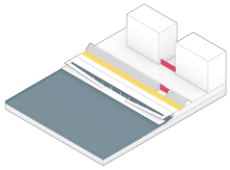
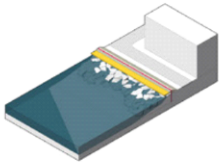
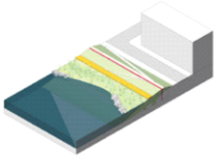
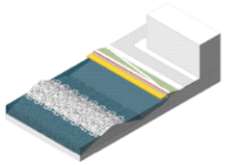
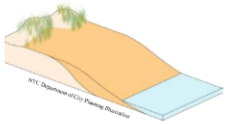
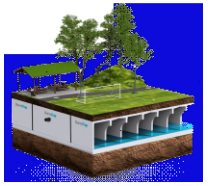


Figure 30. MCA Scorecard

7. Any adaptation strategy that receives a ‘Good’ or ‘Superior’ score in the Prerequisite Criteria should be ranked based on the MCA scores for the remaining Evaluation Criteria of Effectiveness, Feasibility, and Adaptability, which are collectively defined as the ‘Constructability Criteria'. The engineering feasibility of adaptation strategies that rank the highest in the Constructability Criteria should then be assessed based on site-specific key considerations identified during engineering due diligence and field investigation activities, as well as feedback received from the project's key stakeholders. The findings of this assessment should be used to inform the development of flood protection system preliminary designs.
8. Flood protection system preliminary designs should consider incorporating additional strategies such as those identified in **Figure 31** to address underlying causes of any 'Poor' scores in the Constructability Criteria, as well as to incorporate additional co-benefits where practical, such as protection from extreme heat, ecological habitat improvements, and removal of pollutants from stormwater.
9. A “Preferred” flood protection system may be selected from the design alternatives based on additional considerations such as the results of a Cost Benefit Analysis, community and stakeholder feedback, construction schedule and phasing considerations, permitting requirements, and funding opportunities.

Additional Adaptation Strategies	Example
Deployable Barrer	
Rocky Shoreline	
Living Shoreline	

Additional Adaptation Strategies	Example
Breakwaters	
Beaches and Dunes	
Stormwater Storage and Pump Systems	

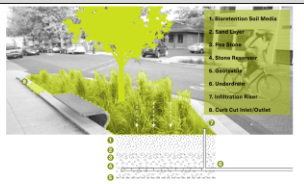
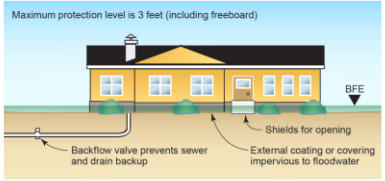
Additional Adaptation Strategies	Example
Green Infrastructure	
Building-Level Flood Adaptations	

Figure 31. Additional Adaptation Strategies

MCA Guideline Image Credits: The resiliency strategy images in the above MCA Guideline are from the City of Boston Coastal Resilience Solutions for Downtown and North End Report, except as noted below:

- *Example images in the righthand column of the* **Figure 24**, *which were created by Arup and Halvorson | Tighe & Bond Studio*
- *Green Infrastructure image source: BWSC Green Infrastructure Handbook*
- *Elevated Land and Elevated Land + Overwater Dock images were modified from the CRS Report images by Arup*
- *Beaches and Dunes image from NYC Department of City Planning*
- *Stormwater Storage and Pump System image from StormTrap*
- *Building-Level Flood Adaptations image from FEMA P-1037 'Reducing Flood Risk to Residential Buildings that Cannot be Elevated*

Resiliency Zones

The Wharf District Flood Resiliency Plan included several Secondary Flood Protection Systems that connect the Primary Flood Protection System located at the waterfront to inland high points, dividing the district into three “Resilience Zones.” Each Resilience Zone is intended to be designed as a coordinated project, ensuring that each zone will be protected from flooding upon completion of its construction regardless of whether adjacent zones or neighborhoods have implemented their own flood protection systems.

These Resilience Zones also reduce the risks of widespread flooding associated with single points of failure, with the Secondary Flood Protection Systems intended to be designed to prevent flooding from spreading across zones.

This approach is also beneficial for streamlining permit approvals, as regulatory agencies including MEPA and DEP have expressed a preference for flood resilience projects to be reviewed holistically, with all components necessary to provide flood protection included in their permit reviews.

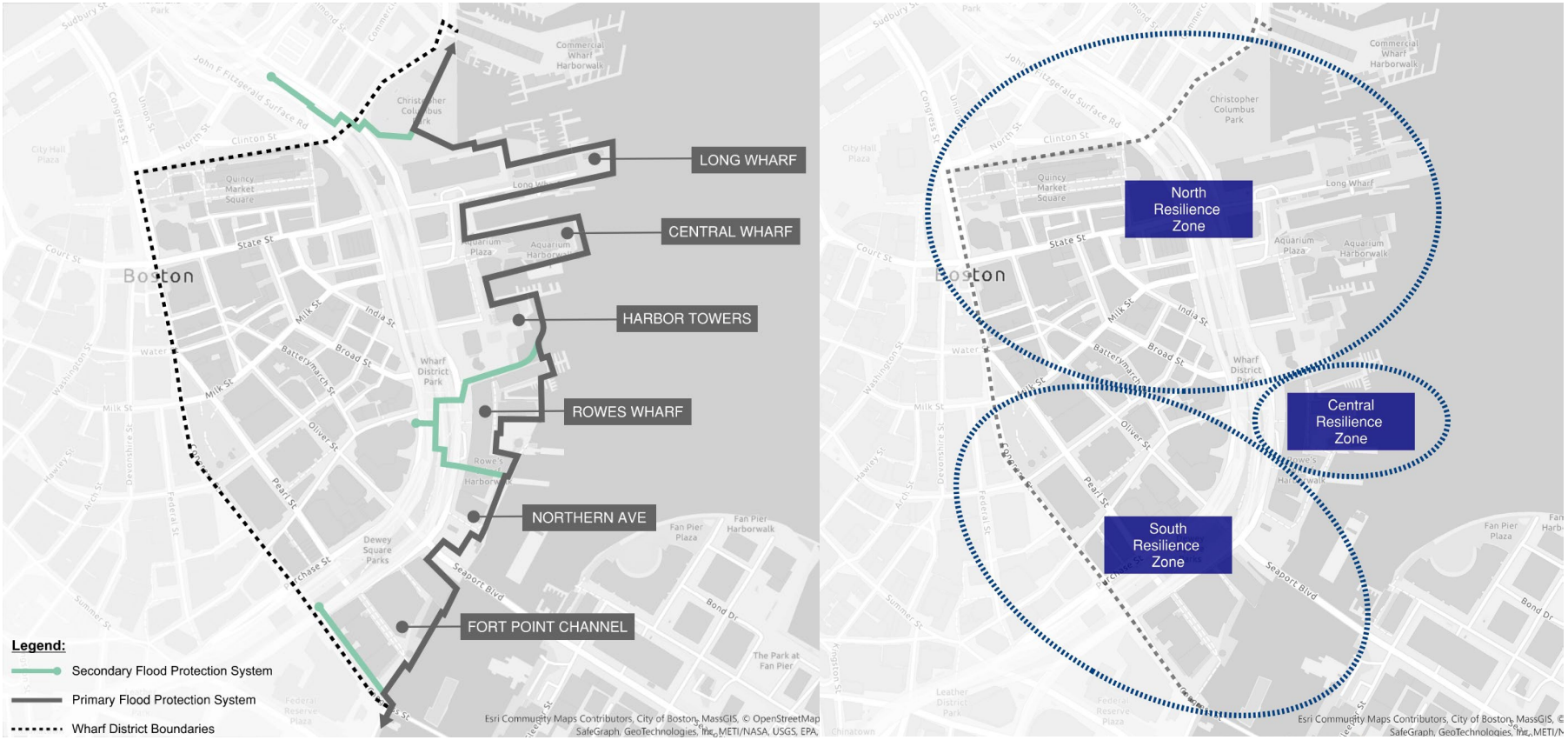


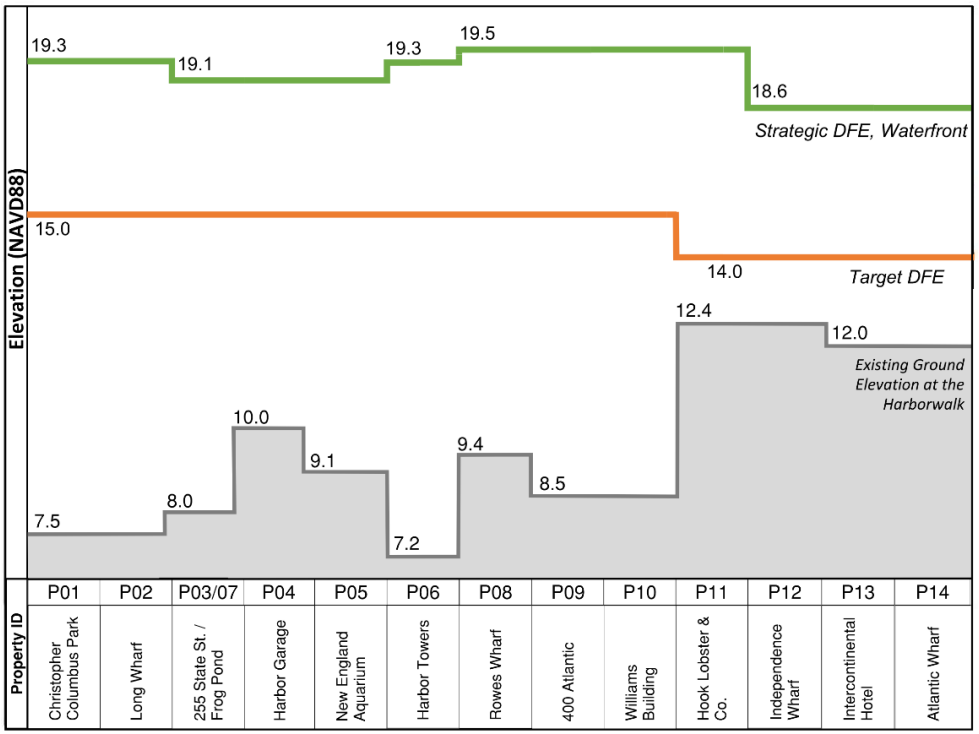
Figure 32. Resilience Zones

Flood Hazard Graphics

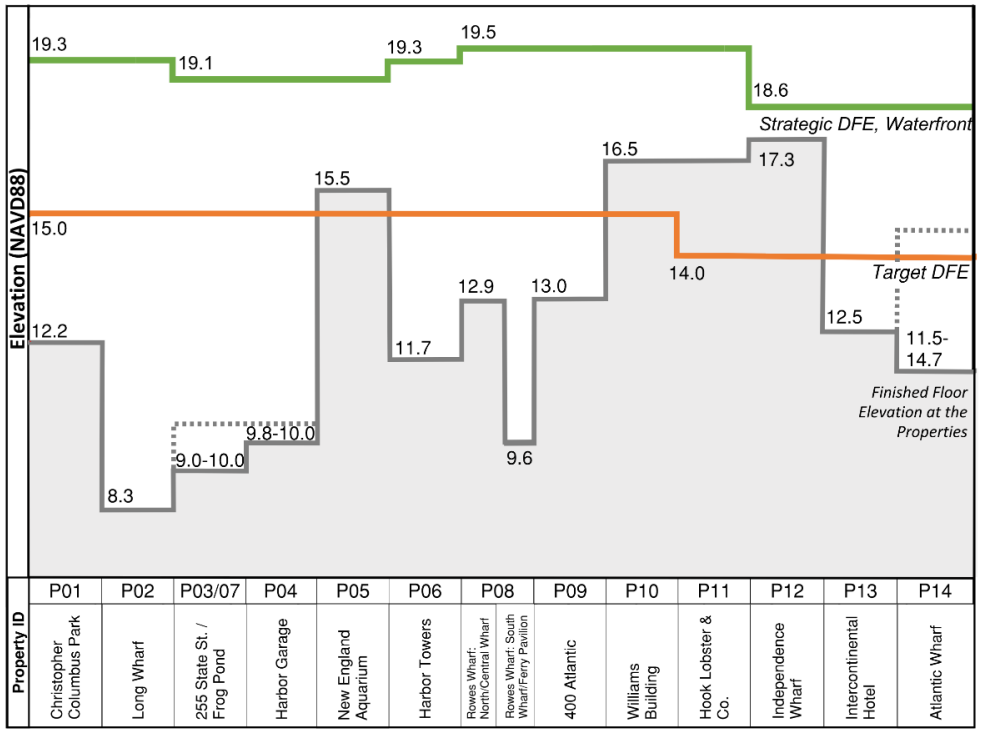
Clearly communicating the risks of flooding is crucial in building consensus for why a flood protection system may be necessary, when such a system would need to be constructed, and the consequences associated with inaction. The following graphics developed by Arup for the Wharf District Council project were successful in helping project stakeholders make informed decisions about how to best protect their properties and the community.

The image on the left in **Figure 33** compares the **existing ground elevations along the Harborwalk** (shown in grey) to the proposed Design Flood Elevations (a near-term "Target DFE" shown in orange, and a longer-term "Strategic DFE" in green) at each property from Christopher Columbus Park (left) to Atlantic Wharf in the Fort Point Channel (right). Flood protections built along the Harborwalk would need to close the gap in elevation between the existing ground elevation and the Target DFE.

The image on the right in **Figure 33** compares the **First Floor Elevations of the waterfront buildings** (shown in grey) to the two proposed DFEs.



Comparison of Ground Elevation at the Harborwalk to DFEs



Comparison of Building First Floor Elevations to DFEs

Figure 33. Example Design Flood Elevation Graphic

The following images are examples of graphics that can be used to effectively communicate the consequences of flood hazards facing a community.

Figure 34 uses a 3D model developed by Halvorson | Tighe & Bond Studio and Arup to provide a powerful image of the extents of flooding within the community.

Figure 35 graphically illustrates the likelihood and probability of flooding for each individual building in the Wharf District over the next 10 to 15 years. This graphic was particularly useful in helping property owners throughout the district understand the near-term consequences of inaction.

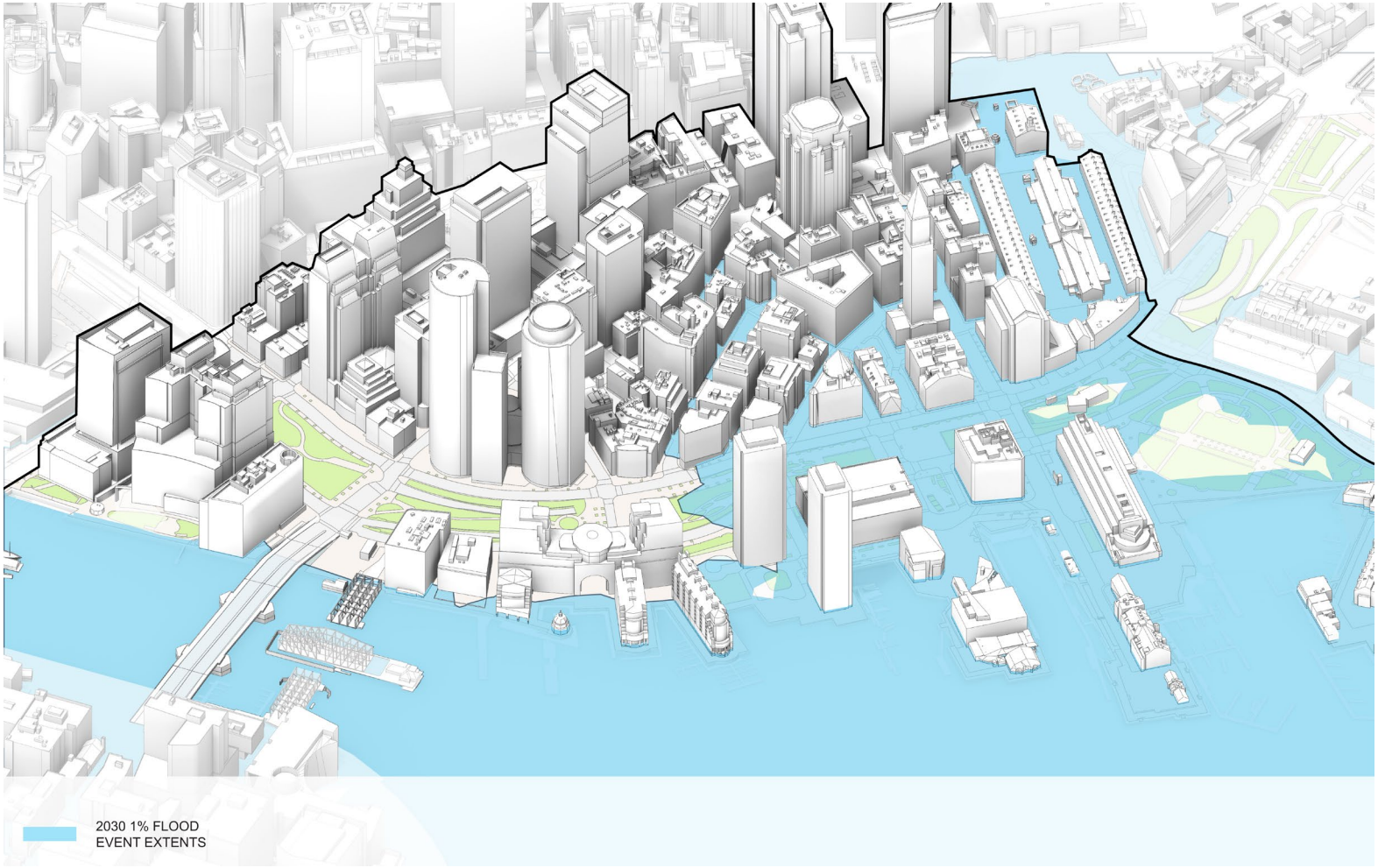
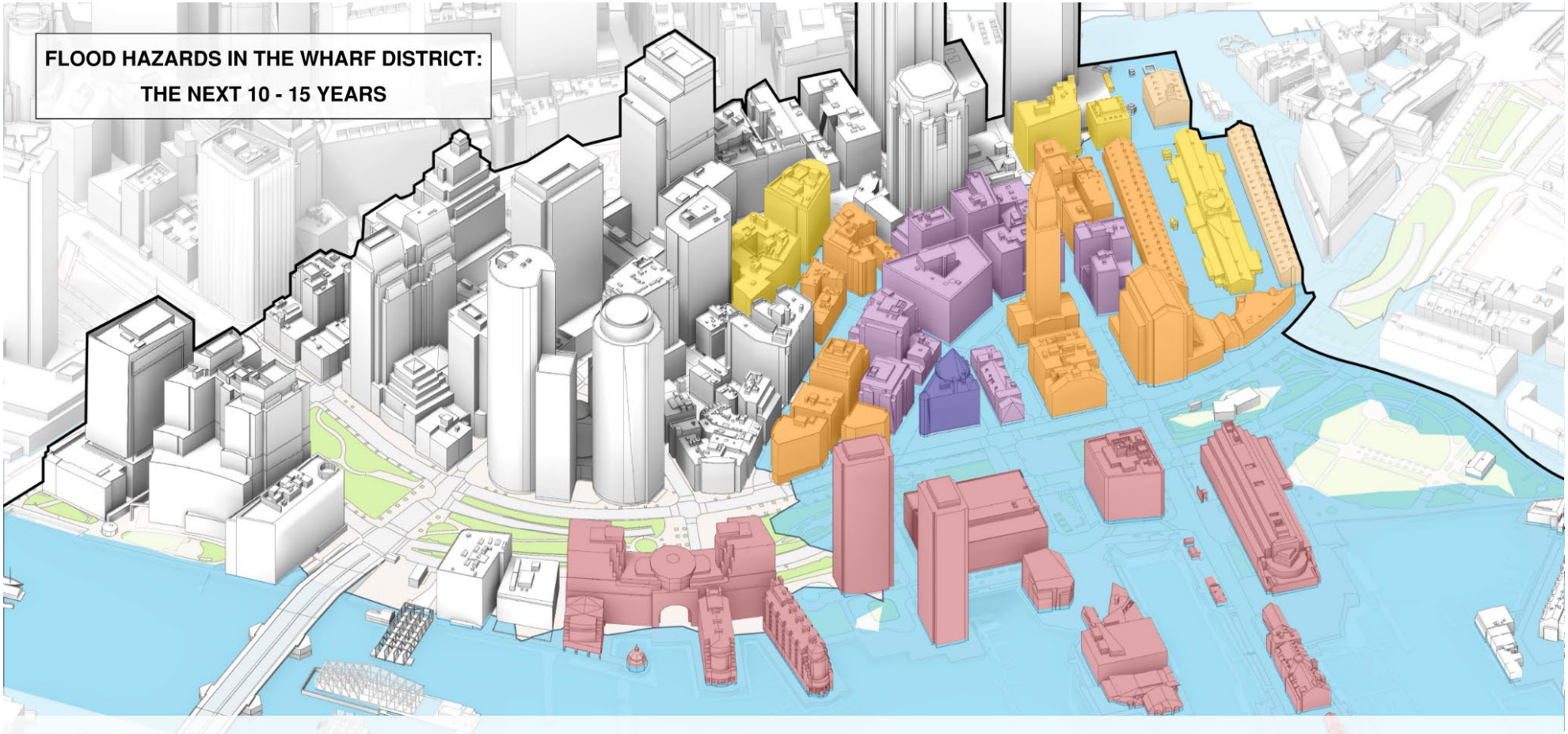


Figure 34. 3D Model of Flood Extents



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BOSTON

Notes:

1. Flood depths used in this analysis are approximate, and are estimated relative to existing ground elevations at each building.

2. Flood probabilities and depths used in this analysis are based on the sea level rise and flood hazard projections of the Boston Harbor Flood Risk Model (BH-FRM) and the City of Boston's Coastal Resilience Solutions for Downtown Boston and North End report.

2030 1% FLOOD EVENT EXTENTS

	100-Year Storm Flood Depth, in Feet *2018's Winter Storm Grayson was roughly a present-day 100-year storm. The expected depth of flooding from a similar 100-year storm occuring in 10 years (2034) and 15 years (2039) is listed below.*		Probability of a 100-Year Storm *The probability of experiencing a 100-year storm within the next 10 to 15 years (by 2034 - 2039) is listed below.*		Probability of Nuisance Flooding *The probability of experiencing at least 6 inches of flooding within the next 10 to 15 years (by 2034 - 2039) is listed below.*	
	2034	2039	by 2034	by 2039	by 2034	by 2039
ZONE 1	1.0' to 2.2'	1.2' to 2.4'	4%	9%	4%	9%
ZONE 2	3.0' to 3.1'	3.2' to 3.3'	4%	9%	4%	9%
ZONE 3	1.9' to 2.7'	2.2' to 3.0'	4%	9%	34%	61%
ZONE 4	3.0' to 3.7'	3.2' to 3.9'	4%	9%	34%	61%
ZONE 5	3.0'	3.2'	10%	14%	38%	64%
ZONE 6	1.0' to 4.0'	1.2' to 4.2'	10%	14%	up to 100%	up to 100%

Figure 35. Flood Hazards in the Next 10 – 15 Years

Implementation Timeline

The Wharf District Council also developed the graphic in **Figure 36** to help each property owner understand the recommended timing for constructing building-level flood resiliency systems to protect individual buildings, as well as when district-scale flood protection systems would become necessary.

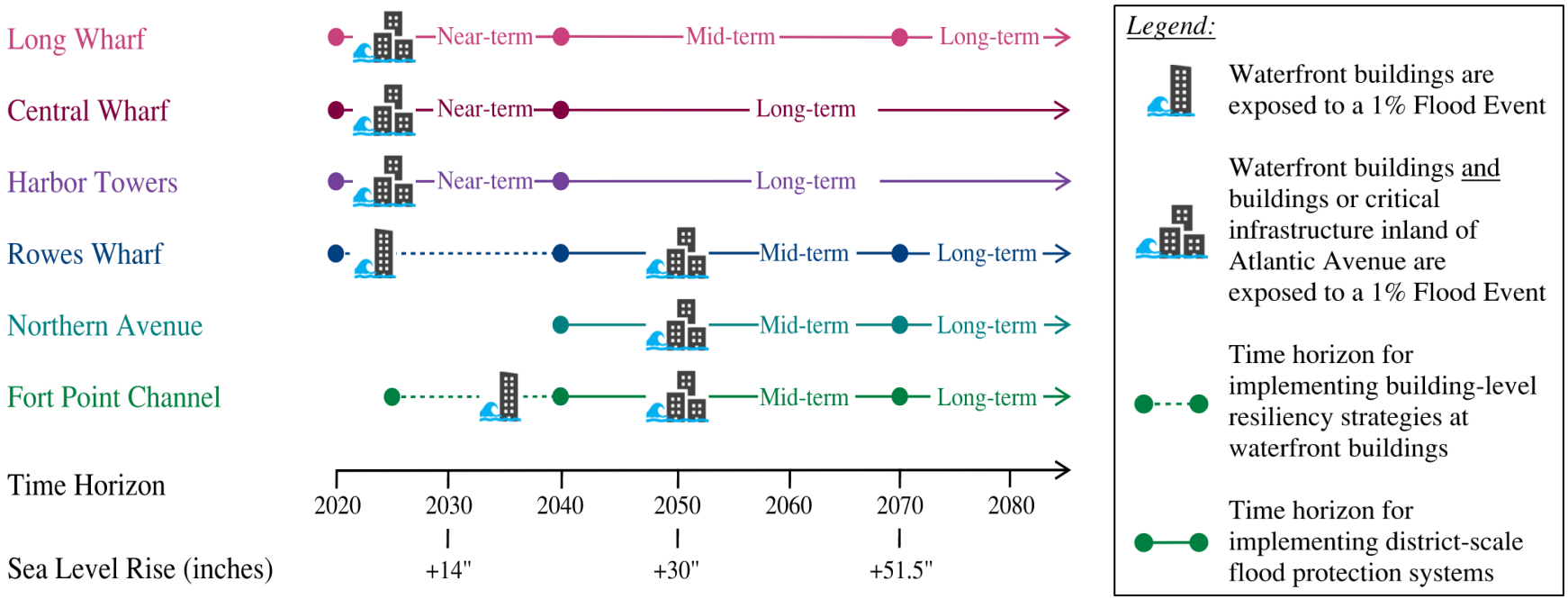


Figure 36. Implementation Timeline

Comparable Project Costs

A comparison of the estimated costs to construct the Wharf District flood protection system to other projects of similar scope and scale within the Northeastern United States is summarized **in** **Figure 37**. All projects used in this comparison were either recently constructed, currently in construction, or were recently issued to bid for construction. This comparison was useful in building confidence in the project's cost estimate.

Project Title	City	Total Project Construction Budget	Linear Feet of Coastline	Cost per Linear Foot of Coastline	Project Description
North & West Battery Park City Resiliency Project	NYC	$ 631,000,000	8,000	$ 79,000	Elevated walkways and floodwalls along the coast. Elevated park space with social stairs and walking paths up the elevated flood protection berm.
Brooklyn Bridge-Montgomery Coastal Resilience (BMCR) Project	NYC	$ 522,000,000	4,800	$ 109,000	Deployable floodwall and gate system with plaza space for pedestrians and bicyclists.
South Battery Park City Resiliency Project	NYC	$ 221,000,000	2,000	$ 111,000	Integrated flood barrier along the coast, and stormwater system upgrades.
Wharf District Flood Resiliency Project	**Boston**	**$ 877,385,500**	**7,800**	**$ 112,500**	
East Side Coastal Resiliency Project	NYC	$ 1,450,000,000	6,600	$ 220,000	Improved park space and facilities, pedestrian bridges, infill, landscaping, and deployable flood gates. Work is located 300 feet or more from the waterfront.

Figure 37. Comparable Project Costs

Building-Level Flood Resiliency Guidelines

The Wharf District Council also produced a set of Building-Level Flood Resiliency Guidelines intended to help property owners identify flood resiliency strategies for protecting their individual buildings. These guidelines are comprised of a Resiliency Checklist provided on the following pages, and examples of common floodproofing strategies for buildings in **Figure 39** – **Figure 41**.

Resiliency Checklist:

The following checklist is provided to assist property owners and residents of individual buildings within the Wharf District identify flood resiliency strategies for their properties.

☑ **Confirm if the property is located within a flood prone area.** Flood prone areas can be identified with the Massachusetts Office of Coastal Zone Management's Sea Level Rise and Coastal Flooding Viewer and BPDA's Zoning Viewer for coastal storm surge flood hazards, and BWSC's Inundation Model Viewer for flood hazards associated with both coastal storm surge and rainfall flood events.

☑ **Identify the property's Sea Level Rise - Design Flood Elevation (SLR-DFE).**

- Identify the Sea Level Rise – Base Flood Elevation (SLR-BFE) for the property by opening the BPDA's Zoning Viewer and clicking on the parcel. The parcel information box will list the SLR-BFE in feet (Boston City Base datum), as shown in **Figure 38.**

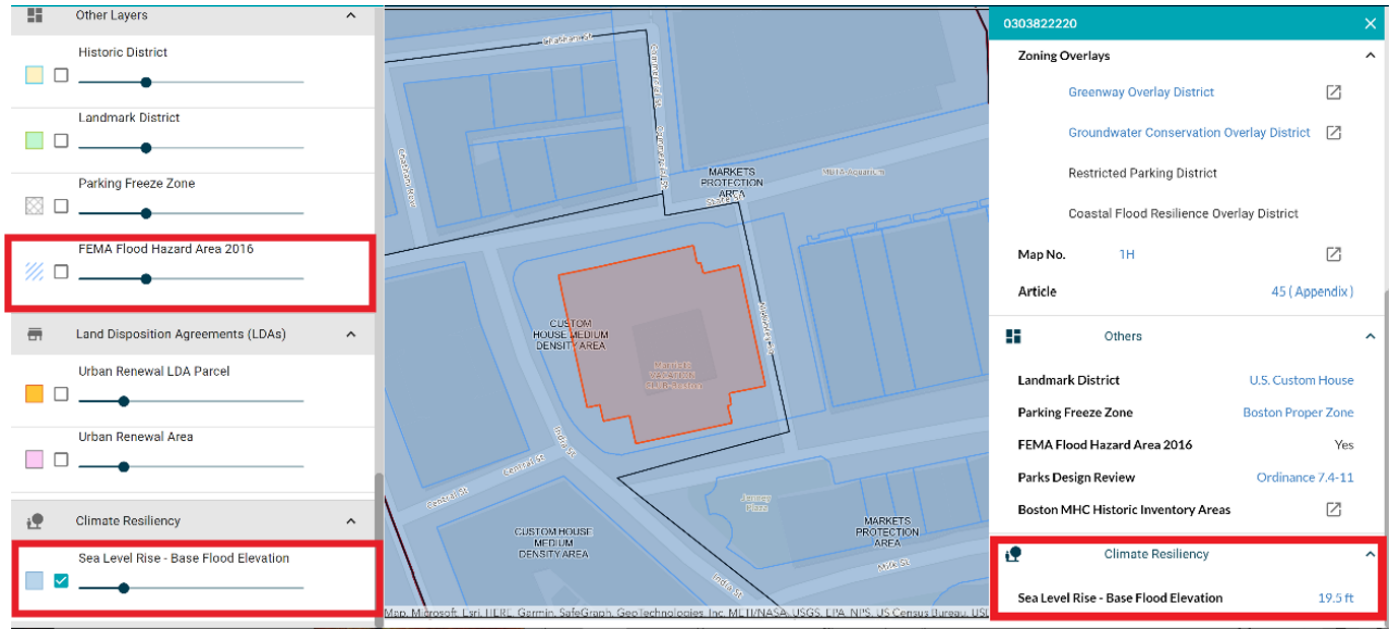


Figure 38. BPDA Zoning Viewer: SLR-BFE

- Calculate the Sea Level Rise - Design Flood Elevation (SLR-DFE) for the property by adding either 1- or 2-feet to the SLR-BFE, based on the requirements of the City's Article 25 A Coastal Flood Resilience Overlay District. Current Article 25 regulations are summarized in the table below. Higher Design Flood Elevations may be chosen if desired by the property owner to further reduce flood risks to the building. *Note: the SLR-DFE for individual buildings may vary from the DFE's used for the district-wide flood protection system located along the waterfront.*

Building Type	DFE
Residential	Buildings with a residential or critical use for the ground floor must be 2' above SLR-BFE. 1' above SLR-BFE if the residential use starts above the ground floor
Non-residential	Buildings with a critical use on the ground floor must be 2' above SLR-BFE. 1' above SLR-BFE for all other uses
Both	Buildings in a FEMA Coastal A, V, or VE zone must be 2' above SLR-BFE

☑ **Identify flood risks to people and physical assets at the property.** Review locations and elevations of infrastructure, emergency egress routes, and shelter-in-place facilities relative to flood elevations and pathways. Include potential above- and below-ground flood pathways in the review. Consider impacts of uplift and lateral forces of floodwaters on the structure.

☑ **Identify and implement a flood adaptation strategy.** Identify and assess potential flood adaptation strategies to mitigate the identified flood risks, and implement the preferred adaptation strategy for the property. Note that flood adaptation strategies for individual buildings shall not preclude the construction of the district-wide flood protection system. Resources for identifying and assessing adaptation strategies for retrofitting existing buildings typical to the Wharf District include:

- BPDA's Coastal Flood Resilience Design Guidelines
- BPWD's Climate Resilient Design Standards & Guidelines for Protection of Public Rights-of-Way
- The Floodproofing Strategy information provided in **Figure 39** – **Figure 41**.

The USACE National Flood Proofing Committee has investigated the effect of various depths of water on masonry walls, discussed in their report titled *Floodproofing Test (USACE, 1988)*. The results of their work show that, **as a general rule, a maximum of 3 feet of water should be allowed on a non-reinforced concrete block wall** that has not previously been designed and constructed to withstand flood loads.

- FEMA P-259 'Engineering Principals and Practices for Retrofitting Flood-Prone Residential Structures'

☑ **Identify applicable regulations.** Consult City, State, and Federal regulations and any other local jurisdictions, such as Historic Districts and Boston's Article 25A Coastal Flood Resilience Zoning Overlay District, to identify all applicable regulatory and approval requirements for any proposed work.

☑ **Develop a Flood Preparedness, Response, and Recovery Plan.** This plan should define how to prepare for and respond to a flood event. Key information to consider includes, but is not limited to:

- Staff and key vendor roles and responsibilities (e.g. removing or securing movable furniture, deploying any deployable barriers, etc.)
- Flood forecast monitoring and communications
- Operational procedures (e.g. setting elevator controls to lock out elevator cabs at the 2nd floor during a flood event)
- Evacuation and/or shelter-in-place procedures, equipment and supplies, and site access restrictions
- Clear guidance on flood recovery priorities to facilitate rapid recovery
- Cleaning and maintenance procedures following an event, including damage inspections of equipment and building systems

☑ **Train, Deploy, and Improve.** Provide regular training for staff responsible for enacting the Flood Preparedness, Response, and Recovery Plan. Following deployments of flood adaptations strategies, review and incorporate lessons learned for future flood events.

Considerations for assessing and selecting adaptation strategies may include:

- Maintaining emergency access including to emergency egresses and hydrants
- Operational capacity to store and deploy the flood protection system
- Permitting requirements
- Suitability for use based on site-specific building construction, site features, and Design Flood Elevation
- Effectiveness in addressing all above- and below-ground flood pathways
- Opportunities to reduce risk through redundant layers of protection
- Ability for incremental implementation
- Winter weather deployment considerations
- Capital costs, social impacts, and environmental impacts
- Operations & maintenance requirements and design life

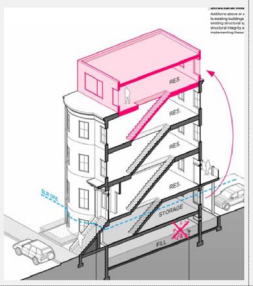
	Dry Floodproofing					
	Passive Systems					
	Repurpose or Relocate or Elevate Ground Floor Use	Floodwalls & Levees	Automatically Deployed Flood Barriers	Backflow Valves & Pressure Covers	Sealants and Membranes	Stormwater Storage
Rough Order Magnitude Capital Costs:	Varies	$	$$$	$	$	$$
Maintenance Effort:	None	Low	Low	Low	Low	Low
Deployment Effort:	None	None	None - Low	None - Moderate	None	None
Storage Requirements:	None	None	None	None - Low	None - Low	None
Design Life:	50+ Yrs	50+ Yrs	50+ Yrs	50+ Yrs	10 - 25 Yrs	50+ Yrs
Types of Products/Solutions:	Enternal or external circulation to Design Flood Elevation 	Levees, Glass Floodwalls, Concrete Structure 	Flood Gates, Flip-Up Barriers, Flood Doors 	Backflow Valves, Pressure Covers 	Waterproof Membrane, Waterproof Sealants  	Surface Ponds, Subsurface Storage Systems, Porous Pavement, Rainwater Harvesting, Bioretention, Swales, Green Roofs 
Manufacturers/ Proprietary Product Names:	N/A	FloodControl International, Oldcastle	FloodControl International, Presray, FloodPanel	Watts, Neenah, TideFlex, Flood-Guard	FST 250, Roxtec, Fiber Reinforced Plastc (FRP) Wrap	ADS StormTech, StormTrap, Brentwood StormTank, Contech

Figure 39. Building-Level Flood Resiliency Guidelines – Dry Floodproofing Strategies – Passive Systems

	Deployable Systems	
	Flood Barriers	Flood Shields
Rough Order Magnitude Capital Costs:	$$	$$
Maintenance Effort:	Moderate	Moderate
Deployment Effort:	High	High
Storage Requirements:	Moderate	Moderate
Design Life:	10 - 50+ Yrs	50+ Yrs
Types of Products/Solutions:	Inflatable Flood Barriers, Modular Flood Barriers, Membrane Barriers, Sandbags 	Door Barriers, Window Panels, Log Barriers 
Manufacturers/ Proprietary Product Names:	Tigerdam, Eco-Dam, Aquafence, ILC Dover Flex-Wall, SmartVent Flex-Wall, FloodBlock	Presray Door Barrier, FloodShield, Presray Window Panels, FloodPanel Flood Log, FloodControl International Removable Stop Logs

Figure 40. Building-Level Flood Resiliency Guidelines – Dry Floodproofing Strategies – Deployable Systems

	Wet Floodproofing		Supporting Strategies	
	Building Modifications	Pumps and Drain Systems	Landscape Strategies	On-site Energy Generation
Rough Order Magnitude Capital Costs:	Varies; must be completed in accordance with building code	Varies	Varies	Varies
Maintenance Effort:	Low	Low	Medium	Medium
Deployment Effort:	None	None - Low	None	Medium
Storage Requirements:	None	None - Low	Low	Varies
Design Life:	20 - 50+ Yrs	Pumps: 5-10 Yrs Drainage: 50+ Yrs	7-10 years	20-40 years
Types of Products/Solutions:	Open Crawlspaces, Anchoring/Raising/Relocating Mechanical & Utility Equipment, Flood Resistant Building Materials 	Sump Pumps, Floor Drains, Back Flow Preventer 	N/A 	Fuel-fired generator, piped natural gas generator, bi-modal solar electric system with battery storage, combined heat & power 
Manufacturers/ Proprietary Product Names:	N/A	N/A	N/A	N/A

Figure 41. Building-Level Flood Resiliency Guidelines – Wet Floodproofing Strategies and Supporting Strategies

Part 3: Recommendations for Public Agencies to Facilitate Community-led Resilience Projects

The Wharf District Council leveraged significant planning efforts completed by the City of Boston. The City's prior resiliency work – particularly the 2016 Climate Ready Boston and 2020 Climate Ready Downtown and North End reports – enabled the Wharf District to prepare designs efficiently and with confidence that the District's plans could be integrated into subsequent resiliency initiatives by the City.

This also provided the necessary credibility for the Wharf District project to maximize stakeholder participation, which was critical for building broad consensus within the community.

In particular, the information developed by the City of Boston and described on the following pages of this report was instrumental in the success of the Wharf District project. **We recommend public agencies interested in fostering community-led resiliency projects consider undertaking similar efforts.**

City of Boston Resiliency Initiatives Utilized by the Wharf District Resiliency Project

- 2016 • Climate Ready Boston
- 2017 • Imagine Boston 2030
- 2017 • Resilient Boston
- 2018 • Resilient Boston Harbor Vision
- 2018 • Climate Resilient Design Standards & Guidelines for Protection of Public Rights-of-Way
- 2019 • Coastal Flood Resilience Design Guidelines
- 2019 • City of Boston Climate Action Plan Update
- 2020 • Climate Ready Downtown and North End: Coastal Resilience Solutions for Downtown and North End
- 2021 • Coastal Flood Resilience Zoning Overlay District

Climate Ready Boston Reports

Figure 42. City of Boston Resilience Reports

Part 3.1 – Identifying neighborhoods where community-led resiliency projects are encouraged

The City of Boston recognized the significant number of private properties along the Wharf District's waterfront necessitated a public-private partnership between the City and property owners to coordinate a flood protection system that crosses property boundaries.

In the Climate Ready Downtown and North End plan, the City therefore explicitly encouraged private property owners in this neighborhood to work together to coordinate flood resilience design efforts, as indicated in **Figure 43**. The City also laid out clear expectations for these community-led projects, and indicated that the City would support these initiatives.

This statement by the City was crucial for establishing the Wharf District Council's credibility for leading their project and directly increased private property owner participation.

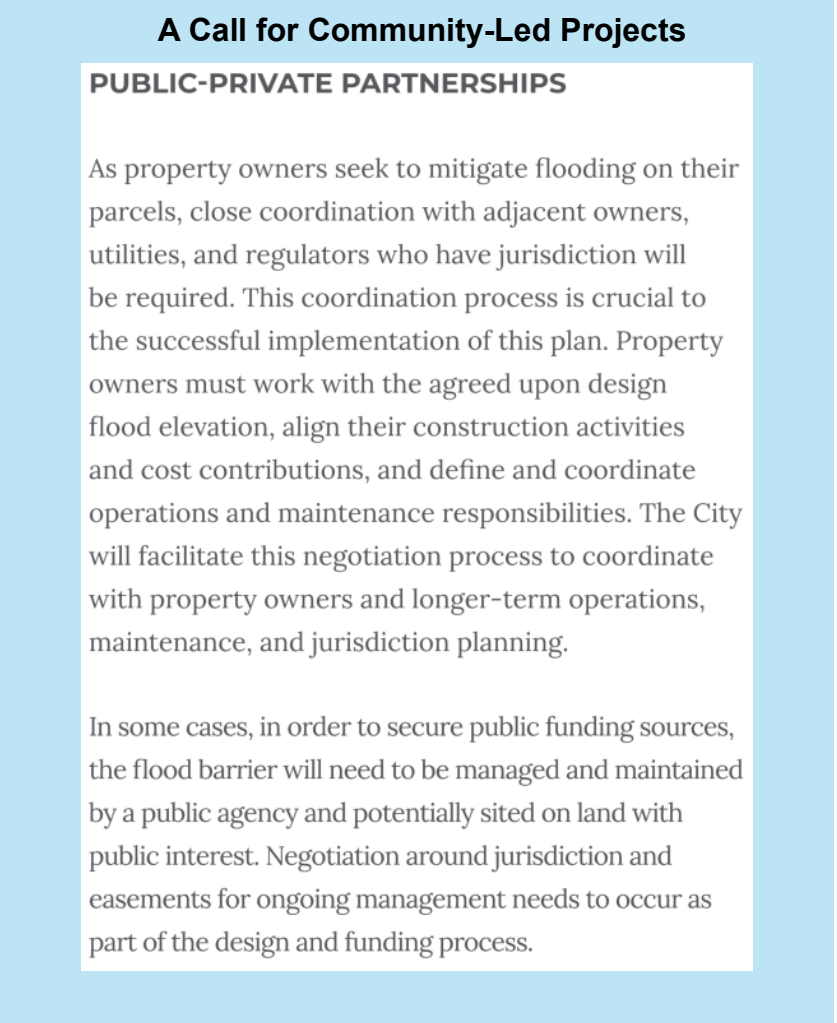
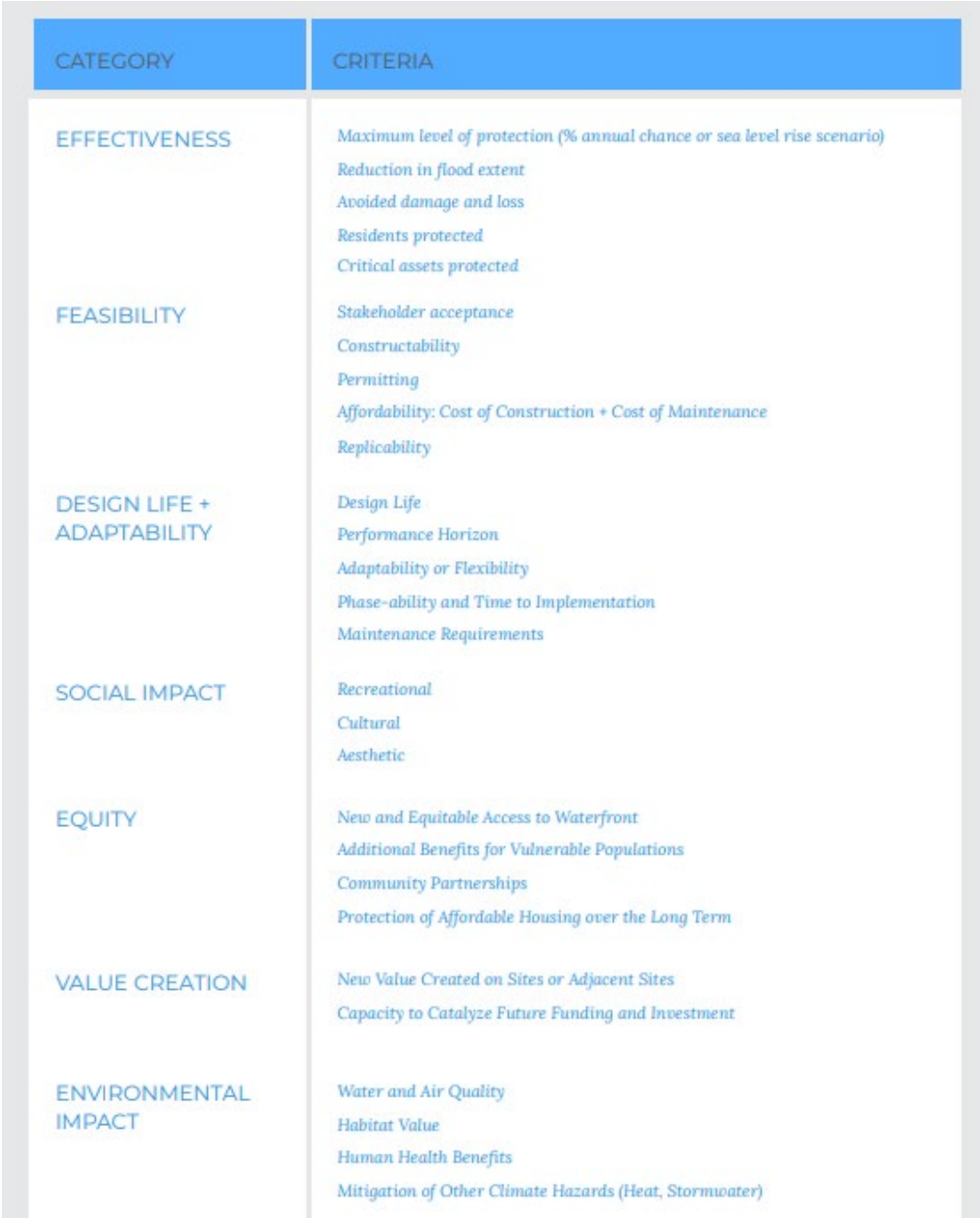


Figure 43. Text from Climate Ready Downtown & North End

Part 3.2 – Documenting community preferences and priorities, and defining Evaluation Criteria

The City of Boston led a significant community engagement initiative, including public workshops, to identify community resiliency goals. The outputs from these initiatives included a summary of community preferences and priorities for resiliency planning, which were used to define a set of Evaluation Criteria intended to help guide and rank proposed climate resilience strategies, see **Figure 44**. The availability of this information enabled the WDC to build on the broad community engagement already completed by the City and focus on targeted stakeholder engagement.

In particular, the availability of Evaluation Criteria developed through robust community engagement provided the WDC team with a roadmap for identifying flood resilience strategies that were likely to be acceptable to the community and the City of Boston, and directly informed the WDC's Evaluation Criteria included in **Part 2** of this handbook.



CATEGORY	CRITERIA
EFFECTIVENESS	*Maximum level of protection (% annual chance or sea level rise scenario)* *Reduction in flood extent* *Avoided damage and loss* *Residents protected* *Critical assets protected*
FEASIBILITY	*Stakeholder acceptance* *Constructability* *Permitting* *Affordability: Cost of Construction + Cost of Maintenance* *Replicability*
DESIGN LIFE + ADAPTABILITY	*Design Life* *Performance Horizon* *Adaptability or Flexibility* *Phase-ability and Time to Implementation* *Maintenance Requirements*
SOCIAL IMPACT	*Recreational* *Cultural* *Aesthetic*
EQUITY	*New and Equitable Access to Waterfront* *Additional Benefits for Vulnerable Populations* *Community Partnerships* *Protection of Affordable Housing over the Long Term*
VALUE CREATION	*New Value Created on Sites or Adjacent Sites* *Capacity to Catalyze Future Funding and Investment*
ENVIRONMENTAL IMPACT	*Water and Air Quality* *Habitat Value* *Human Health Benefits* *Mitigation of Other Climate Hazards (Heat, Stormwater)*

Figure 44. Climate Ready Downtown and North End Plan Evaluation Criteria

Part 3.3 – Identifying required Design Flood Elevations

A neighborhood-scale flood protection system is only effective if the entire system is designed to a consistent minimum level of protection.

It was critically important that Boston's public agencies provided leadership in establishing minimum Design Flood Elevations (DFEs) for the design of district-wide flood protection systems to ensure consistency between the WDC project and ongoing City resiliency efforts.

Boston provided minimum near-term and long-term DFEs for neighborhood-scale flood protection systems in their Climate Ready Boston reports. For flood protection systems designed to protect individual buildings, Boston also provides Base Flood Elevations (BFEs) for each property in their Zoning Overlay District in their publicly accessible Zoning Viewer, and instructions on how to establish a DFE from this BFE are provided in their zoning regulations. Boston also provided clear guidance to private property owners that individual buildings should protect themselves at the building level to provide a second layer of protection in addition to any district-wide resiliency systems.

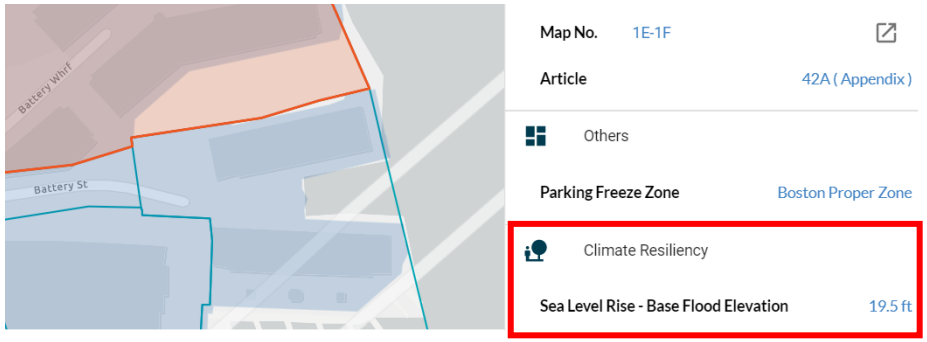


Figure 45. Base Flood Elevations in the Boston Zoning Viewer

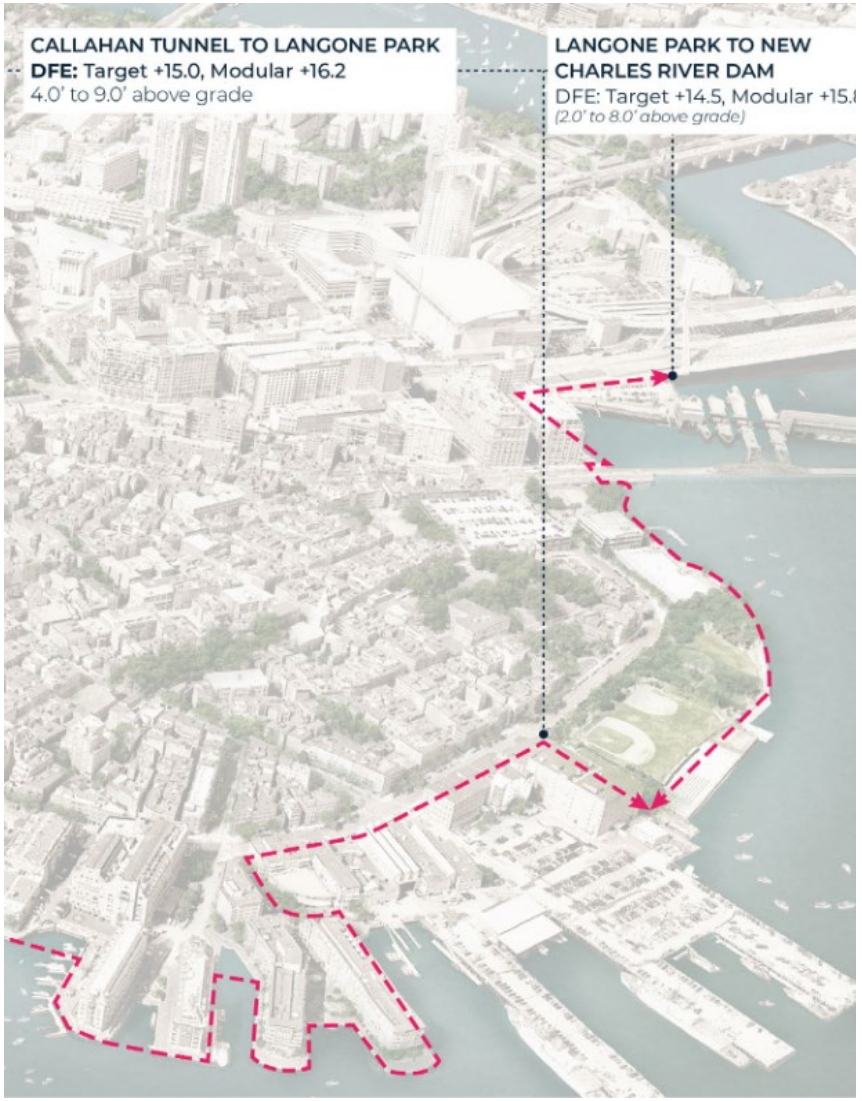


Figure 46. DFEs in the Climate Ready Boston Reports

Part 3.4 – Identifying acceptable resiliency system locations

The Climate Ready Downtown and North End plan laid out three routes through the neighborhood which the City identified as potentially acceptable locations for a district-wide flood protection system to be constructed, as shown in **Figure 47.** This narrowed down the options required to be studied by the WDC project and further enabled consistency between WDC and City initiatives.

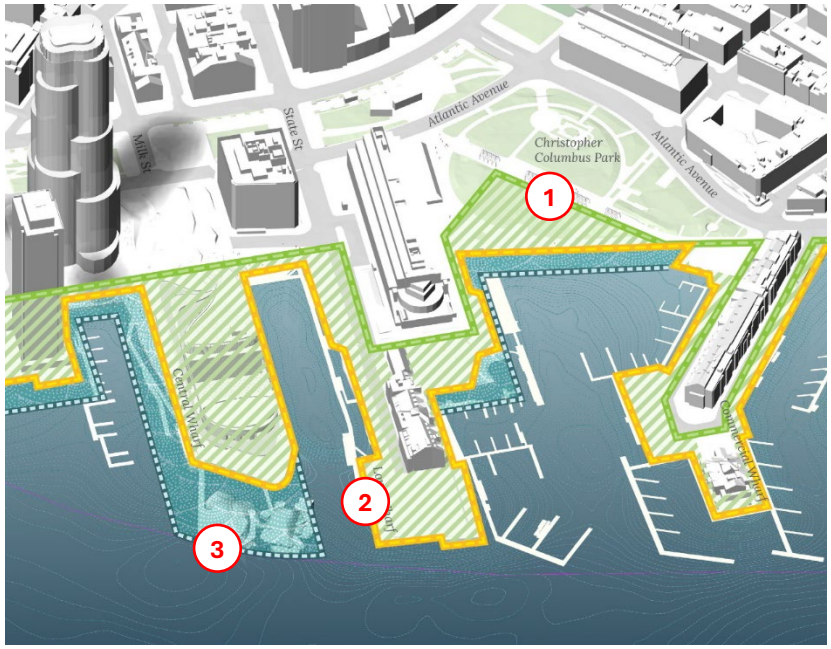


Figure 47. Resiliency System Potential Locations

Part 3.5 – Identifying acceptable resiliency strategies

A flood resiliency toolkit is included in the Climate Ready Downtown and North End plan, providing axion images and descriptions of various types of acceptable resiliency strategies that could be incorporated into a flood resiliency system, see **Figure 48**.

The availability of pre-determined DFEs, potential flood protection system locations, and a toolkit of acceptable strategies helped streamline the WDC's planning efforts, reducing project costs, and enabling the WDC team to efficiently prepare resiliency design plans for the Wharf District.

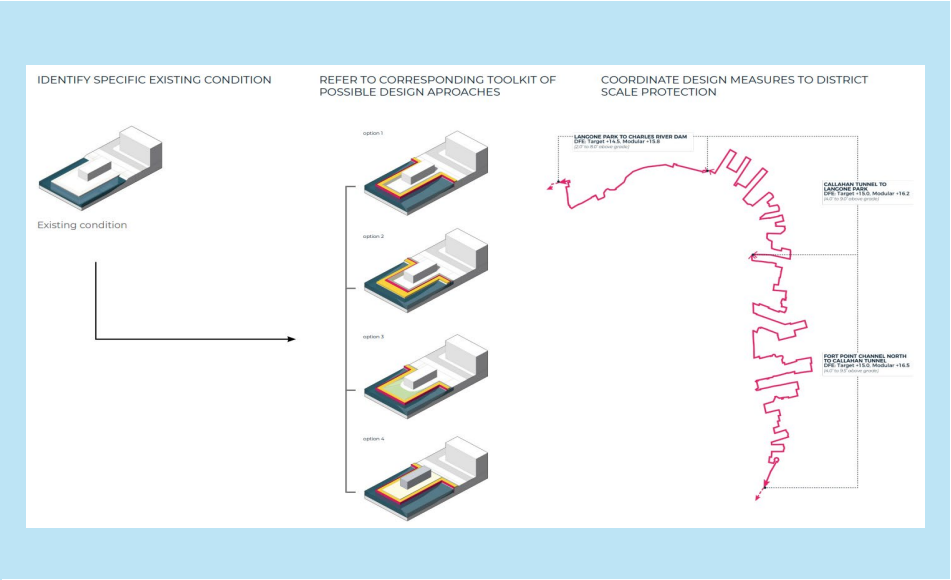


Figure 48. Resiliency Toolkit from Climate Ready Downtown and North End Plan

Part 3.6 – Developing flood resiliency design guidelines

In 2018 and 2019 the City released flood resiliency standards and guidelines for public rights-of-way and for coastal flood resiliency projects, see **Figure 49.** The best practices established by these guidelines provided useful references for the design of the Wharf District's flood protection systems.

Figure 49. Flood Resiliency Design Guidelines

Part 3.7 – Defining social equity for waterfront resiliency planning

The Climate Ready East Boston Phase II Report defines designing for equity as it relates to waterfront resiliency planning as addressing the issues indicated in **Figure 50:**

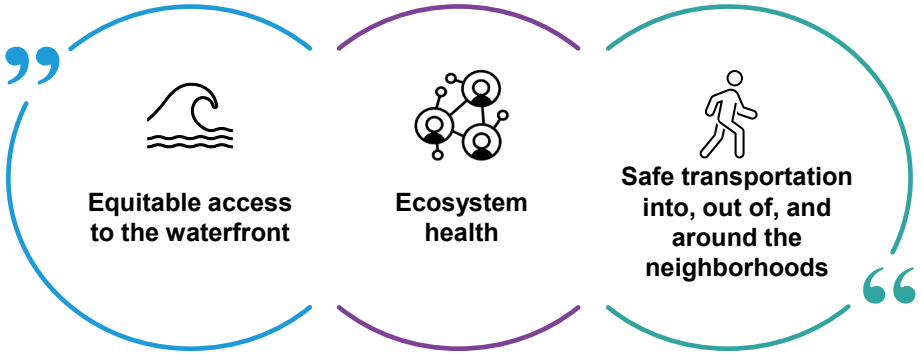


Figure 50. Social Equity for Waterfront Resiliency Planning

Establishing clear metrics endorsed by the City of Boston for incorporating social equity goals in the design of waterfront flood resiliency systems was extremely helpful in ensuring the design options studied by the WDC plan appropriately addressed the issues of social equity that are important to our community. This definition was also valuable as it provided authority for community groups like WDC to move forward with an agreed approach to addressing important considerations of equitable design, directly supporting the Wharf District Council's ability to build consensus amongst community stakeholders.