CITY OF MIAMI

RESILIENT WATERFRONT ENHANCEMENT PLAN

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Miami's waterfront, bounded by Biscayne Bay and the Miami River, is one of the City's most treasured assets. It is a vibrant setting of parks, walkways, and marinas with a rich history as an entertainment and cultural destination for the City's residents and visitors. In addition to serving as the City's economic and cultural core, the waterfront is also the first line of defense for coastal communities to withstand impacts from coastal storm surge flooding and sea-level rise.

The City's waterfront was developed in context of historic water level conditions. Much of the existing coastal development is located within six feet of existing sea level is now at risk due to sea-level rise. To address ongoing flood vulnerabilities that threaten the City's long-term resilience, the City has developed a Resilient Waterfront Enhancement Plan. This Plan lays out conceptual shoreline enhancement alternatives that will mitigate current and future flood risks while also emphasizing nature-based features that support local ecosystems in the design. The alternatives were designed as prototypes that can easily be expanded or applied to other stretches of the shoreline with similar characteristics. The Plan was designed to supplement the implementation of the City's Waterfront Design Guidelines (Miami21, Appendix B) that will reduce flood impacts from tidal events and storm surge, provide standards for aesthetic cohesion, help the City adapt to sea-level rise over time, and enhance waterfront access.

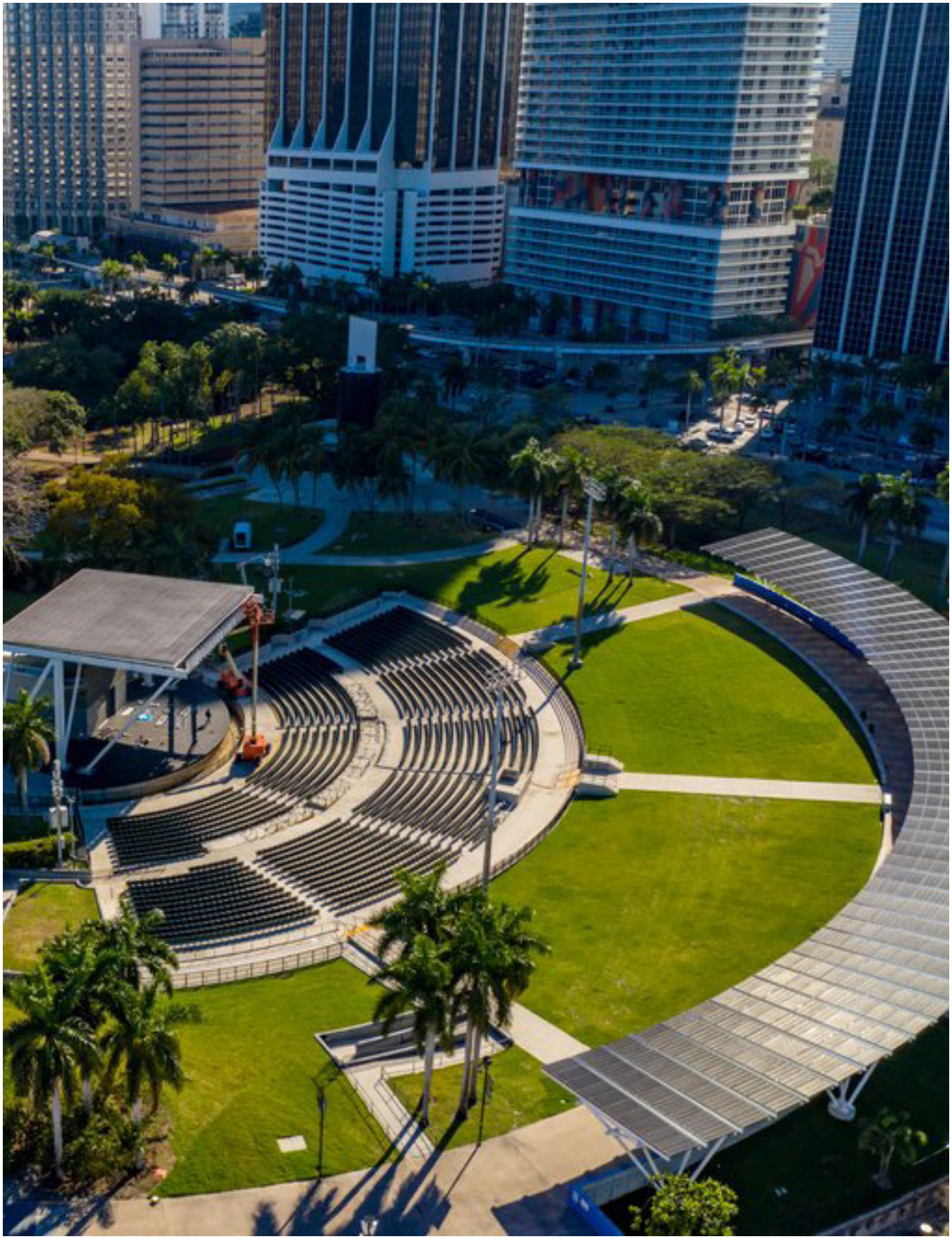
1.1 Project Overview and Purpose

The goal of the Resilient Waterfront Enhancement Plan is to present shoreline enhancement alternatives and provide guidance for the City to finance, procure, design, permit, construct, and maintain a waterfront that emphasizes nature-based design features.

To support this effort, the Plan includes a set of design alternatives that incorporate shoreline enhancement strategies at pilot locations along the waterfront. The pilot sites are representative of four common shoreline typologies across Miami: end-of-road on Riverfront, end-of-road on Bayfront, park on Riverfront, and park on Bayfront. The goal of the design typologies is to provide inspiration and ideas for shoreline enhancement strategies that are applicable and able to be implemented for a range of waterfront settings.

The City experiences common challenges with implementing nature-based projects, including hurdles of permitting concerns and timelines, grant requirements, lack of familiarity and/or maintenance concerns. Through this enhanced waterfront plan, the City aims to address these hurdles and provide easy-to-implement protocols and design criteria.

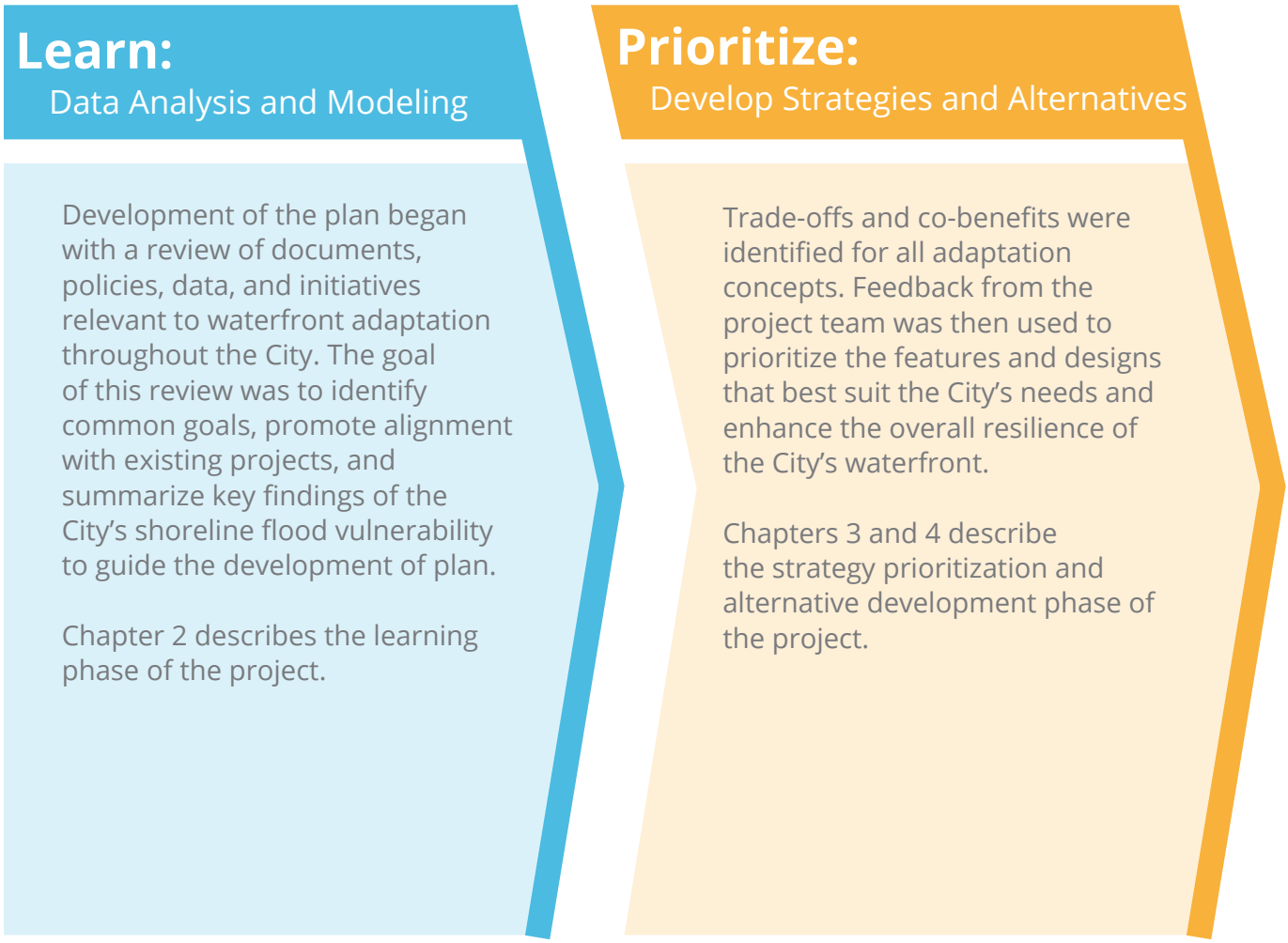
The Resilient Waterfront Enhancement Plan will also help the City implement "Goal 3" of the Miami Forever Climate Ready Strategy, which aims to reduce the City's risk of coastal and riverine flooding through a combination of nature-based and structural means.



1.2 Conceptual Approach

The framework used for the City of Miami's Resilient Waterfront Enhancement Planning process, shown in **Figure 1-1**, is organized around four interdependent themes: Learn, Prioritize, Permit, and Communicate. Each theme is designed to build on one another, creating an actionable plan that includes shoreline enhancement strategies that are innovative yet feasible, anticipates potential permitting hurdles, analyzes key waterfront issues facing the City, and is informed by close inter-agency coordination and engagement with the public.

Figure 1-1: Resilient Waterfront Enhancement Plan Framework



Permit:
Identify Permitting Design Criteria

To promote strategies that are compliant with regulatory requirements, potential design alternatives were shared with Federal, State and County regulatory agencies for guidance on potential permitting and implementation needs of the waterfront enhancement conceptual designs. Findings from this step were used to develop a comprehensive permitting guide that informs design considerations and serves as the first step in developing an implementation framework.

Chapters 5 describes the permitting exercises completed during this phase of the project.

Implement:
Strategies for Implementation

While permitting criteria is a critical step towards implementation, additional strategies for funding, phasing, construction, operations, maintenance, and engagement are necessary for the advancement of the design alternatives. The Interdepartmental Project Team, City Department Directors, and key stakeholders were routinely engaged to help develop and review the implementation strategies.

Chapter 6 describes the implementation phase of the project.

1.3 Report Organization

The plan is organized as follows:

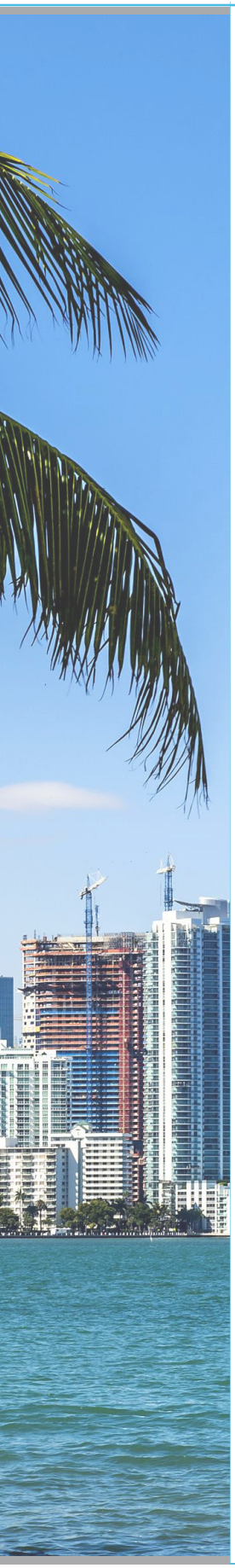
- **Chapter 1** – **Introduction**: Provides an overview of the plan scope, purpose, and organization.
- **Chapter 2** – **Setting and Context:** Provides a brief history of Miami's evolving shoreline and waterfront development to set the context for the Plan. Criteria includes discussion of the existing and future water levels along the City's waterfront and the implications of sea-level rise for the City's flood vulnerability.
- **Chapter 3** – **Building Resilience with Nature-Based Solutions**: Summarizes the development, evaluation, and prioritization of strategies to be considered in waterfront design alternatives.
- **Chapter 4** – **Design Typologies**: Describes the development of alternatives and supporting details for each representative shore type.
- **Chapter 5** – **Permitting Requirements**: Identifies key regulatory permitting requirements, agencies, and how they apply to the design alternatives .
- **Chapter 6** – **Implementation Strategies**: Summarizes the considerations and next steps to advance implementation of nature-based strategies in each of the focus areas.

1.4 Stakeholder Engagement

Stakeholder engagement was a key element to the success of the City's Resilient Waterfront Enhancement Plan. To ensure that this plan aligns with the needs and priorities of local stakeholders and agencies involved with planning, management, and preservation of the City's waterfront, the Resilient Waterfront Enhancement Plan was developed through close collaboration with the Interdepartmental Project Team. Members of the project team included representatives from the City of Miami Departments of Resilience and Public Works, Capital Improvements, Planning, Parks and Recreation, Office of Resiliency and Sustainability, and The Nature Conservancy. Continuous engagement with this core group provided the opportunity to learn about waterfront flood protection projects, to discuss the various ways the City is vulnerable to sea-level rise and flooding and how it affects the community, natural environment, and other assets, and to develop nature-based shoreline adaption strategies.

Federal, State, and County regulatory agencies were also engaged to discuss potential permitting requirements for prioritized strategies and design alternatives. Regulatory agencies involved included the United State Army Corps of Engineers, United States Fish and Wildlife Service, South Florida Water Management District, Florida Department of Environmental Protection, and the Miami-Dade County Division of Environmental Resources Management.

A targeted key stakeholder group formed of six organizations including local government, community groups, business organizations, and universities was engaged during the final stages of plan development to provide feedback, to refine the waterfront design alternatives, and to identify opportunities for potential partnerships needed for strategy implementation. The key stakeholder group included the Climate Resilience Committee, Architecture and Engineering (A/E), Land Use Attorneys, and the Construction Industry Discussion Group.



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The City of Miami's waterfront has experienced dramatic land use changes and development over the past century. Recognition of these changes and how they contribute to the City's vulnerabilities helps frame future actions that may be necessary to enhance the resilience of the waterfront.

The City is familiar with the challenges of accounting for flood risk and water management in urban design. However, living with the water today (and in the coming decades) does not look the same as it did historically. Due to climate change and associated sea-level rise, parts of Miami now regularly experience flooding during heavy rain events and King Tides. Rising water levels reduce the efficacy of gravity-fed stormwater systems which can prolong instances of urban flooding. Saltwater also continues to encroach landward, elevating coastal groundwater levels and flooding parts of the City from below.

This section describes the historical context of the City's evolving shoreline and provides a summary of existing policies and studies that influence future plans for waterfront enhancements. This section also includes analyses like existing water level conditions along the City's waterfront, observed historical changes in local sea levels, and future sea level projections. This includes mapped sea-level rise and storm surge scenarios used to identify key flood vulnerabilities along the City's shoreline.

2.1 History of Living with Water

Bounded by Biscayne Bay to the east, bisected by the Miami River, and underlain by a shallow groundwater aquifer, the City of Miami is shaped by its proximity to water. The City's 88 miles of waterfront that was once characterized by palmetto scrub and mangroves has since experienced a dramatic change.

These coastal wetlands once served as a sponge for excess stormwater and as a buffer against tropical storms. However, channelization of the Miami River and the draining and filling of floodplains removed many natural stretches of the shoreline while increasing access to the region.

Thus, the creation and expansion of this extensive water management system, which still operates today, led to rapid urbanization. With wetlands being drained and water channeled into a system of rivers and canals, the railroad system was extended. Subsequently, the construction of a major highway in the early 1900s soon followed, resulting in increased infrastructure investments and rapid population growth.

Floods remain one of the region's greatest water management challenges, but it is now exacerbated due to climate change, affecting the City's long-term resilience. A combination of seawalls, pumps, and drainage networks currently reduce flooding impacts to the City's waterfront. However, these gray engineered approaches to flood mitigation are increasingly challenged by rapidly changing and increasing performance needs due to sea-level rise and heavy precipitation. Historically, flood mitigation strategies have not prioritized environmental and water quality, as well as the health of aquatic ecosystems.

Over the past several decades, residents, community leaders, public officials, and agencies have increasingly recognized the role for nature-based solutions to mitigate flood risk and enhance the livability of the City. In addition to reducing the impacts of coastal hazards, nature-based features such as marshes, beaches, mangroves, and reefs have the added benefit of improving the health of adjacent waterways, increasing the aesthetics of the shoreline, and enhancing recreational opportunities.

Combined with this growing initiative to integrate more natural elements in to the City's urban fabric helps manage future climate conditions, is an increased effort to improve access to public waterfront areas. The City continues to make investments in its public waterfront areas and trails, such as the Baywalk and Riverwalk, to improve public awareness, connectivity, and safety for residents and visitors.

This story of Miami's waterfront reflects the community's complex and evolving relationship to the water's edge. Despite the significant changes that have occurred over the past century, the waterfront has continuously served as the social, cultural, historic, and economic core of the City. Recognition of the waterfront's evolution helps frame anticipated future changes in the decades ahead, such as the raising of the shoreline and buildings, using more nature-based approaches to flood protection, guiding future development, and changing land uses.

2.2 Existing Policies, Studies, and Design Guidance

The Resilient Waterfront Enhancement Plan was developed to create design concepts that address potential flood impacts based on existing and future sea-level conditions within the context of state and regional policies, and relevant studies. This section summarizes a review of documents, reports, and initiatives relevant to the Resilient Waterfront Enhancement Plan.

This is not an exhaustive list of waterfront planning and design studies completed in the region to date, but represents a subset of the most relevant documents and projects that were reviewed to provide local context and inform the development of the plan.

Nature-based Solutions Design Guidance

Table 2-1: Nature-based Solutions Design Guidance Studies Summary

Policy or Study	Summary
Waterfront Edge Design Guidelines (WEDG) Manual Waterfront Alliance 2018	• Describes a credit-based program to promote resilience, ecology, and access considerations in the planning and design of complex waterfront projects • Describes the point scoring for each category, the overall project certification process, and opportunities for tailoring solutions to support resilience, ecology, and access for a variety of waterfront uses (e.g., public parks, industrial)
Waterfront Resilience Miami, Florida: Advisory Services Panel Report Urban Land Institute 2019	• Provide strategic recommendations for addressing waterfront resilience along Biscayne Bay and the Miami River through the perspectives of design, finance, policy, and implementation • Recommendations include specific strategies focused on adoption of waterfront design guidelines, infrastructure financing strategies, transparent community engagement, and leveraging past plans and studies to inform actions moving forward
Nature-Based Solutions Guidance Engineering with Nature 2021	• Collection of 26 guidance documents authored by global experts to provide technical, policy, and economic guidance for integrating nature-based solutions into project design and management

City or Regional Initiatives / Studies

Table 2-2: City or Regional Initiatives/ Studies Document Summary

Policy or Study	Summary
City of Miami Seawall Ordinance City of Miami; Chapter 20 of the City's code pertaining to flood damage prevention [June 2020] City of Miami 2020	• Describes citywide revised standards of seawalls and waterfront barriers • Requires all new construction, reconstruction, and repair of seawalls, bulkheads, living shorelines, and all other flood protection features fronting tidally influenced areas have a minimum elevation of 6.0 feet NAVD88 • Requires the top of waterfront features fronting the Miami River or its tributaries to be constructed at a minimum elevation of 4.0 feet NAV88 with the ability to incrementally be raised at least two additional feet • New elevation standards were informed by seawall height analysis that showed structure elevations beyond 6.0 feet NAVD88 provide marginal benefits in the number of structures protected
Resilient305 Strategy Miami-Dade County, City of Miami, City of Miami Beach (2019) 100 Resilient Cities 2019	• Regional resilience strategy listing 59 actions to help local municipalities prepare and respond to climate change, social issues, and economic inequalities
Citywide Stormwater Master Plan (SWMP) City of Miami 2021	• Assesses the existing condition of the City's drainage infrastructure and water management features and identifies improvements needed to address existing and future capacity and flooding issues • Prioritizes recommendations to be included in the City's Capital Improvement Plan, taking into consideration changing climate conditions, including future sea-level rise, rising groundwater, and combined rainfall-storm surge events • Creates prioritized list of capital projects needed to address flooding Citywide which informs spending for $192 million from the Miami Forever General Obligation Bond funds for Stormwater Mitigation
Miami Forever Climate Ready City of Miami 2020	• Strategy to reduce potential impacts of climate change hazards over the next 40 years • Engaged residents in the process through a series of neighborhood meetings to determine priorities for adaptation • Closely aligns with multijurisdictional efforts for resilience, such as the Resilient305 Strategy and the Regional Climate Action Plan 2.0
Miami 21 - Appendix B: Waterfront Design Guidelines City of Miami 2009 Amended in 2010 & 2021	• Provides guidelines to create a cohesive Riverwalk and Baywalk experience for the 25 feet of public walkway that is required to be built and maintained on both public and private properties along Waterways identified in the Miami 21 zoning code • Goals include the creation of a more resilient waterfront which provides space and opportunities to accommodate potential flooding from both stormwater and sea-level rise through sustainable practices

City Park Redesign Projects

Table 2-3: City Park Redesign Projects Summary

Policy or Study	Summary
Morningside Park Resilient Shoreline Project City of Miami/ The Nature Conservancy 2021	• Waterfront park was redesigned to reduce ongoing and future flood risks for the park and adjacent communities • Design focused on enhancing elements of the park's natural waterfront for flood and erosion protection, (e.g., adding native vegetation to reduce erosion, adding a vegetated berm to raise the shoreline elevation, and expanding the intertidal zone to reduce wave energy) • Nature-based approach enhances the local Biscayne Bay ecosystem and increases the park aesthetic value, bolstering the park's overall resilience
Jose Marti Adaptive Redesign Project City of Miami 2020	• Design includes retrofitting portions of the existing seawall, constructing new seawall and living shoreline sections, and other coastal nature-based resilience improvements • Design goal of increasing the resilience of the park and the neighborhoods that surround it against flooding, natural hazards, and climate change impacts • The project was the first WEDG certified project in the City of Miami and includes water access enhancements such as a floating boardwalk, the addition of a water taxi slip, and maximizing waterfront viewing opportunities
Miami Coastal Alternatives Technical Memorandum City of Miami/ The Nature Conservancy, 2019 Jacobs 2019	• Describes an evaluation of four proposed project sites located adjacent to Biscayne Bay and their suitability to provide nature-based coastal defense flood reduction benefits to the property • Sites were selected based on existing flood vulnerability and active partnerships, which increase their ability to implement recommended strategies • Proposed improvements included a nature-based only strategy and a hybrid of nature-based and hardened shoreline strategy • Study also quantified the benefit cost ratio for each of the strategies, revealing a higher ratio for the proposed coastal defense projects that use natural strategies
Sewell Park and Margaret Pace Park Master Planning Documents City of Miami	• Documentation showing concept-level plan view ideas and photos of potential park amenities that will inform forthcoming Master Plans for the two park sites.

2.3 Existing Water Conditions

The current design of the City's waterfront is largely influenced by historically observed water level conditions. The City's coastal water levels fluctuate naturally throughout the day due to astronomical tides produced by the gravitational pull of the moon and sun. Typical water level conditions for Miami have an average range of 2.3 feet between high and low tides.

The City also experiences higher than normal tide events several times a year. Referred to as King Tides, these predictable high tide events occur seasonally in September through November when the alignment and position of the moon and sun creates a combined gravitational pull that causes higher than usual water levels. There are typically four to five King Tide events per season with about two days of "peak tide" occurring per event. When these King Tides result in surface flooding, the phenomenon is referred to as "sunny day flooding." During these events, coastal water can overtop low-lying areas of the shoreline and backflow through the stormwater network, temporarily flooding roadways and other infrastructure with seawater. King Tide events can also be exacerbated by easterly winds, rainfall, or storms, and high groundwater levels especially during the wet season, allowing high tides to reach farther inland and push water up into the City's canals and rivers. This highlights the need for a comprehensive consideration of flood protection strategies, particularly at the waterfront which receive much of the excess floodwater before it drains to the bay and river.

In addition to annual high tide events, the City of Miami also experiences tropical storms and hurricanes, which primarily occur during Hurricane Season, June through November. Storm surge and large waves, and tropical storm and hurricane conditions can cause coastal water to travel several miles inland due to Miami's low elevation and flat topography. Resulting effects from large-scale storm flood events can damage or destroy infrastructure and property, erode shorelines, and inundate coastal assets for up to several days.

Table 2-4 presents daily and storm tide levels affecting the City. Storm tide levels greater than a 25-year return period were modeled as part of the FEMA South Florida Storm Surge Study by simulating a large number of storm events using a coupled hydrodynamic and wave model. Storm tide elevations vary around the City's shoreline due to spatial variations in storm surge response to winds, air pressure, bathymetry, shoreline orientation, and wave effects.

Table 2-4: Existing daily tide levels and storm tide elevations at the City of Miami

Water Level	*Relative to:* NAVD88 (ft)
100-year Storm Tide Level†	6.9 to 10.5
50-year Storm Tide Level†	6.1 to 9.0
25-year Storm Tide Level†	3.5 to 4.9
10-year Storm Tide Level†	3.1 to 4.4
King Tide (varies year to year)	1.5 to 2.0
Mean Higher High Water (MHHW)*	0.7
North American Vertical Datum of 1988 (NAVD88)	0.0
Mean Sea-level rise (MSL)*	-0.5
Mean Lower Low Water (MLLW)*	-1.6

*NOTES: * Daily tide levels were estimated by NOAA based on analysis of observed water level data at the Virginia Key tide station (NOAA NOS #8723214) and are referenced to a 1983-2001 baseline (with a mid-point of 1992). Daily tide levels reported above have been adjusted to account for 0.43 feet of sea-level rise occurring from 1992 to 2020.*

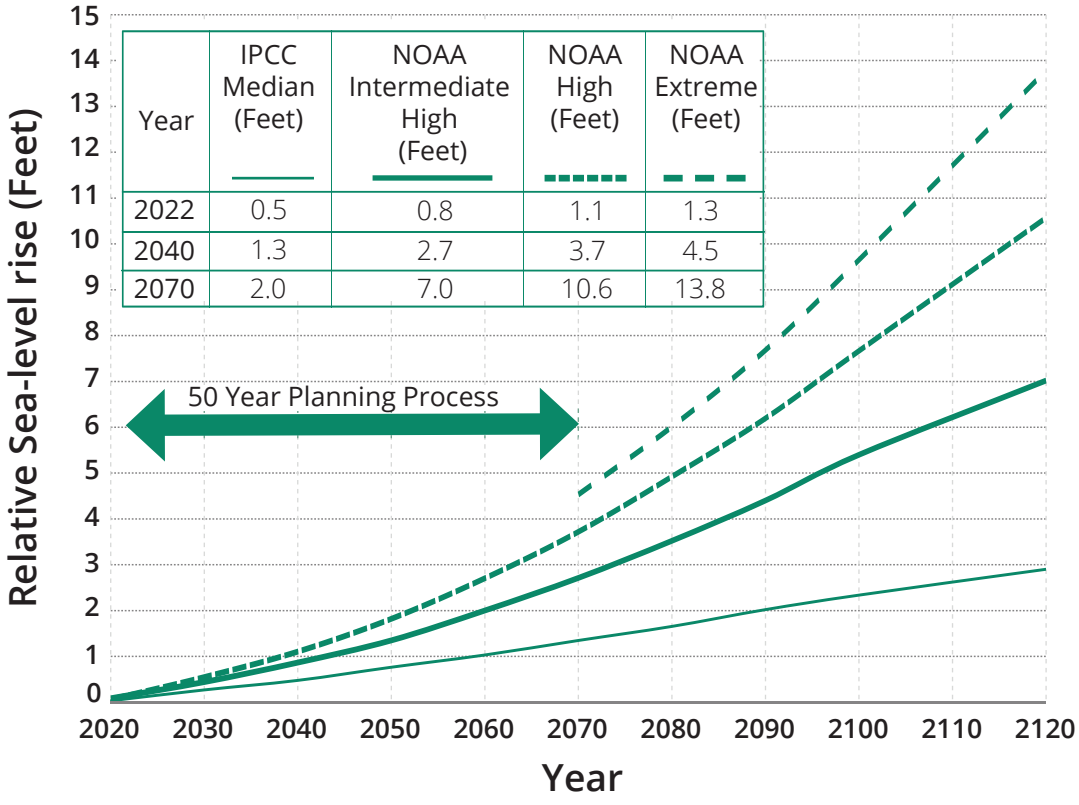
† Storm tide elevations were estimated as part of the FEMA South Florida Storm Surge Study (FEMA 2021) and have been adjusted to account for 0.43 feet of sea-level rise occurring from 1992 to 2020.

2.4 Observed and Projected Sea-level rise

Since its installation in 1931, tide measurements from the local Virginia Key tide station (NOAA NOS #8723214) show that sea levels have increased by 0.9 feet (NOAA 2021) (approximately 3 mm/year). Recent observations indicate that regional sea-level rise rates are also accelerating faster than global rates. From 2000 to 2017, sea levels in Southeast Florida increased by 3.9 inches (approximately 6mm/year) (Compact 2020). This acceleration is likely due to localized effects such as changes in the speed and thermodynamics of the Florida Current and Gulf Stream (Domingues et al. 2018; Sweet et al. 2018; Volkov et al. 2019).

In 2019, the Southeast Florida Regional Climate Change Compact (Compact) released an update of the Unified Sea-level rise Projections Guidance Report (Compact 2020), which outlines regional sea-level rise projections through the year 2120. The Compact guidance presents three curves for potential application to projects (**Figure 2-1**), depending on factors such as project lifespan, adaptability, and risk tolerance [see **Table 2-5**] (1) IPCC Median, (2) NOAA Intermediate High, and (3) NOAA High. A fourth curve, NOAA Extreme, is also included for informational purposes, representing the upper limit of sea-level rise in response to a potential massive Antarctic ice sheet collapse by the end of the century. Projections are updated every five years with the best available science. These projections are used by the City to inform stormwater capital projects.

Figure 2-1: Sea-level rise projections for Miami



Year	IPCC Median (Feet)	NOAA Intermediate High (Feet)	NOAA High (Feet)	NOAA Extreme (Feet)
2022	0.5	0.8	1.1	1.3
2040	1.3	2.7	3.7	4.5
2070	2.0	7.0	10.6	13.8

Note: SLR projections are representative of the Virginia Key Tide Station (NOAA NOS #8723214) location within Biscayne Bay have been adjusted to reference a baseline year of 2020.

Based on these projections, sea levels are mostly likely to range between 1.3 and 4.5 feet higher over the next 50 years, and 2.9 to 10.6 feet higher over the next century. Long term projections (2070-2120) have a significant range of variability due to uncertainty in climate dynamics and future greenhouse gas emission reduction efforts.

Table 2-5: Recommended applications of sea-level rise projections

Application of IPCC Median Curve
• Design life less than 50 years (<2070) • Low consequences associated with infrastructure failure • Infrastructure can be easily replaced • Highly adaptable • Limited interdependencies with other infrastructure/networks
Application of NOAA Intermediate High Curve
• Design life less than 50 years, but infrastructure may be in place for longer • Limited adaptability • Moderate to high consequences associated with infrastructure failure • Greater factor of safety is needed over the IPCC Median Curve
Application of NOAA High Curve
• Design life greater than 50 years (>2070) • Critical infrastructure • Infrastructure cannot be easily replaced or removed • Interdependencies with other infrastructure/networks • Catastrophic consequences associated with infrastructure failure

2.5 Waterfront Characteristics and Vulnerable Shorelines

Of the City's 88 miles of shoreline, 29 are publicly-owned and the remaining 59 miles are privately-owned. Publicly-owned areas of the waterfront are typically characterized by waterfront pedestrian trails, parks, or right-of-way areas located at the termination of roadways along the shoreline. Privately-owned waterfront typically consists of residential property, commercial development, or marinas.

The Resilient Waterfront Enhancement Plan focuses on developing design alternatives that represent common uses of publicly-owned shoreline, categorized by the following four typologies:

- **End-of-Road on Riverfront**
- **End-of-Road on Bayfront**
- **Park on Riverfront**
- **Park on Bayfront**

Pilot locations for each shoreline typology were selected.

Water Level and Sea-level rise Scenarios

To inform the Resilient Waterfront Enhancement Plan, future sea-level rise projections based on NOAA Intermediate-High were selected for the planning time horizons of 2020 (existing), 2040, and 2070 to align with Compact recommendations for near-term infrastructure planning. Each planning time horizon was evaluated under two water level conditions: 1) Annual Nuisance Flooding/King Tide and 2) Coastal Storm Flooding (**Table 2-6**).

Annual nuisance flood conditions were represented by a King Tide elevation of 2.0 feet NAVD88. The water level elevation corresponds with typical annual maximum high tide observations that occur during predicted fall King Tide events in addition to the tidal elevations. This elevation also aligns with other City flood planning initiatives, including the Stormwater Master Plan. Coastal storm flood conditions were represented by a storm surge elevation of 6.0 feet NAVD88. This water elevation corresponds to the stillwater storm conditions (in the absence of waves) experienced during Hurricane Irma, which caused widespread flooding throughout the City in September 2017.

Table 2-6: Planning water level and sea-level rise scenarios

Planning Time Horizon	Sea Level Rise (ft)	Annual Nuisance Flooding/ (King Tide, ft NAVD88)	Coastal Storm Flooding (Storm Surge, ft NAVD88)
2022 (Existing)	+0.0	2.0	6.0
2040	+0.8	2.8	6.8
2070	+2.7	4.7	8.7

These water level and sea-level rise scenarios were used to evaluate the potential exposure of the City's coastal and inland riverine areas to existing and future flooding. These scenarios were also used to assist with identifying pilot sites along the shoreline suitable for nature-based solutions for flood mitigation. This informed the design and schematics for flood protection strategies and design alternatives described in Chapter 4 (Building Resilience with Nature-based Solutions).

Key Flood Risks and Focus Areas

The sections that follow present an overview of citywide sea-level rise flood extents and the criteria used to select "pilot sites" that were evaluated for suitability of nature-based solutions for flood protection as part of the Resilient Waterfront Enhancement Plan.

Sea-level rise Flood Mapping

Sea-level rise flood maps were created to evaluate low-lying areas of the City's shoreline that potentially exposes inland areas and assets to annual nuisance floods/King Tide and temporary storm surge events. The flood maps were created by projecting different water level and sea-level rise scenario over the City's topography to estimate an inland flood extent boundary for existing (blue), 2040 (orange), and 2070 (yellow) water level conditions (**Map 2-1** and **Map 2-2**).

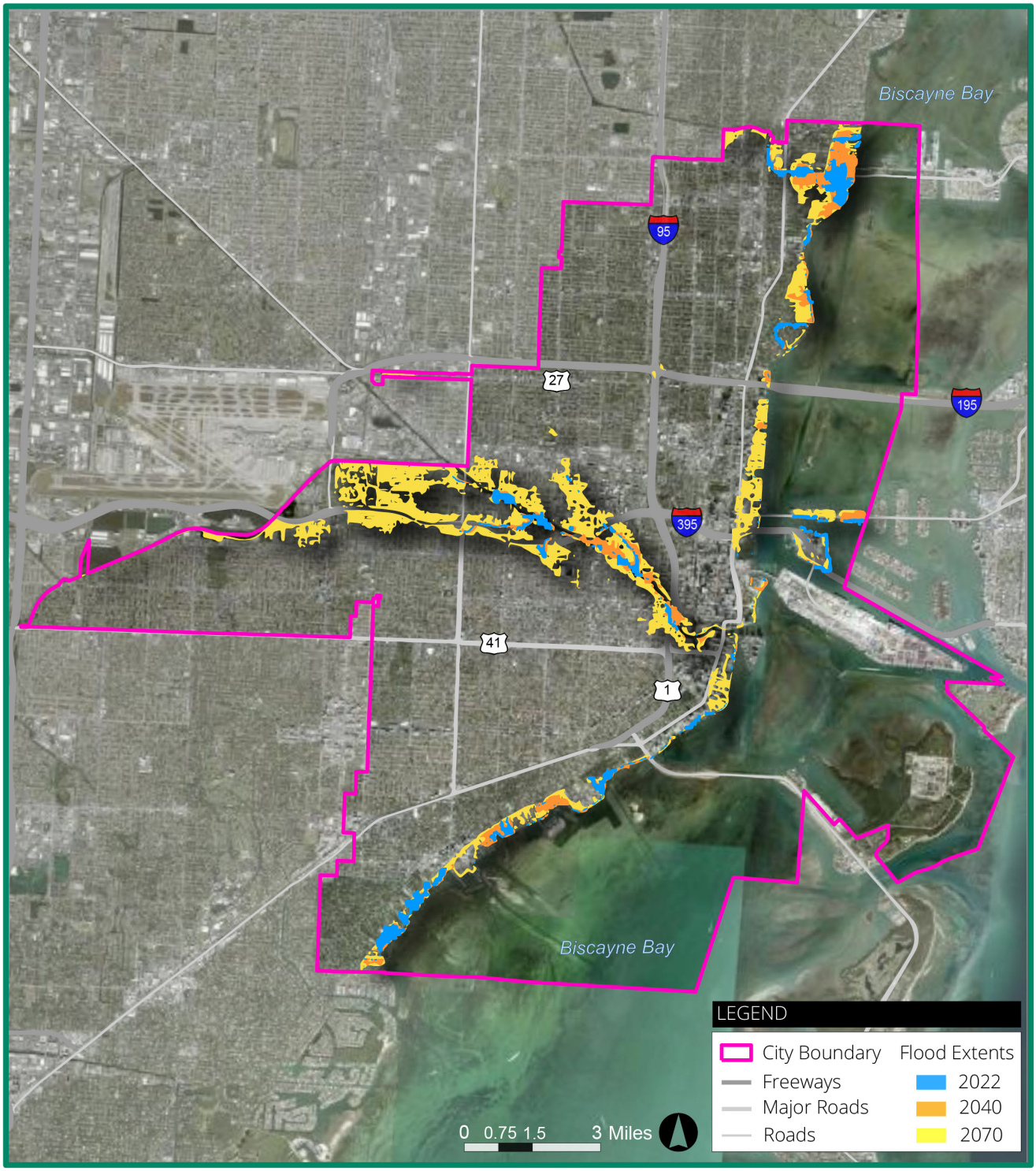
Flood Risk Without Intervention- Nuisance Floods/King Tide

Without shoreline improvements, only the immediate shoreline is currently exposed to annual nuisance floods/King Tide events. However, by 2040, flooding could expand to include low-lying waterfront areas, particularly within 400 feet of the Riverfront and within 700 feet of the Bayfront. By 2070, much of the City's waterfront shoreline could be overtopped by annual nuisance floods/King Tide events. Flood exposure extends to include areas within 1,000 feet adjacent to the Miami River or Bayfront.

Flood Risk Without Intervention- Storm Surge

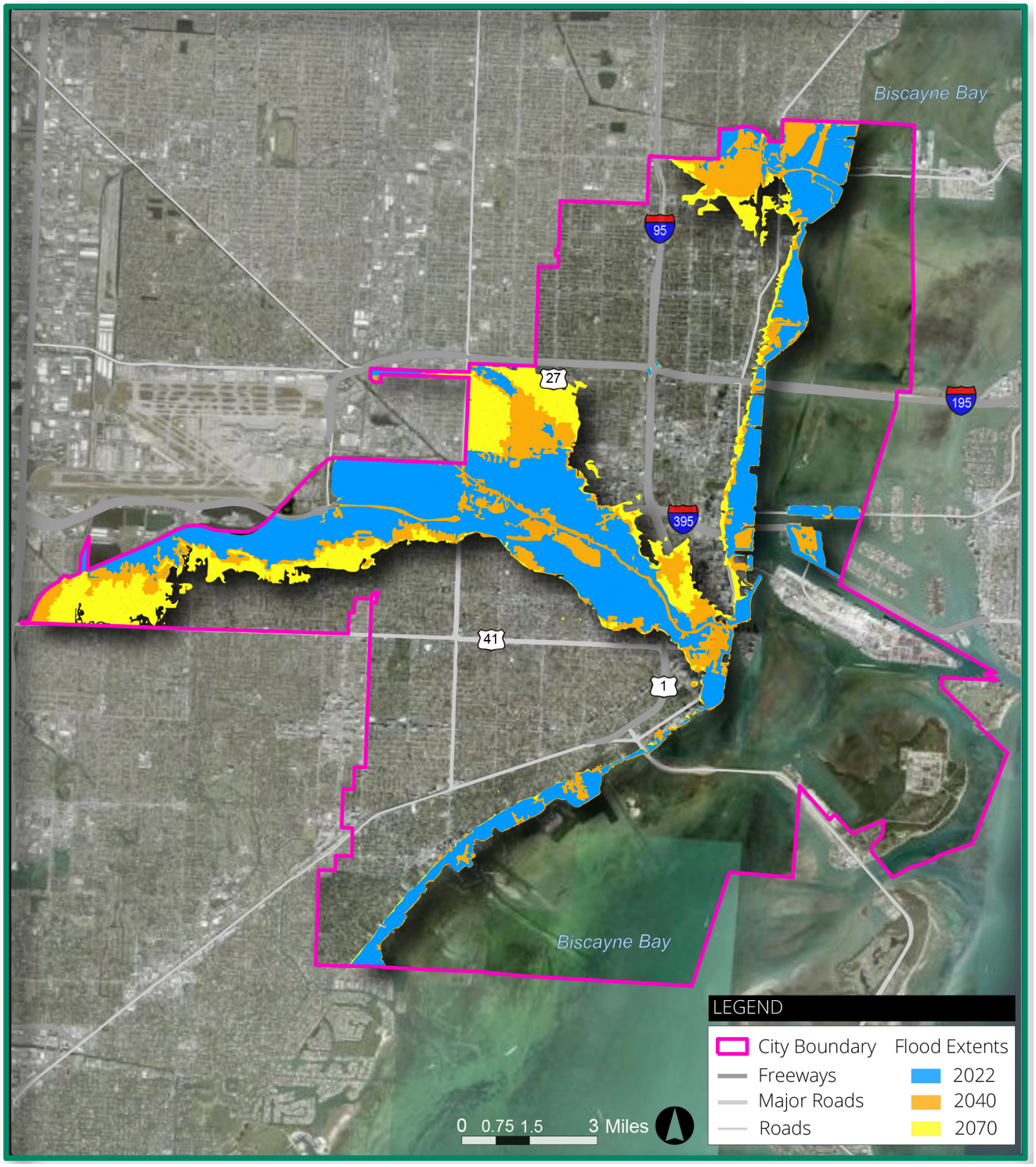
Much of the City's waterfront is already at risk to exposure to temporary flooding during storm surge events, particularly within 3,000 feet of the Miami River and within 1,500 feet of the City's Bayfront. By 2040, areas within 3,200 feet of the Riverfront and within 1,700 feet of the Bayfront may experience storm surge flooding. By 2070, areas within 3,700 feet of the Riverfront and within 2,000 feet of the Bayfront may experience storm surge flooding.

Map 2-1: Projected Nuisance Floods/ King Tide with Sea-level rise



MAP DISCLAIMER: The map is intended as a planning-level tool to illustrate the potential for coastal flooding along the Miami waterfront as sea levels rise and does not represent the exact location of flooding. The map is based on model output and does account for all the complex and dynamic coastal and riverine processes that contribute to flood events.

Map 2-2: Projected Coastal Storm Surge Flooding with Sea-level rise



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2.6 Pilot Sites

Nature-based shoreline enhancements evaluated in the Resilient Waterfront Enhancement Plan were designed using the concept of "pilot sites". Four pilot sites were identified to represent Miami's various waterfront landscape traits, flood dynamics, and vulnerabilities.

Selection of the four representative pilot sites were based on the following conditions:

- The site is representative of a shoreline typology (end-of-road Riverfront, end-of-road Bayfront, park Riverfront, or park Bayfront)
- The site is at risk to existing or future flood conditions
- The site is publicly owned shoreline or within public right of way
- The site reflects a variety of shoreline settings (e.g., high density, urban, suburban, natural)
- There is opportunity to increase existing environmental quality at the site
- The site has potential to provide social benefits (e.g., increased waterfront access) to adjacent communities served

Based on these considerations and discussions with the Project Advisory Committee, the following locations were identified as pilot sites for evaluation of suitable nature-based shoreline flood protection strategies:

- **NE 5th Ave (End-of-Road on Riverfront)**
- **NE 26th St (End-of-Road on Bayfront)**
- **E.G. Sewell Park (Park on Riverfront)**
- **Margaret Pace Park (Park on Bayfront)**

MAP DISCLAIMER: The maps shown on the following pages illustrate the flooding extents and is intended as a planning-level tool to illustrate the potential for annual nuisance flooding/King Tide and coastal storm surge along the Riverfront and Bayfront as sea levels rise and does not represent the exact location of flooding. **Tables 2-6 through 2-9** provide the average flood depth for 2022, 2040, and 2070 at each pilot site based on available data. These flood depths are based on a model output and do not account for complex and dynamic coastal and riverine process that contribute to average flood depths.

End-of-Road on Riverfront: NE 5th Ave

This site is an example of end-of-road on the Riverfront shoreline typology. It represents a sparsely developed shoreline armored by a low concrete seawall (**Figure 2-2**). Adjacent properties include a mix of low income residential housing and vacant land.

The site is currently at risk to shoreline flooding due to King Tide and storm surge events (**Map 2-3** and **Map 2-4**). In October 2020, a King Tide event with a water level elevation of approximately 2.1 feet (NAVD88) occurred, overtopped the shoreline and caused flooding of the end-of-road

Figure 2-3: October 2020 King Tide Flooding

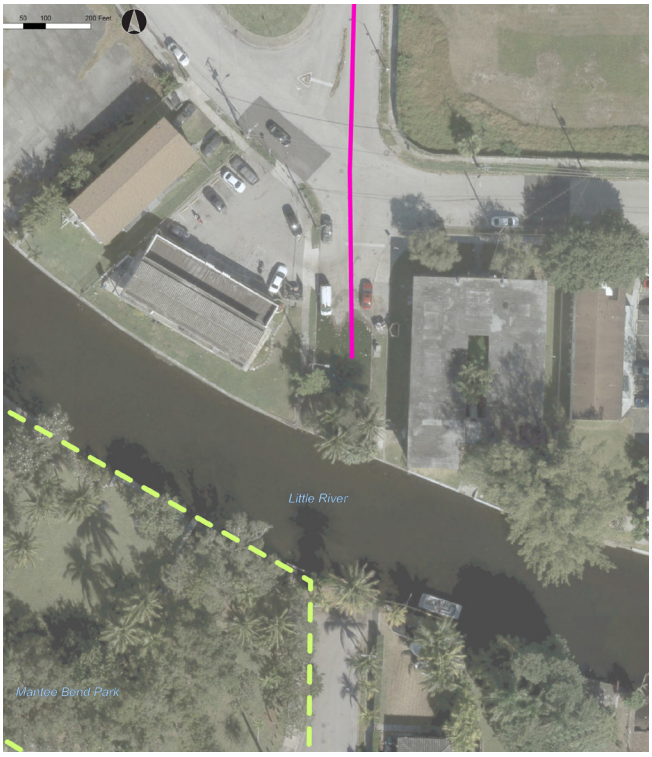
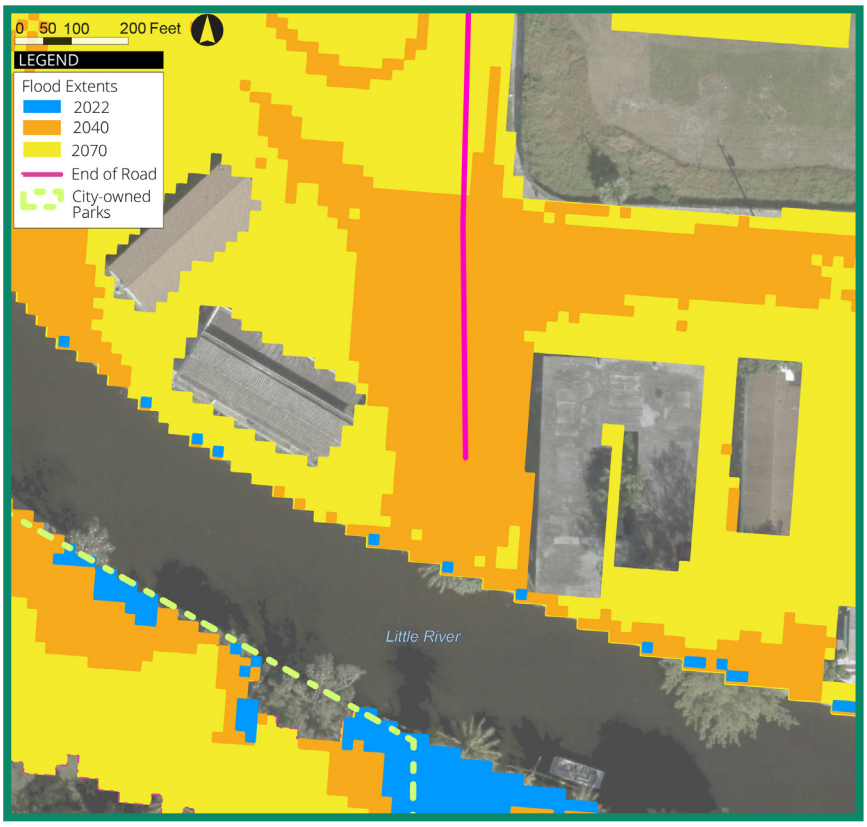


Figure 2-2: NE 5th Ave Aerial and Shoreline Conditions

Map 2-3: Projected Annual Nuisance/King Tide Flooding at NE 5th Ave Pilot Site



Map 2-4: Projected Coastal Storm Flooding at NE 5th Ave Pilot Site

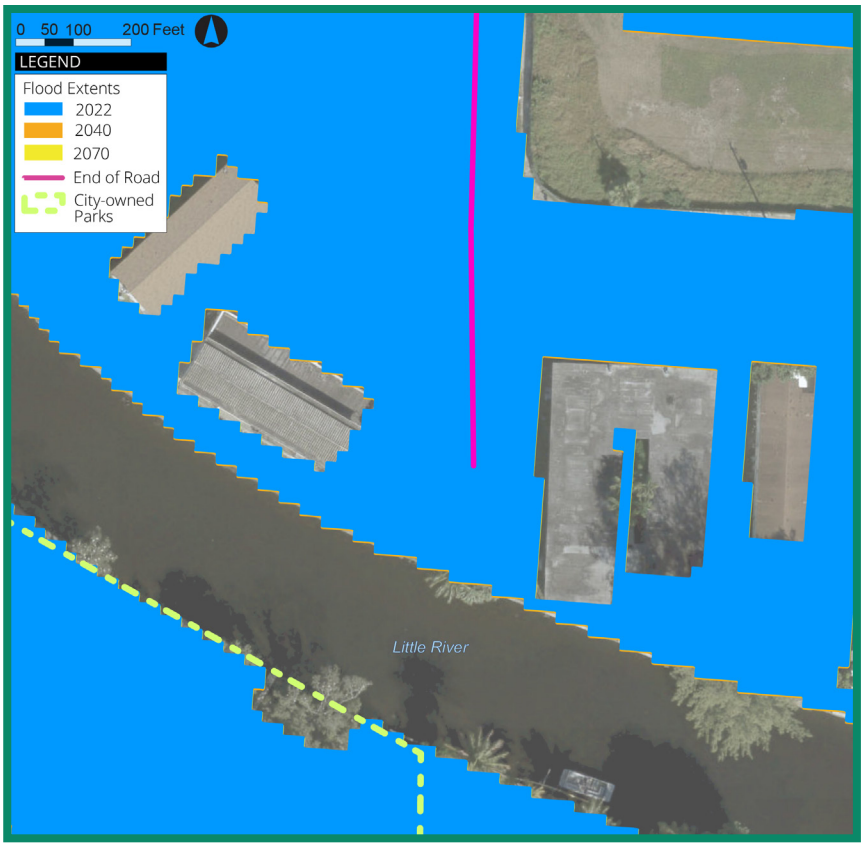


Table 2-6: Average Depth of Flooding for Sea-level Rise Scenarios - NE 5th Ave Pilot Site

Planning Time Horizon	Annual Nuisance Flooding/ (King Tide Depth, ft)
2022 (Existing)	0.0
2040	1.9
2070	2.0
Planning Time Horizon	**Coastal Storm Flooding (Storm Surge Depth, ft)**
2022 (Existing)	3.3
2040	4.1
2070	6.0

End-of-Road on Bayfront: NE 26th St

This site is an example of end-of-road on the Bayfront shoreline typology. It represents an urban shoreline that is hardened by a seawall. Similar to much of the Miami shoreline, the site has space constraints for large-scale shoreline enhancement projects due to a limited distance between the water edge and backshore development (**Figure 2-4**). Adjacent properties are characterized by high-density residential. Renovation and expansion of the Baywalk is currently planned for a pedestrian pathway that will cross the site. However, the modification of the seawall and water edge is not part of the existing plan.

The site is currently at risk to widespread flooding due to coastal storm surge events and heavy rainfall. Although the site does not currently experience annual nuisance flooding, the shoreline may be overtopped during King Tide events by 2070 (**Map 2-5** and **Map 2-6**).

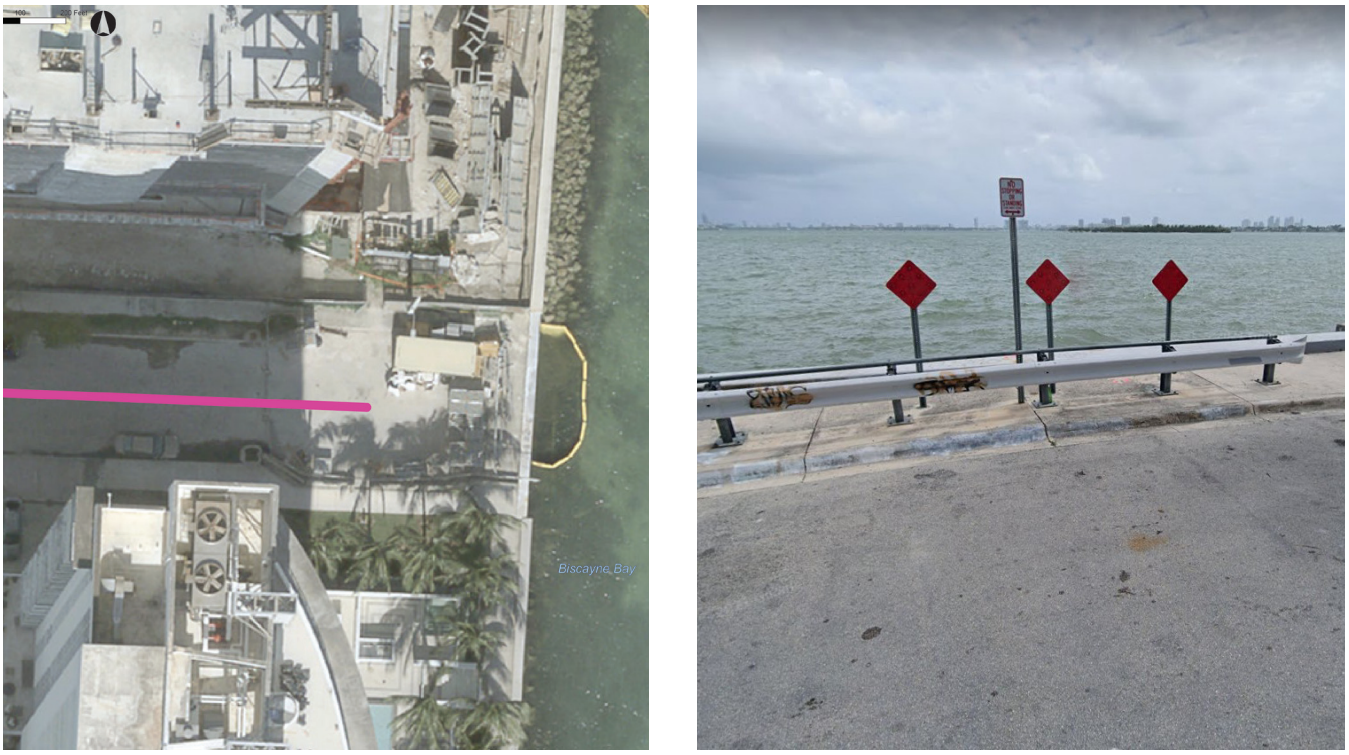
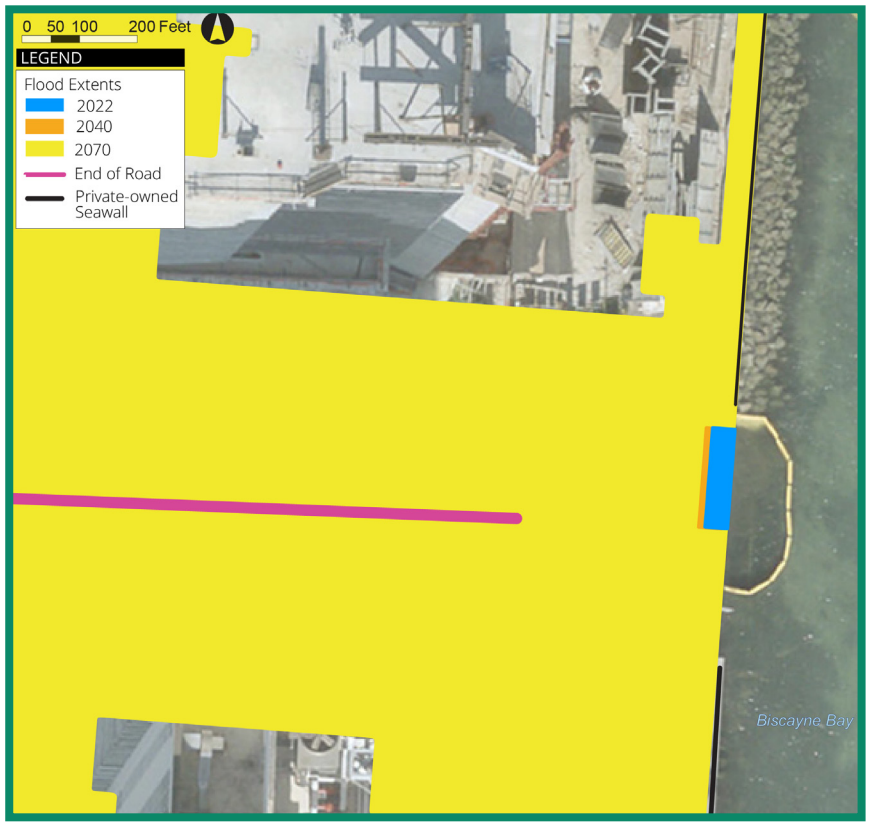


Figure 2-4: NE 26th St Aerial and Shoreline Conditions

Map 2-5: Projected Annual Nuisance/King Tide Flooding at NE 26th St Pilot Site



Map 2-6: Projected Coastal Storm Flooding at NE 26th St Pilot Site

Table 2-7: Average Depth of Flooding for Sea-level Rise Scenarios - NE 26th St Pilot Site

Planning Time Horizon	Annual Nuisance Flooding/ (King Tide Depth, ft)
2022 (Existing)	1.0
2040	1.4
2070	2.4
Planning Time Horizon	**Coastal Storm Flooding (Storm Surge Depth, ft)**
2022 (Existing)	3.8
2040	4.5
2070	6.4

Park on Riverfront: E.G. Sewell Park

This site is an example of a park on the Riverfront shoreline typology. Although the full length of the shoreline is hardened by riprap, it has a natural and undeveloped grass area, providing a potentially large footprint for shoreline enhancement alternatives (**Figure 2-5**). Adjacent properties include a mix of single family and multi-family residential areas that are served by the park's amenities.

The grass area is at shoreline elevation and currently at risk to widespread flooding due to storm surge, annual King Tide events, and heavy rain fall events. There is a ridge within the park that acts as a natural berm within the 250 feet of shoreline that helps protect extensive flooding from occurring further in the interior of the park. (**Map 2-7** and **Map 2-8**).

Shoreline enhancement strategies developed as part of the Resilience Waterfront Enhancement Plan for Sewell Park were designed with concepts already being prioritized for the park's forthcoming master plan.

Figure 2-5: Sewell Park Aerial and Shoreline Conditions

Map 2-7: Projected Annual Nuisance/King Tide Flooding at E.G Sewell Park Pilot Site

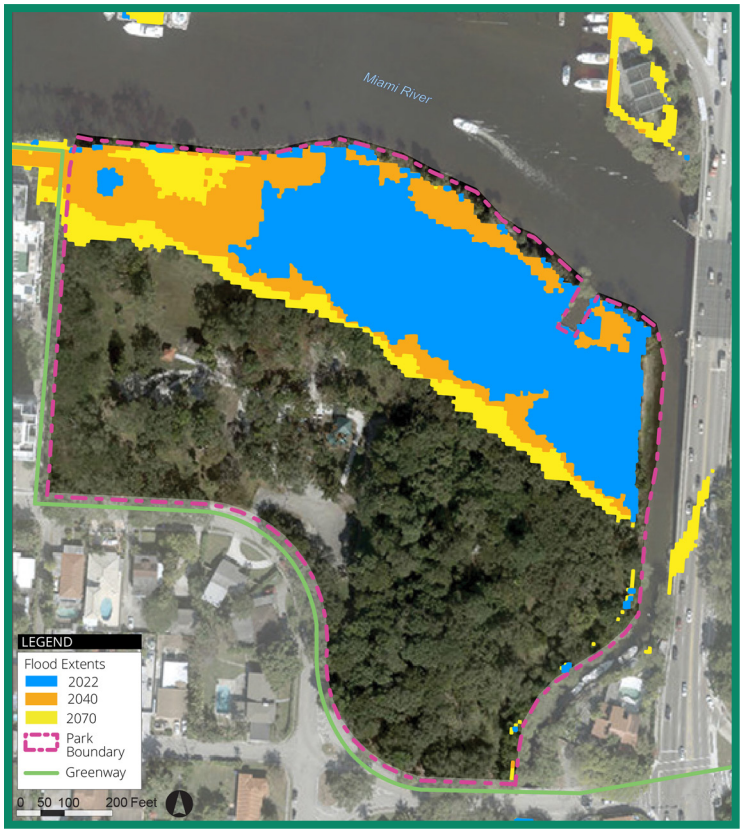
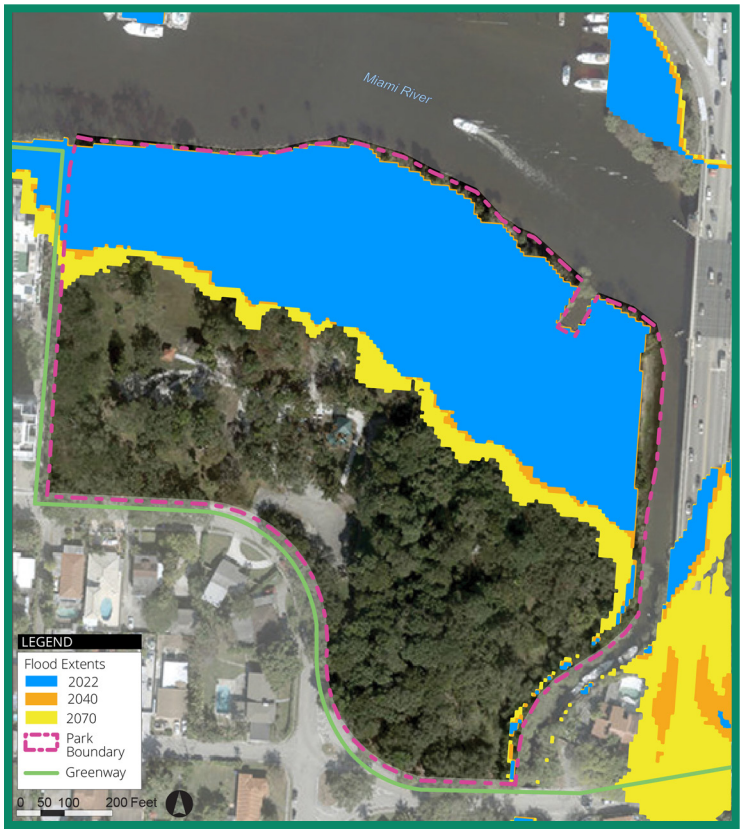


Table 2-8: Average Depth of Flooding for Sea-level Rise Scenarios - E.G. Sewell Park Pilot Site

Planning Time Horizon	Annual Nuisance Flooding/ (King Tide Depth, ft)
2022 (Existing)	0.5
2040	1.1
2070	2.8
Planning Time Horizon	**Coastal Storm Flooding (Storm Surge Depth, ft)**
2022 (Existing)	3.8
2040	4.5
2070	7.9

Map 2-8: Projected Coastal Storm Flooding at E.G Sewell Park Pilot Site



Park on Bayfront: Margaret Pace Park

This site is an example of a park on the Bayfront shoreline typology. The park is currently experiencing shoreline erosion and is hardened by riprap along the water's edge. There are several areas of established mangroves along the northern edge of the park, (**Figure 2-6**). The park provides access to greenspace and the water for several adjacent high-density residential properties.

The park is currently at risk to widespread flooding during storm surge events and experienced flood damage along the shoreline during Hurricane Irma in 2017 (**Figure 2-7**). Although the park is not currently at risk to King Tides, the extent of flooding during these annual events is expected to become extensive by 2070 (**Map 2-9** and **Map 2-10**).

Shoreline enhancement strategies developed as part of the Resilience Waterfront Enhancement Plan for Margaret Pace Park were designed in alignment with concepts already being prioritized for the park's forthcoming master plan.

Figure 2-7: Debris line from Hurricane Irma

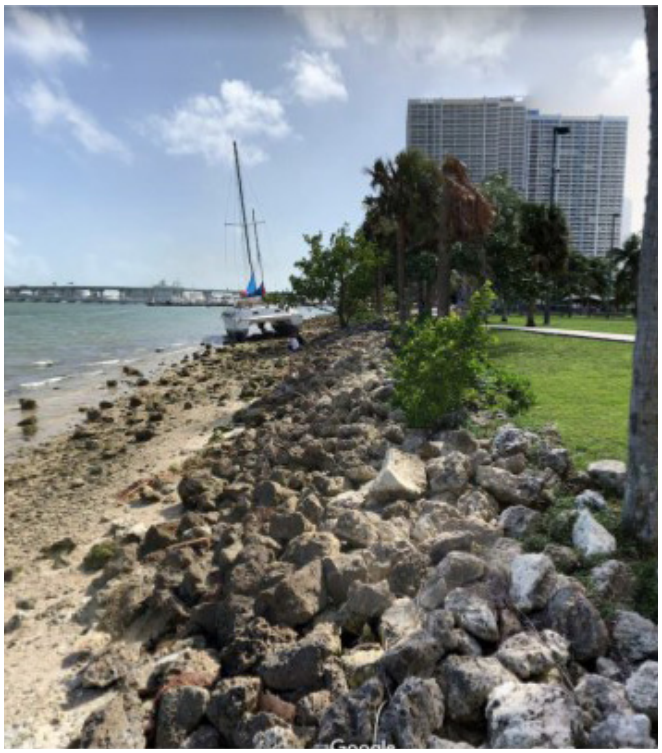


Figure 2-6: Margaret Pace Park Aerial and Shoreline Conditions

Map 2-9: Projected Annual Nuisance/King Tide Flooding at Margaret Pace Park Pilot Site

Table 2-9: Average Depth of Flooding for Sea-level Rise Scenarios - Margaret Pace Park Pilot Site

Planning Time Horizon	Annual Nuisance Flooding/ (King Tide Depth, ft)
2022 (Existing)	0.7
2040	1.5
2070	2.8
Planning Time Horizon	**Coastal Storm Flooding (Storm Surge Depth, ft)**
2022 (Existing)	2.1
2040	2.7
2070	4.1

Map 2-10: Projected Coastal Storm Flooding at Margaret Pace Park Pilot Site

CHAPTER 3

BUILDING RESILIENCE WITH NATURE-BASED SOLUTIONS

BUILDING RESILIENCE WITH NATURE-BASED SOLUTIONS

3

Nature-based solutions are defined by The Nature Conservancy as "project solutions that are motivated and supported by nature and that may also offer environmental, economic, and social benefits, while increasing resilience." It is an umbrella concept that includes many terms, including:

- Natural Infrastructure – intentional or strategic preservation, enhancement, or restoration of a natural system or semi-natural system to provide a desired benefit (e.g., flood protection, enhanced water quality, carbon sequestration).
- Low Impact Development – Systems and practices that use or mimic natural processes that result in a desired benefit, which is primarily for capture and onsite treatment of stormwater runoff.
- Ecosystem Services – Services provided by ecological systems to support human life.

This chapter discusses the process of incorporating nature-based solutions into the City's waterfront to address identified key flood vulnerabilities for each of the City's pilot sites discussed in Section 2.6.

3.1 Guiding Principles

A key objective of the project is to develop a set of nature-based design alternatives that provide near- and long-term flood protection for the City's waterfront while promoting the ecological and social resilience of the surrounding communities. For this project, an alternative is defined as a set of individual strategies that work together to achieve the project goals.

Several guiding principles were considered during the development of the proposed alternatives:

- **Flood Protection** - One of the primary goals of the project is flood protection for the City's waterfront communities. Project alternative designs reflect shoreline heights that comply with the City's seawall ordinance, using a minimum elevation of 6.0 feet NAVD88. Alternatives may also be designed to consider phased flood protection with implementation prioritized for the water edge, followed by waterfront amenities, and inland areas.

  Where possible, flood protection strategies aim to incorporate nature-based features that provide both flood protection and ecosystem services. More conventional gray infrastructure, such as elevated berms and seawalls, were also incorporated for some of the alternatives for a hybrid green-gray design to provide an enhanced level of flood protection for highly exposed locations.

- **Environmental Benefits** - Much of the City's waterfront is characterized by conventional gray infrastructure that is focused on flood and erosion protection with minimal concern for the adjacent ecosystems. Development of the design alternatives considered a number of strategies to enhance the provided environmental benefits and to create a more resilient shoreline. Targeted environmental benefits include restoration of existing and transitional habitats, stormwater retention, and water quality treatment.

- **Community Access** - Where possible, the proposed design alternatives consider ways to improve public waterfront access, including the use of trails, parking, or viewing opportunities. Art installations and interpretive signage was also incorporated to provide opportunities for educating the community and visitors about the benefits of nature-based solutions along the City's waterfront.

- **Stakeholder input** - Stakeholder input was solicited through regular meetings and workshops with the Project Team, City of Departmental Directors, and The Nature Conservancy. Federal, State, and County regulatory agencies were also engaged to discuss potential permitting requirements of developed design alternatives. Design alternatives were also presented to the City of Miami Climate Resilience Committee and the A/E Discussion Group to provide input on consistency with waterfront priorities.

3.2 Strategy Menu Development and Prioritization

The development of design alternatives was completed in multiple stages. During the first stage, the project team created an initial list or "menu" of shoreline strategies that could potentially be implemented along the City's waterfront. Strategies ranged from strictly nature-based (e.g., tidal vegetation and mangroves) to conventional gray infrastructure (e.g., bulkhead/seawall) and included documentation of benefits, challenges, and complementary strategies that could be used for hybrid protection. **Figures 3-1 and 3-2** on the following pages show the Shoreline Strategy Enhancement Strategy Menu and the typical cross-shore placement of the strategies in the menu.

To select and prioritize shoreline strategies, members of the project team were asked to select individual strategies that were applicable for each of the pilot sites based on their knowledge of existing priorities for the project location and what would be preferred by community members.

After selecting a subset of preferred strategies from the menu for each pilot site, participants evaluated each individual strategy using a set of criteria to score the performance of each proposed strategy (**Table 3-1**). For each strategy, participants assigned ratings ranging from very low to very high based on the criteria within each category. The goal was to qualitatively evaluate the trade-offs between the different criteria categories and select a set of strategies that were most balanced across the categories.

Preferences identified in the workshop were used to formulate different combinations of strategies to create a set of design alternatives for each pilot sight developed in Chapter 4 (Design Alternatives).

Table 3-1: Strategy Evaluation Criteria

Evaluation Category	Criteria
Engineering	Construction impacts (traffic disruption, environmental impacts, etc.)
	Ability to adapt over time
	Ability to be expanded to other locations
	Suitable for local site conditions
Environmental	Ability to protect, enhance, and expand ecosystem function
	Ability to improve water quality
	Ability to provide carbon sequestration benefits
Social	Improved water connection/access
	Enhances aesthetics of the site
	Ability to protect/enhance recreational opportunities
Feasibility	Capital costs
	Likelihood to obtain public support
	Strategy can be implemented within existing policies, procedures, and regulations

Figure 3-1: Shoreline Enhancement Strategy Menu

Softer Techniques - Smaller Waves, Smaller Fetch, Gentler Slope, Sheltered Coast

Vegetation Only	Stormwater Retention	Edging	Sills
Mangroves Benefits: • Dissipates wave energy • Reduces erosion • Provides habitat/increases biodiversity • Traps sediment • Carbon sink/sequestration • Water purification Challenges: • Requires maintenance/ monitoring until established • Efficacy requires more space Unmaintained plants may block water views • Limited high water protection Pairs Well With: • Revetment, (Living) Breakwater, Bulkhead/Seawall, Sills, Elevated berm **Tidal Vegetation/Seagrass** Benefits: • Dissipates wave energy • Reduces erosion • Provides habitat/increases biodiversity • Traps sediment • Carbon sink/sequestration • Water purification • Protection of seawalls Challenges: • Limited protection from large storms • Requires maintenance/ monitoring until established • Prone to degradation from pollutants/poor water quality • No high water protection Pairs Well With: • Revetment, (Living) Breakwater, Bulkhead/ Seawall, Sills, Edging, Elevated Berm, Elevated Platform	**Stormwater Retention/ BMPs** Benefits: • Treatment and storage of stormwater • Provides habitat Challenges: • Vegetation may be sensitive to saltwater inundation • Requires maintenance/ monitoring until established • No high water or coastal storm protection • Could be costly Pairs Well With: • Edging, Revetment, Breakwater, Bulkhead/Seawall, Sills, Elevated Berm	**Multifunctional Wave Attenuation** Benefits: • Dissipates wave energy • Reduces erosion • Promotes Water Access Challenges: • No high water protection • May require extension into water Pairs Well With: • Bulkhead/Seawall, Elevated Berm **Bio-logs** Benefits: • Dissipates wave energy • Reduces erosion • Provides habitat • Traps sediment • Filters stormwater runoff • Cost-effective Challenges: • Breaks down over time • No high water protection • Limited protection from large storms • May require routine maintenance Pairs Well With: • Vegetation, Sills **Vegetated Geogrid** Benefits: • Reduces erosion • Provides habitat • Adds aesthetic value Challenges: • Required maintenance until vegetation is established • Costly to install • Requires heavy equipment/ intensive labor to install Pairs Well With: • Sills, Breakwater, Bulkhead/ Seawall	**Oyster Balls/Bags/ Castles** Benefits: • Dissipates wave energy • Enhances water quality • Supports oyster restoration efforts • Boosts local economy • Reduces erosion • Provides habitat/increases biodiversity Challenges: • No high water protection • Damage caused by debris/ sedimentation • Monitoring and maintenance required Pairs Well With: • Seawall/Bulkhead, Vegetation **Marsh Sills** Benefits: • Dissipates wave energy • Slows inland water transfer • Provides habitat/increases biodiversity • Increases natural stormwater infiltration • Toe protection helps prevent wetland edge loss Challenges: • No high water protection • Requires more land area • Uncertainty of successful vegetation growth and competition with invasive species Pairs Well With: • Seawall/Bulkhead, Vegetation, Breakwater

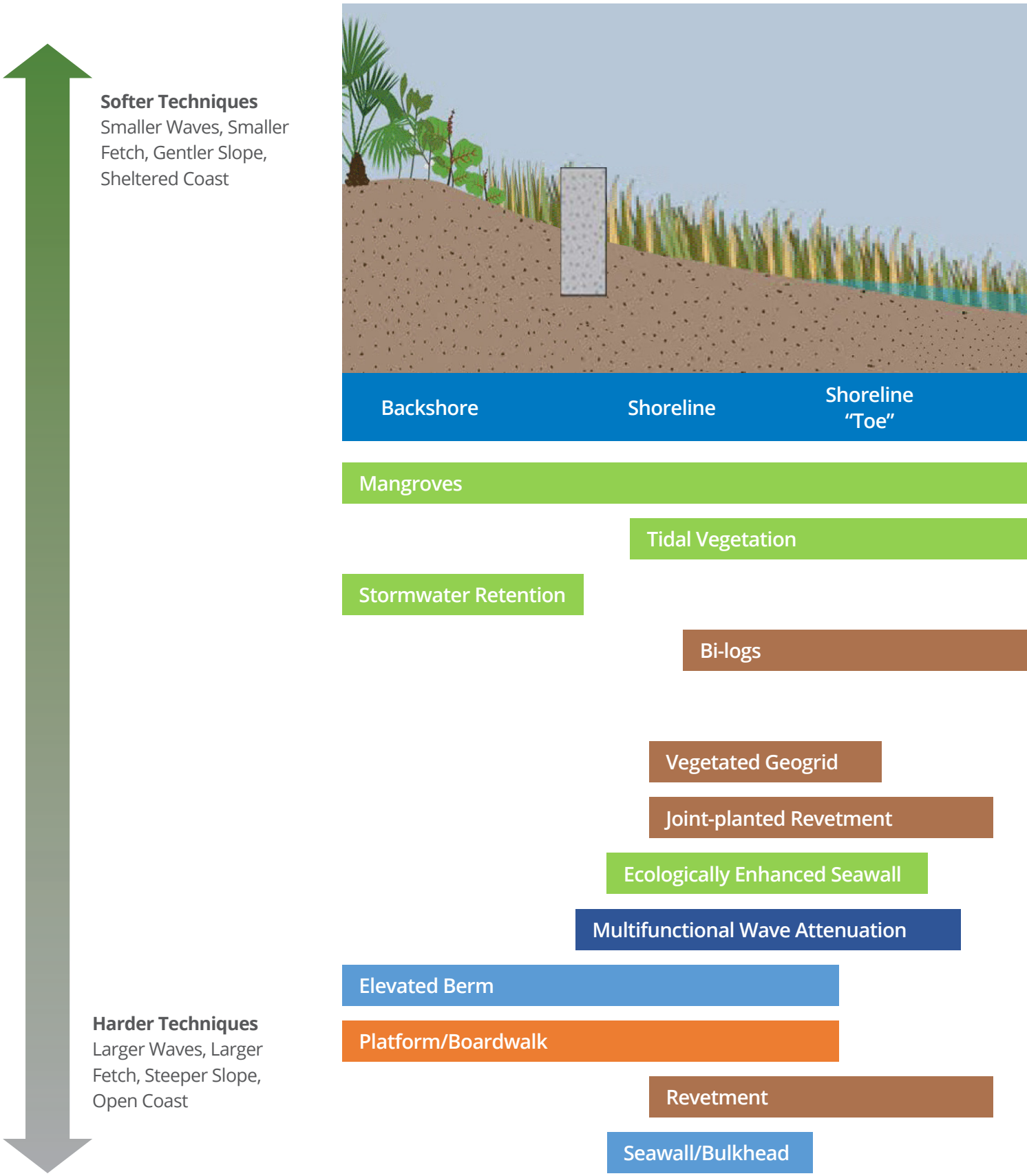
BUILDING RESILIENCE WITH NATURE-BASED SOLUTIONS

Flood Protection | Water Quality | Habitat Restoration | Wave Attenuation | Erosion Control | Scenic/Recreation Value

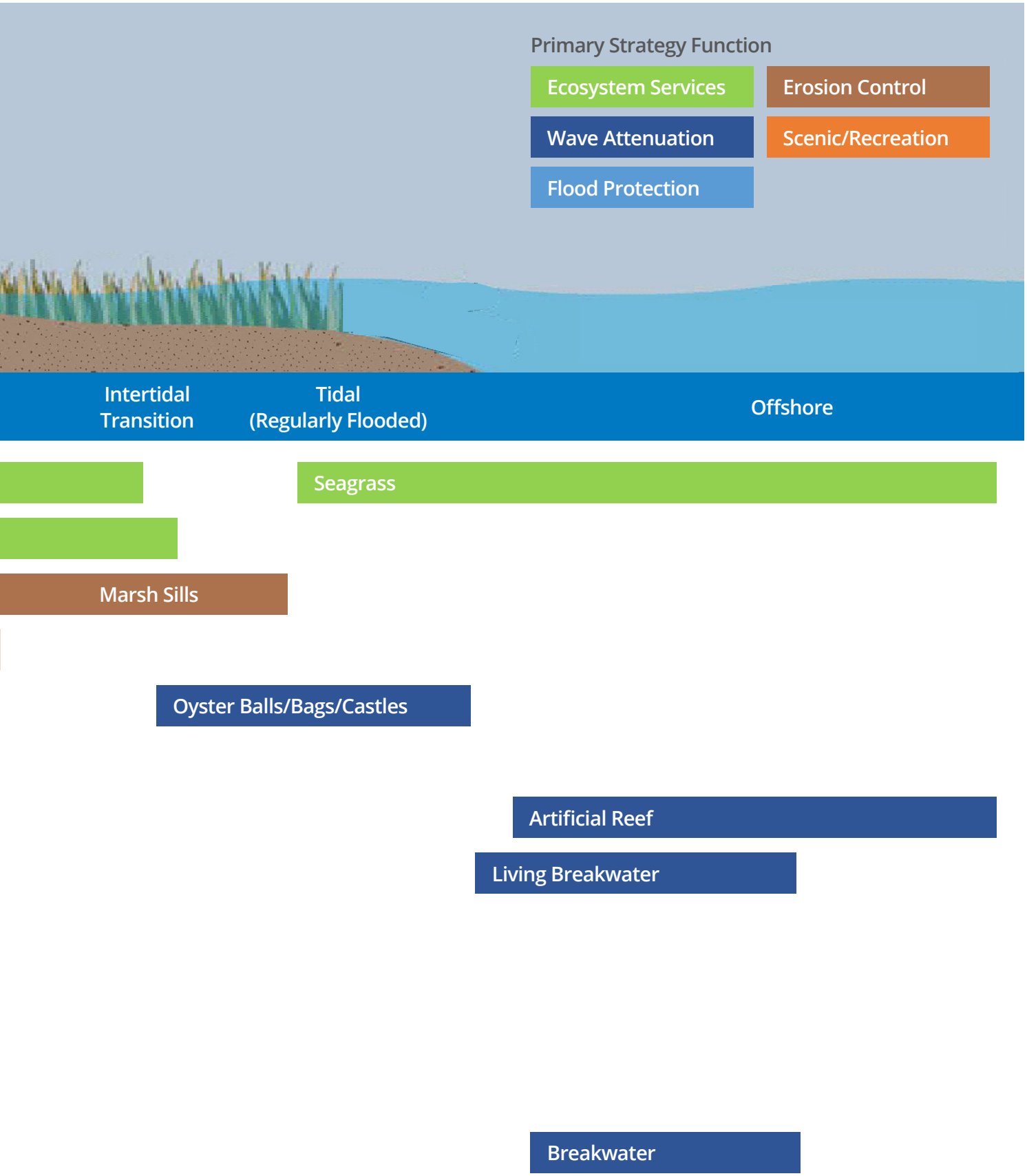
Harder Techniques - Larger Waves, Larger Fetch, Steeper Slope, Open Coast

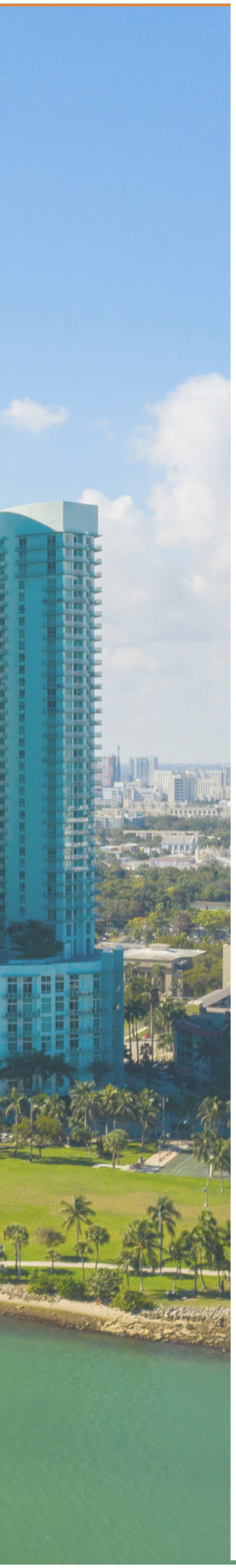
Elevated Features	Breakwater	Revetment	Bulkhead/Seawall
Platform/Boardwalk Benefits: • Promotes public/water access • Aesthetically pleasing • Increased educational opportunities • Low environmental impacts Challenges: • No coastal hazard protection • Damage caused by debris • Can shade out vegetation if used in tandem Pairs Well With: • Seawall/Bulkhead, Vegetation, Revetment, Edging, Sills, Vegetation **Elevated Berm** Benefits: • Provides protection from waves and flooding • Adaptable to higher elevations over time • Can be designed for multipurpose use Challenges: • Vulnerable to erosion without supplemental strategy • Costly to install • Requires heavy equipment/ intensive labor to install • Routine maintenance necessary Pairs Well With: • Revetment, Vegetation, Sills,(Living) Breakwater	**Breakwater** Benefits: • Reduces wave energy • Reduces storm surge flood levels • Promotes sediment accumulation • Easy to repair if damaged • Can provide offshore habitat • Supports recreational opportunities Challenges: • No high water protection • Requires heavy equipment/intensive labor to install • Not aesthetically pleasing • May pose danger to watercraft Pairs Well With: • Vegetation only, Edging, Sills, Revetment, Bulkhead/Seawall **Living Breakwater** Benefits: • Reduces erosion • Enhances habitat/increases biodiversity • Supports recreational opportunities Challenges: • No high water protection • Requires heavy equipment/intensive labor to install • May pose danger to watercraft • Requires maintenance/monitoring until established Pairs Well With: • Vegetation only, Edging, Sills, Revetment, Bulkhead/Seawall **Artificial Reef** Benefits: • Provides habitat/increases biodiversity • Dissipates wave energy Challenges: • Requires maintenance/monitoring until established • No high water protection • May pose danger to watercraft Pairs Well With: • Vegetation, Edging	**Revetment** Benefits: • Reduces wave energy • Stabilize shoreline through rocks or other materials on the sloping shoreline • Provides toe protection Challenges: • No high water protection • Prevents upland sediment to estuarine habitats • Requires heavy equipment/intensive labor to install Pairs Well With: • Joint-planted Revetment, Edging, Seawall/Bulkhead **Joint-planted Revetment** Benefits: • Enhanced habitat of revetment • Increased educational opportunities • Increased wave/current reduction and sediment trapping • Reinforces revetment Challenges: • Plantings may die out if they become inundated by tides • Vegetation may be sensitive to water quality • Requires maintenance/ monitoring until established Pairs Well With: • Revetment	**Seawall/Bulkhead** Benefits: • Fixes shoreline position • Provides flood protection • Reduces wave impacts Challenges: • Increases erosion of adjacent areas • Maintenance and elevation necessary over time • Provides no ecological benefits • Costly to install • Requires heavy equipment/ intensive labor to install Pairs Well With: • Revetment, mangroves, sills, ecological enhanced seawall, oyster balls **Ecologically Enhanced Seawall** Benefits: • Enhanced habitat of armored structure • Increased wave energy dissipation • Increased educational opportunities • Enhanced aesthetic value Challenges: • Success of ecosystem enhancement may depend on local water quality • Requires maintenance/ monitoring Pairs Well With: • Seawall/bulkhead

Figure 3-2: Typical Cross-Shore Strategy Placement



BUILDING RESILIENCE WITH NATURE-BASED SOLUTIONS





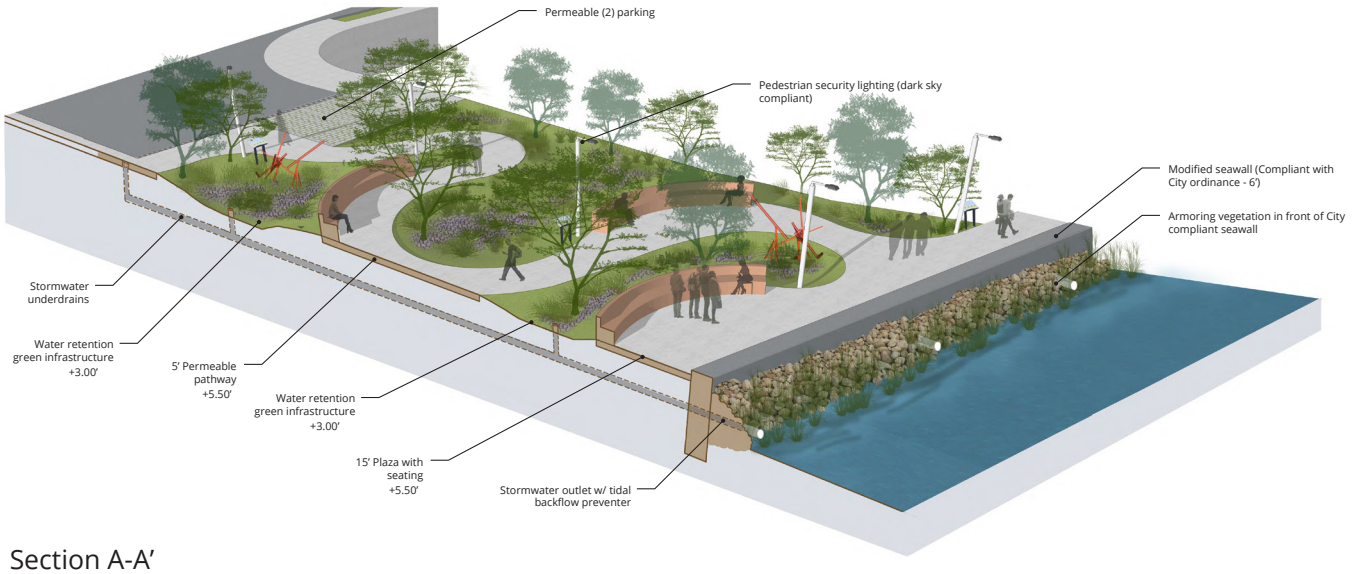
4

The figures in the following pages summarize the conceptual shoreline enhancement alternatives for each waterfront typology. Elements in each alternative include features and individual strategies that will be incorporated into concept-level sketches for each alternative. Alternatives for each location range in complexity, required modification, and level of nature-based features in the design. Alternatives on the left side of the tables are associated with a lower amount of intervention, less complexity, and typically have a more gray or traditional urban design. Conversely, alternatives on the right side of the tables require more intervention at the site, a more complex design, and incorporates more nature-based features.

4.1 Typology 1: End-of-Road on Riverfront - NE 5th Ave

Existing Site Photos

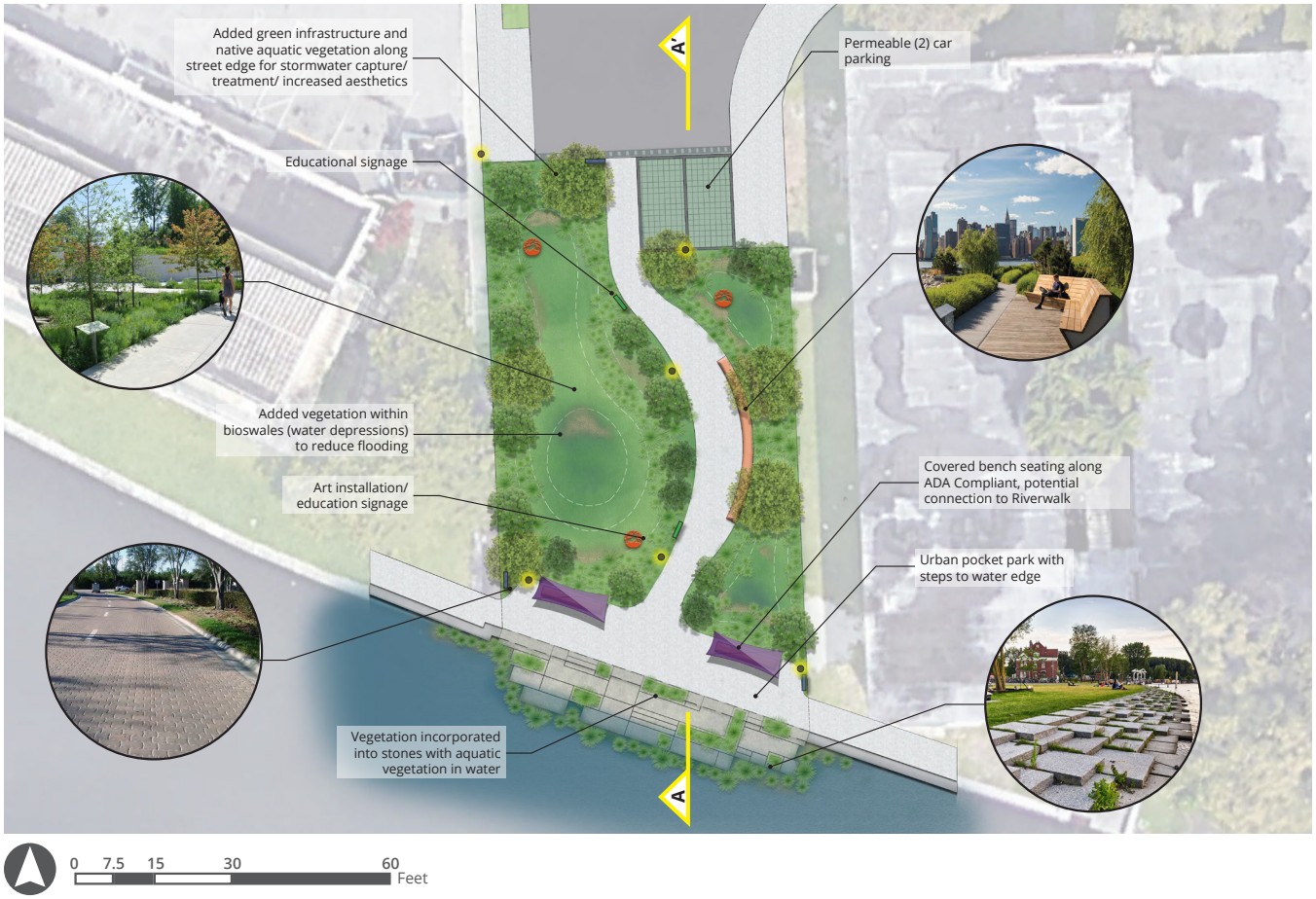
Alternative 1

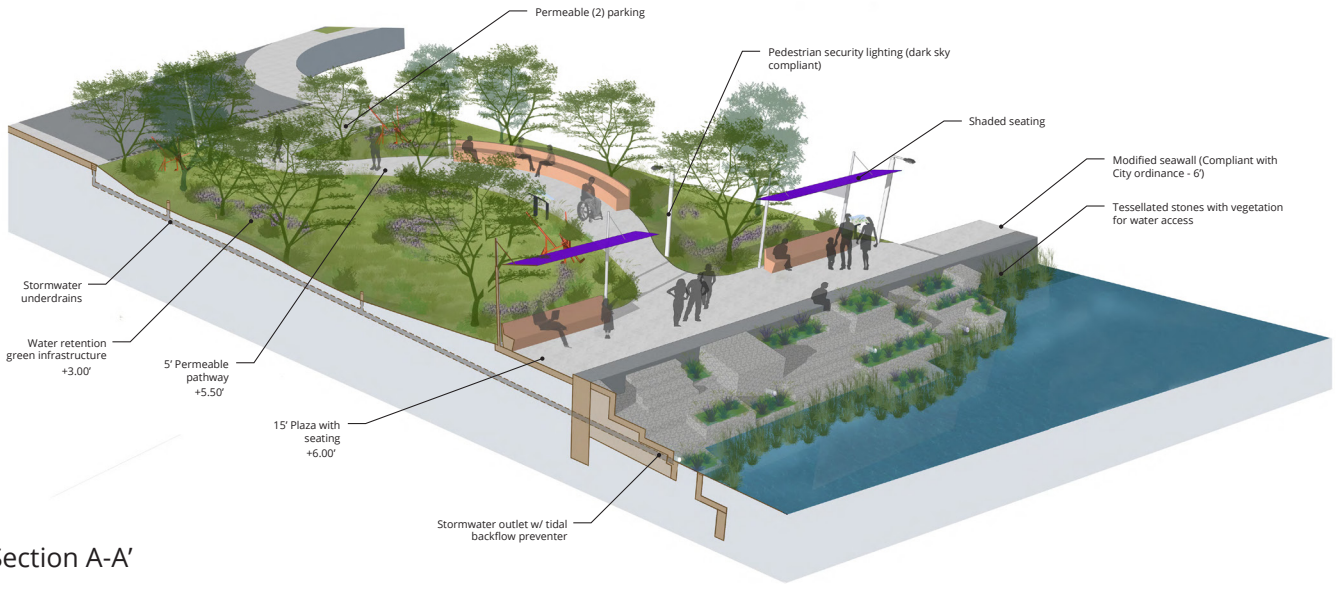


Section A-A'

Figure 4-1: End-of-Road on Riverfront - NE 5th Ave: Alternative 1

Alternative 2

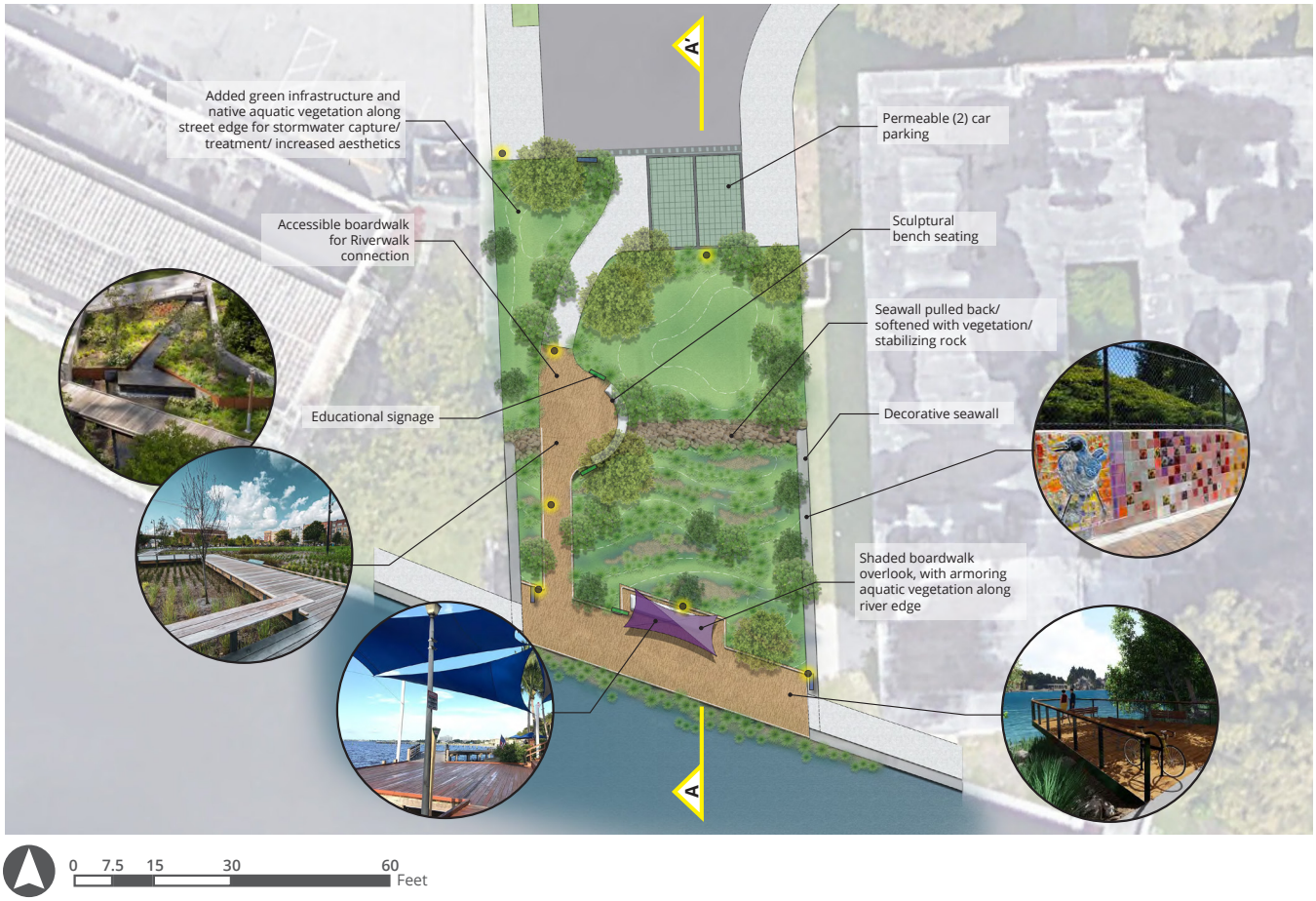


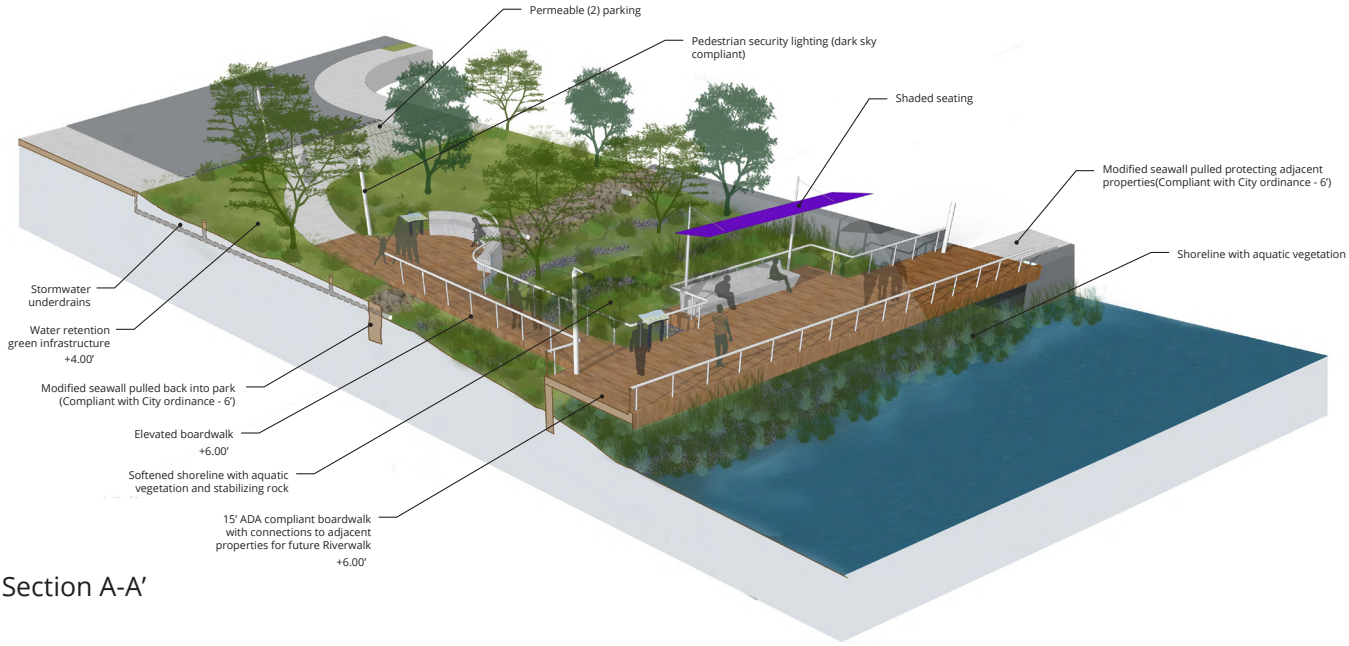


Section A-A'

Figure 4-2: End-of-Road on Riverfront - NE 5th Ave: Alternative 2

Alternative 3





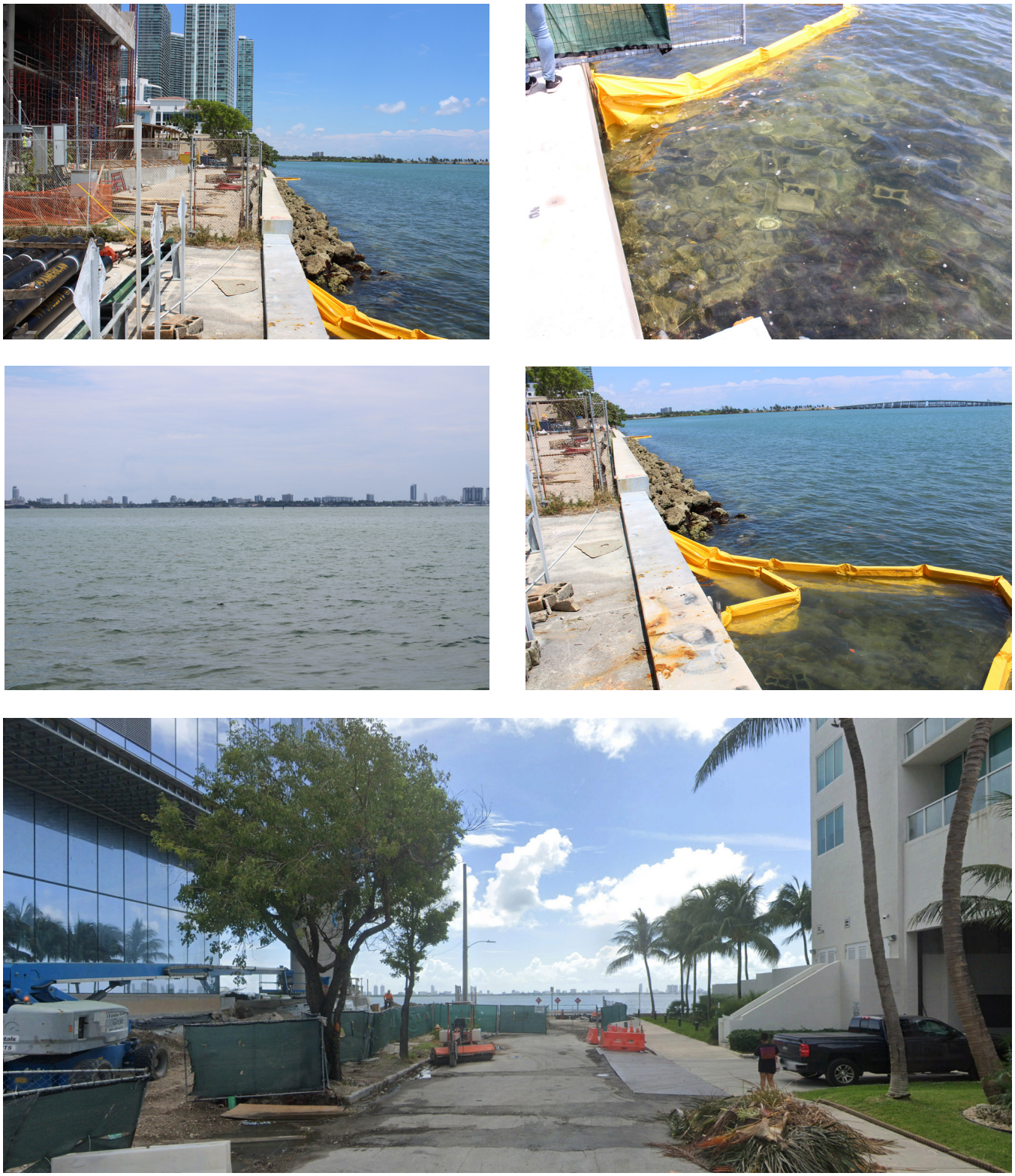
Section A-A'

Figure 4-3: End-of-Road on Riverfront - NE 5th Ave: Alternative 3

Alternative Summaries

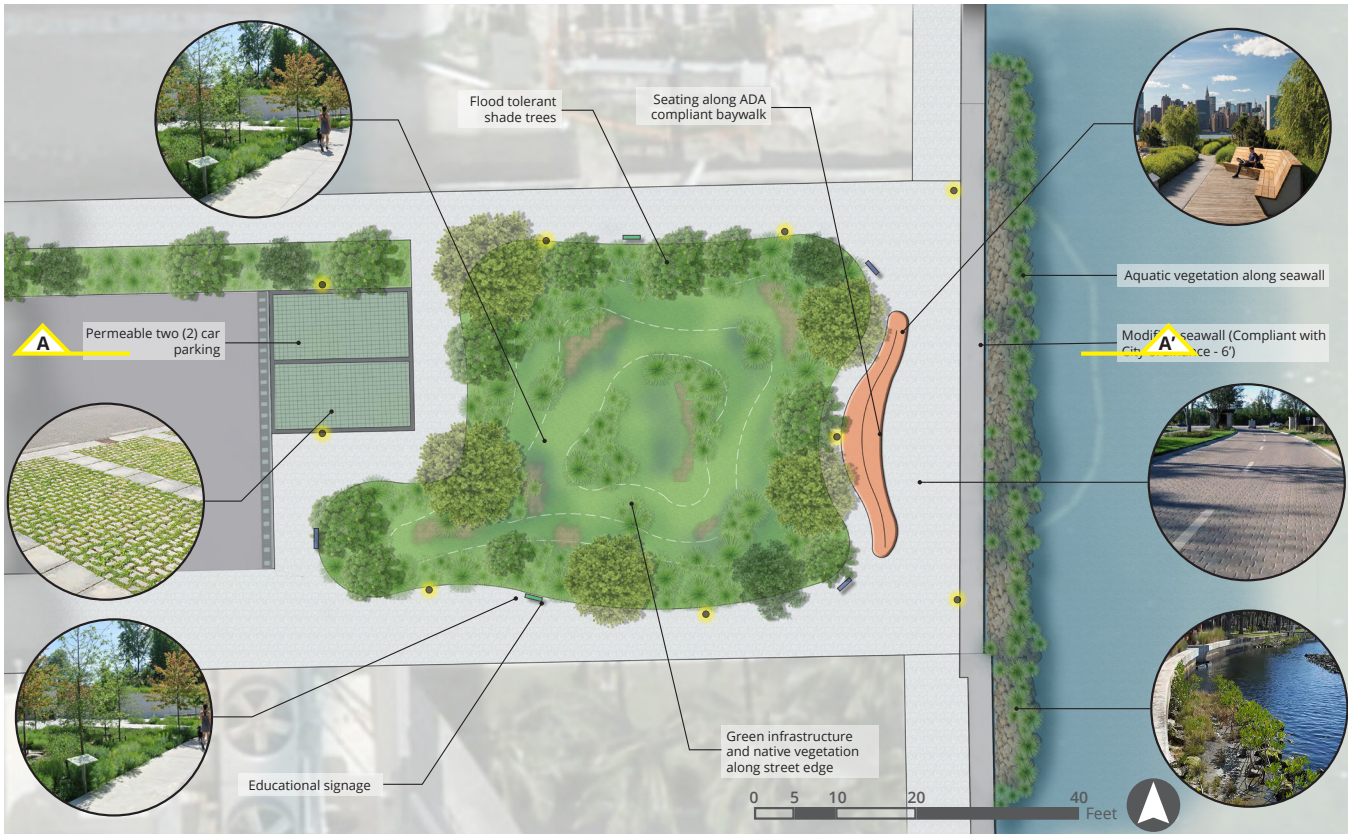
Less Intervention Lower Complexity More Gray/Traditional		More Intervention Higher Complexity More Green/Nature-based
Alternative 1	**Alternative 2**	**Alternative 3**
Theme: Pocket Park with no water access; focus on elevated green space and water views	**Theme:** Pocket park with water access	**Theme:** Elevated walkway along river, soften seawall
• Elevated seawall to be compliant with City seawall ordinance ~ 6ft • Added vegetation in front of seawall • Added green infrastructure and native vegetation in park for stormwater capture/treatment/ increased aesthetics • Picnic/ seating to view water • Install/ incorporate shade sails/ shade trees within seating area • Include ADA sidewalks for future Riverwalk connectivity • No direct water access	• Elevated pocket park with permeable paving and green infrastructure for stormwater capture/treatment/ increased aesthetics • Pull seawall back and add terraced/ stepped transitional habitat and path to water edge • "Tessellated" stones providing water access, incorporate vegetation planters into steps to prevent illegal docking • Install shade sails along pocket park amenities (seating areas) • Include ADA sidewalks for future Riverwalk connectivity	• Elevated walkway with ADA compliance that extends beyond the site boundary (follows waterfront) • Preserving navigable channel for water transportation as well as ensure future Riverwalk connectivity • Add terraced naturalized shoreline with native vegetated river edge • Maintain viewshed with seating • Add more shade trees within site and along the street edge (species to be tolerant to flooding) • Include ADA sidewalks for future Riverwalk connectivity • Incorporate local art installation into design

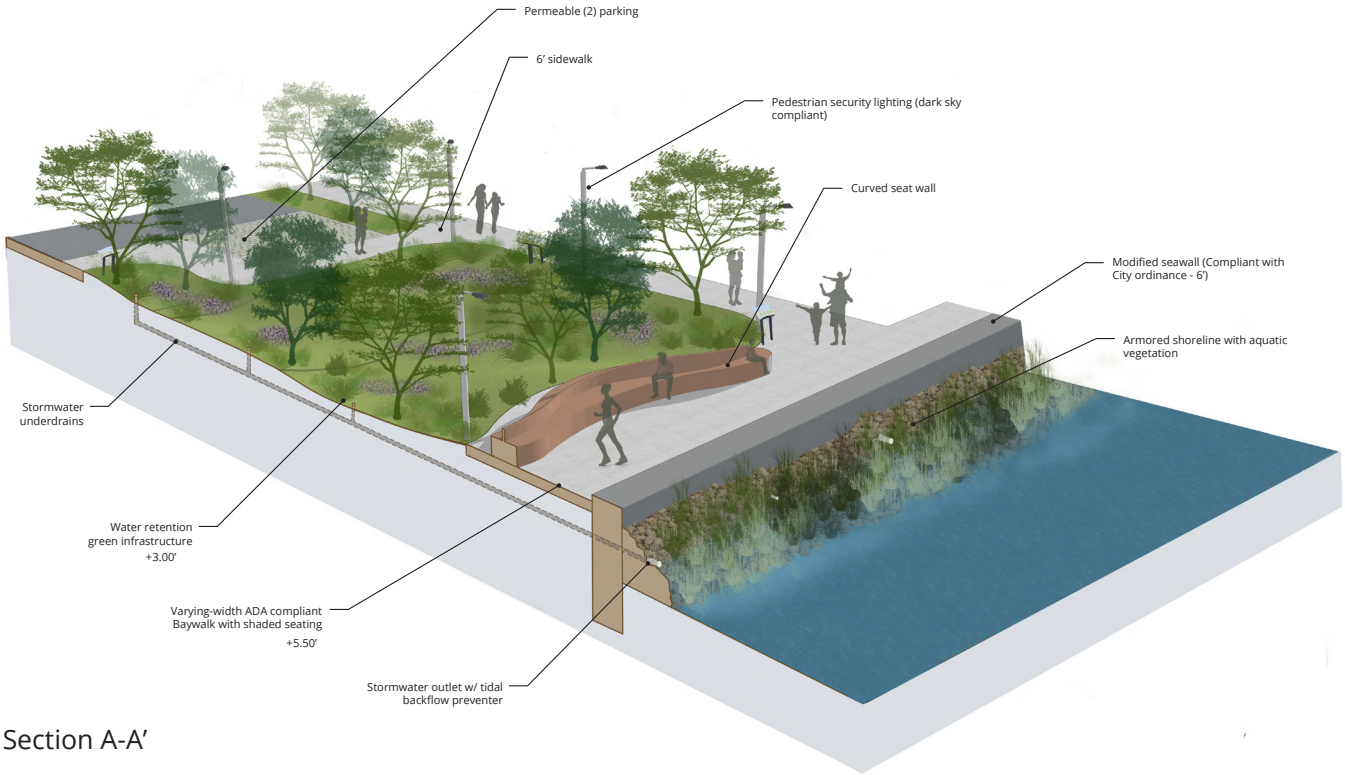
4.2 Typology 2: End-of-Road on Bayfront - NE 26th St



Existing Site Photos

Alternative 1

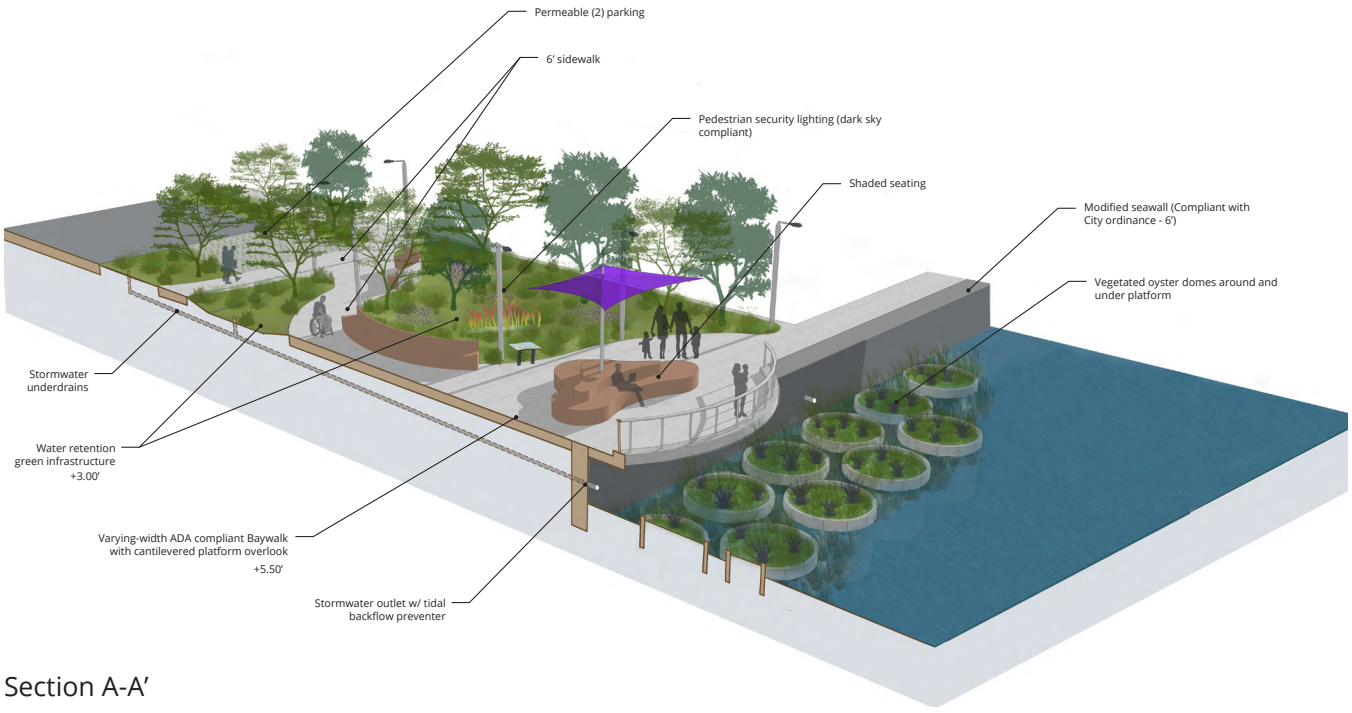




Section A-A'

Figure 4-4: End-of-Road on Bayfront - NE 26th St : Alternative 1

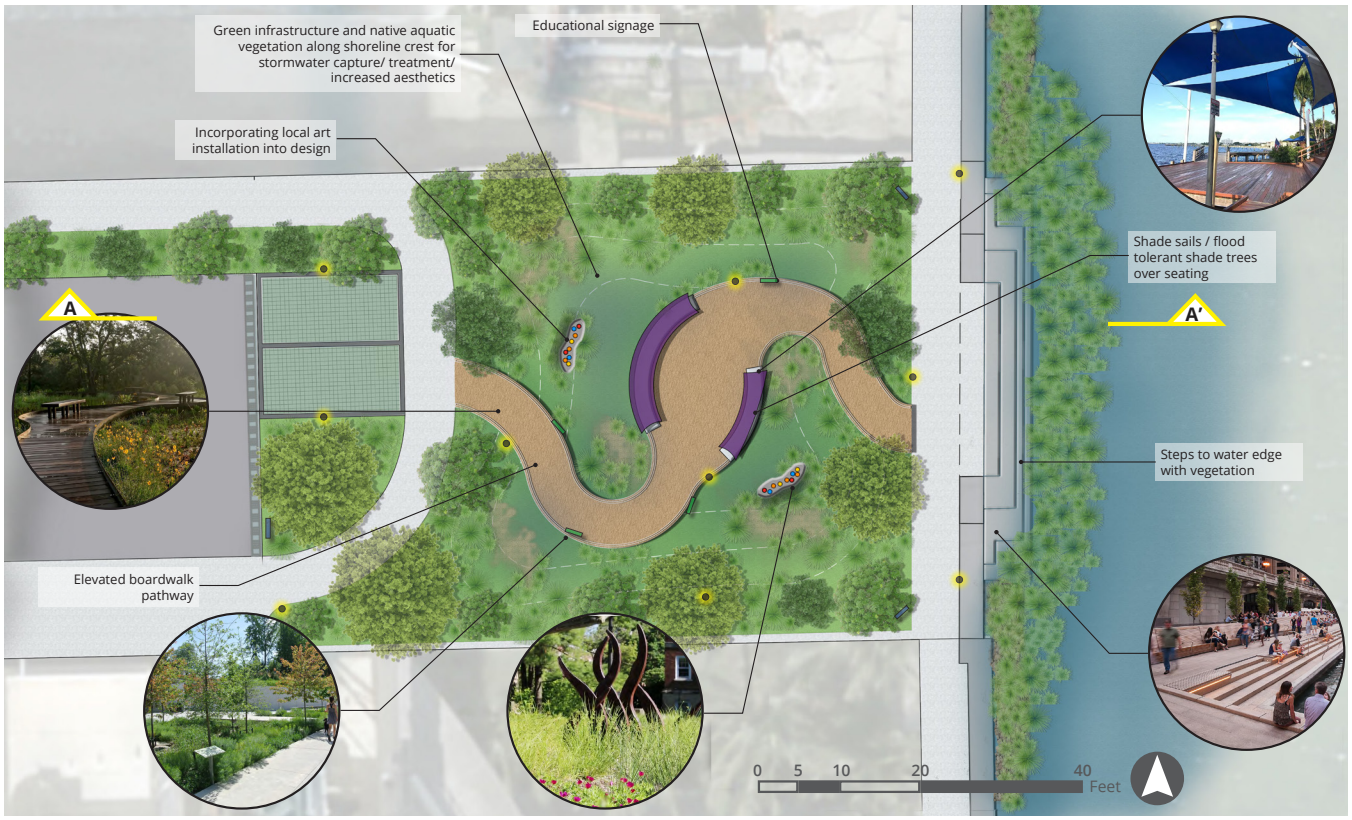
Alternative 2

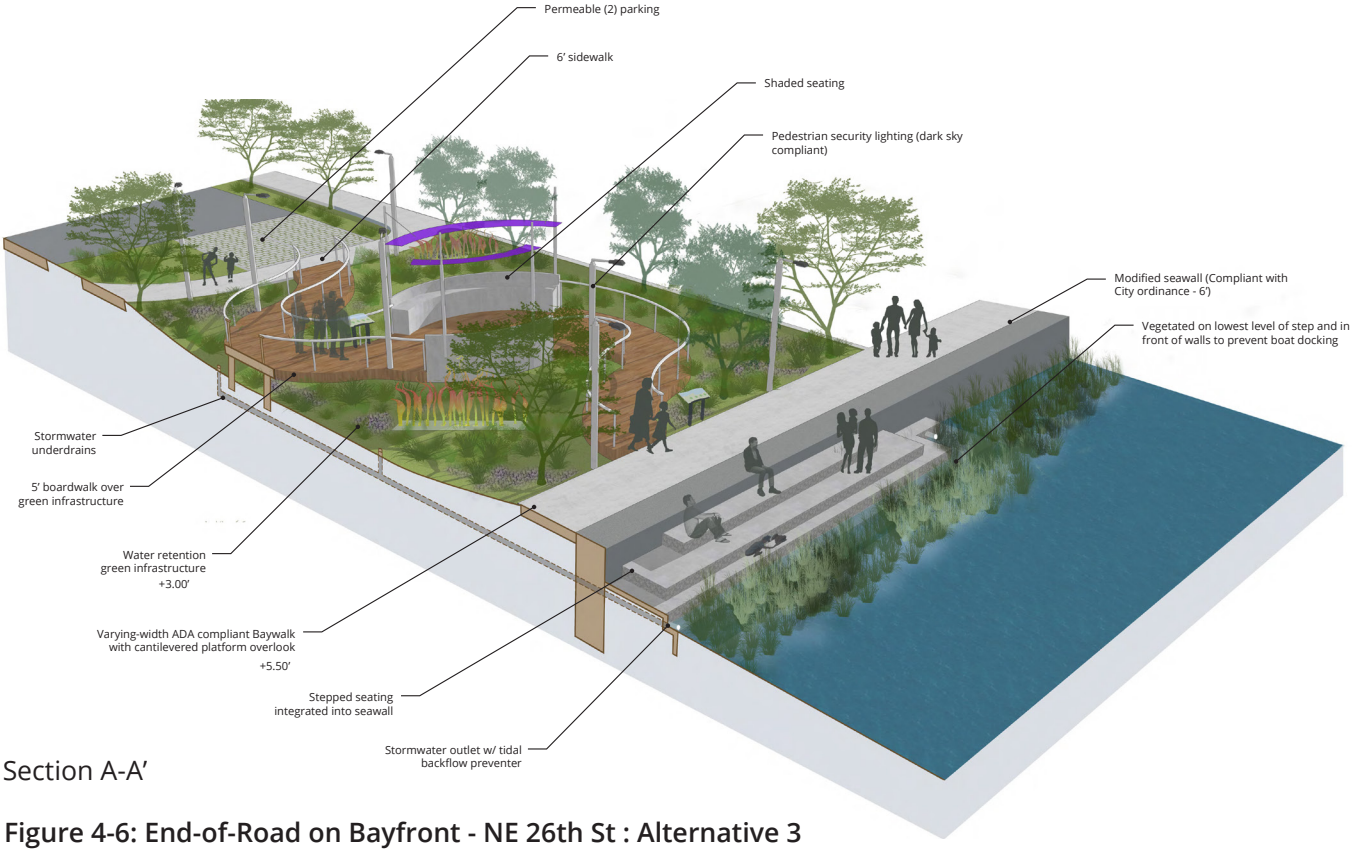


Section A-A'

Figure 4-5: End-of-Road on Bayfront - NE 26th St : Alternative 2

Alternative 3





Section A-A'

Figure 4-6: End-of-Road on Bayfront - NE 26th St : Alternative 3

Alternative Summaries

Less Intervention Lower Complexity More Gray/Traditional		More Intervention Higher Complexity More Green/Nature-based
Alternative 1	**Alternative 2**	**Alternative 3**
Theme: Adding nature-based features to existing site	**Theme:** Observational Platform over shoreline edge	**Theme:** Pocket Park with water access
• Modify seawall to be compliant with City seawall ordinance ~ 6ft • Added aquatic vegetation planters in front of seawall • Added green infrastructure and native vegetation on street edge for capture/treatment/increased aesthetics • Add shade trees along path edge (species to be tolerant to flooding) • Added seating along ADA compliant Baywalk	• Platform deck extending over water edge (ties in with ADA compliant Baywalk) • Added vegetation around and under decking • Added green infrastructure and native aquatic vegetation along street edge for stormwater capture/treatment/increased aesthetics • Incorporate educational signage • Install shade sails over observational platform • Add shaded seating	• Urban Pocket Park with steps to water edge • Setback seawall to integrate steps • Incorporate vegetation into steps, if space allows • Add green infrastructure and native aquatic vegetation along shoreline crest for stormwater capture/treatment/ increased aesthetic • Incorporate local art installation into design • Install shade sails or shade trees (species tolerant to flooding) • Pocket Park is ADA and ties into Baywalk

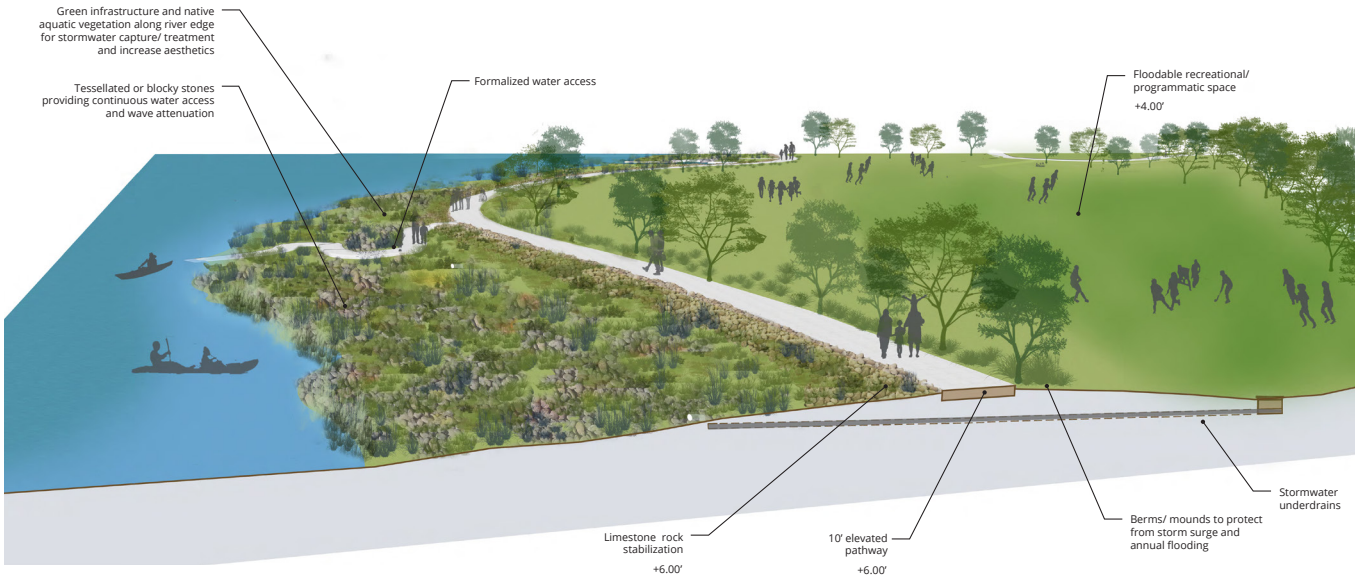
4.3 Typology 3: Park on Riverfront - E.G Sewell Park






Existing Site Photos

Alternative 1



Section A-A'

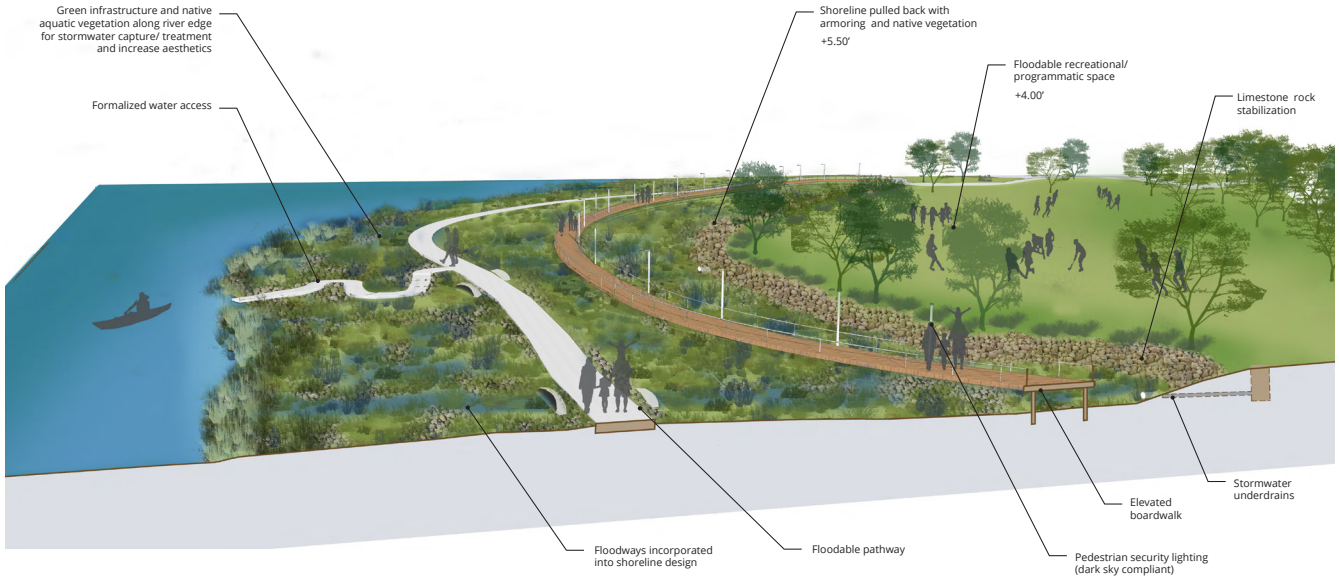
Figure 4-7: Park on Riverfront - E.G Sewell Park: Alternative 1

Alternative 2

Section A-A'

Figure 4-8: Park on Riverfront - E.G. Sewell Park: Alternative 2

Alternative 3



Section A-A'

Figure 4-9: Park on Riverfront - E.G. Sewell Park: Alternative 3

Alternative Summaries

Less Intervention Lower Complexity More Gray/Traditional		More Intervention Higher Complexity More Green/Nature-based
Alternative 1	**Alternative 2**	**Alternative 3**
Theme: Elevated shoreline with increased accessibility to programmable spaces and transitional habitat	**Theme:** Layered shoreline focused on redundant protection and access to nature	**Theme:** Layered shoreline focused on redundant protection with programmable space and access to nature
• Elevated shoreline with small berm and joint-planted armoring to tie in transitional habitats, particularly near park edges • Incorporate water access trail (green pavers/ permeable paving) along waterfront to maintain views and ADA access • Elevate and maintain open green space landward of trail to offset frequent flood risk of riverplain area • Include park amenities (seating, educational signage, bike racks, water fountains, trash receptacles) where applicable	• Add sills and transitional habitat using native river vegetation along shoreline • Incorporate lower floodable permeable pathway for access during normal water level conditions • Elevated boardwalk landward of path to maintain access during high water events • Tie pathway into upland areas of park • Add more shade trees within the park river floodplain zone (species to be tolerant to flooding) • Include park amenities (seating, educational signage, bike racks, water fountains, trash receptacles) where applicable	• Add sills and transitional habitat using native river vegetation along shoreline • Incorporate lower floodable permeable pathway for access during normal water level conditions • Elevate and maintain open green space landward of trail to offset frequent flood risk of riverplain area • Elevated boardwalk landward of path to maintain access during high water events • Tie pathway into upland areas of park • Add more shade trees within the park river floodplain zone (species to be tolerant to flooding) • Include park amenities (seating, educational signage, bike racks, water fountains, trash receptacles) where applicable

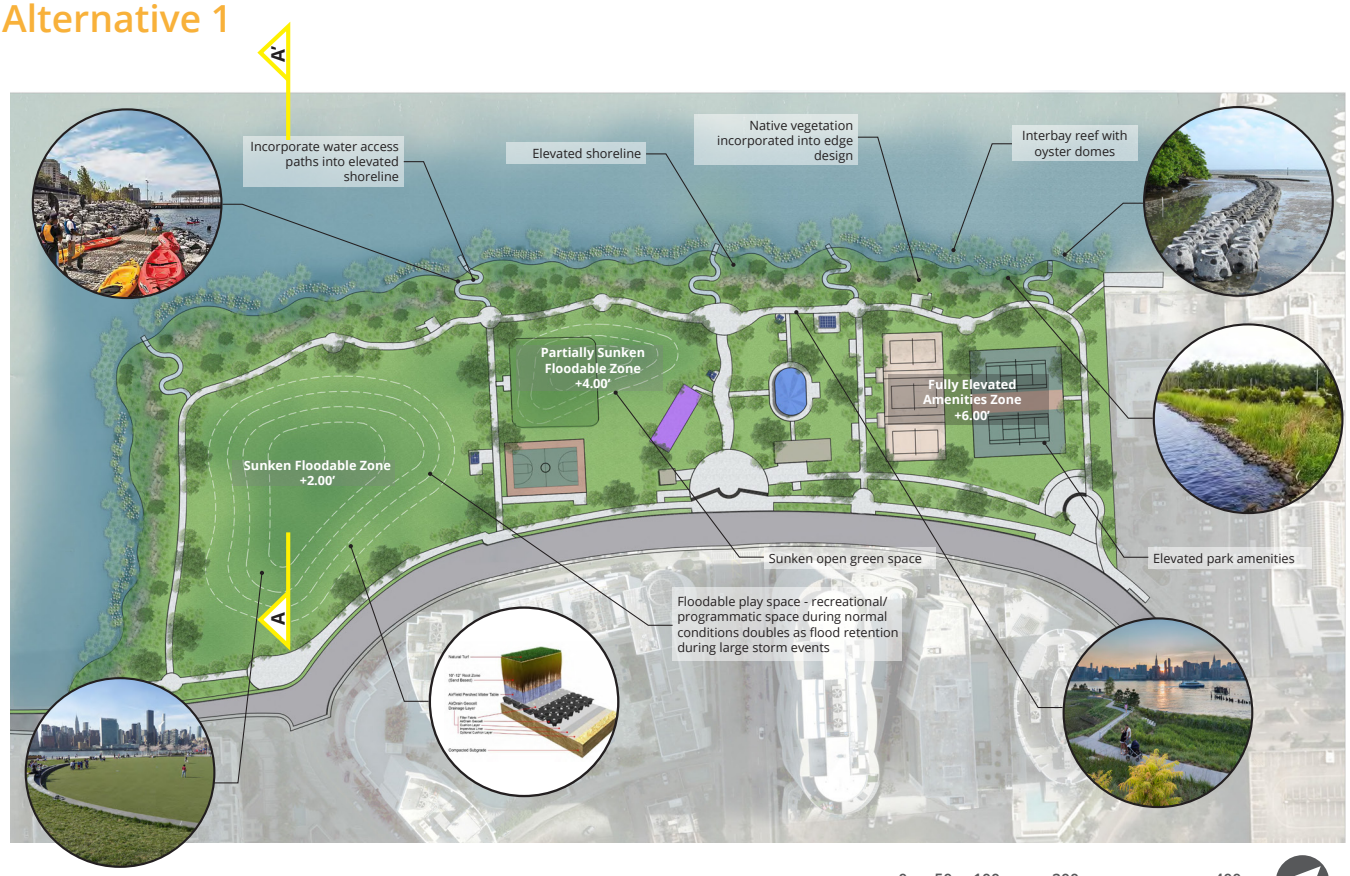
4.4 Typology 4: Park on Bayfront - Margaret Pace Park

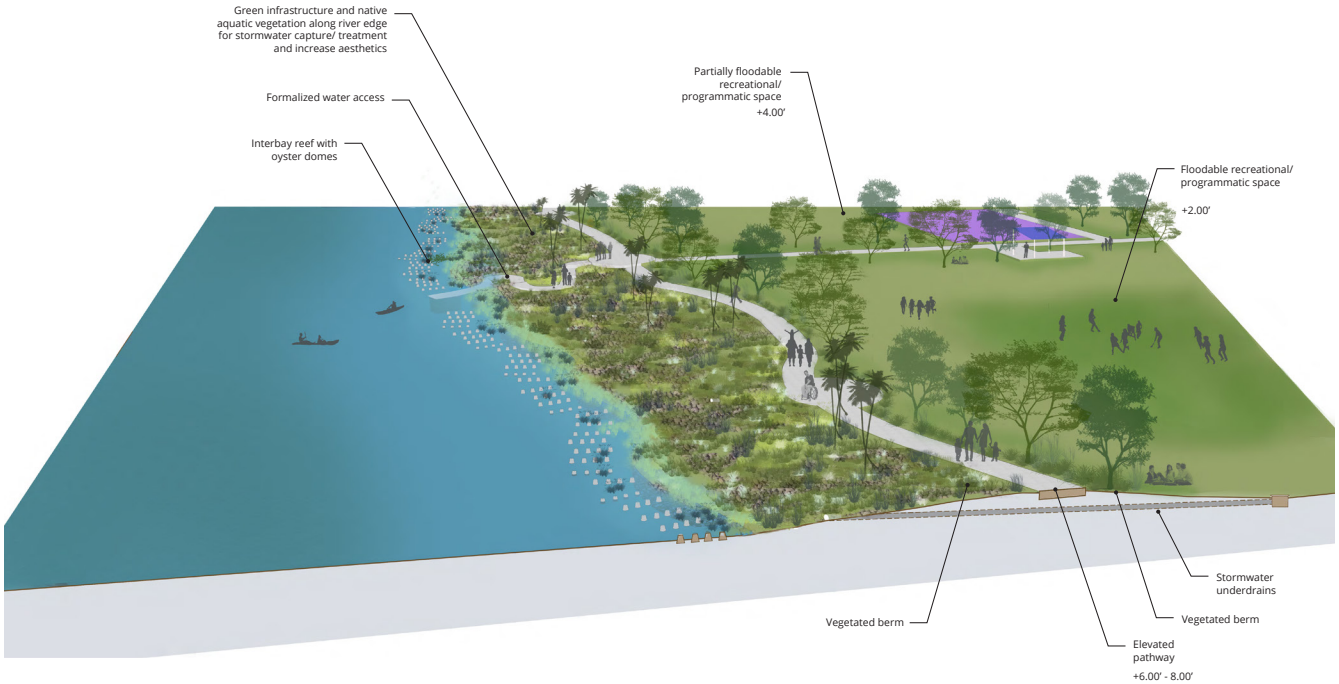





Existing Site Photos

Alternative 1

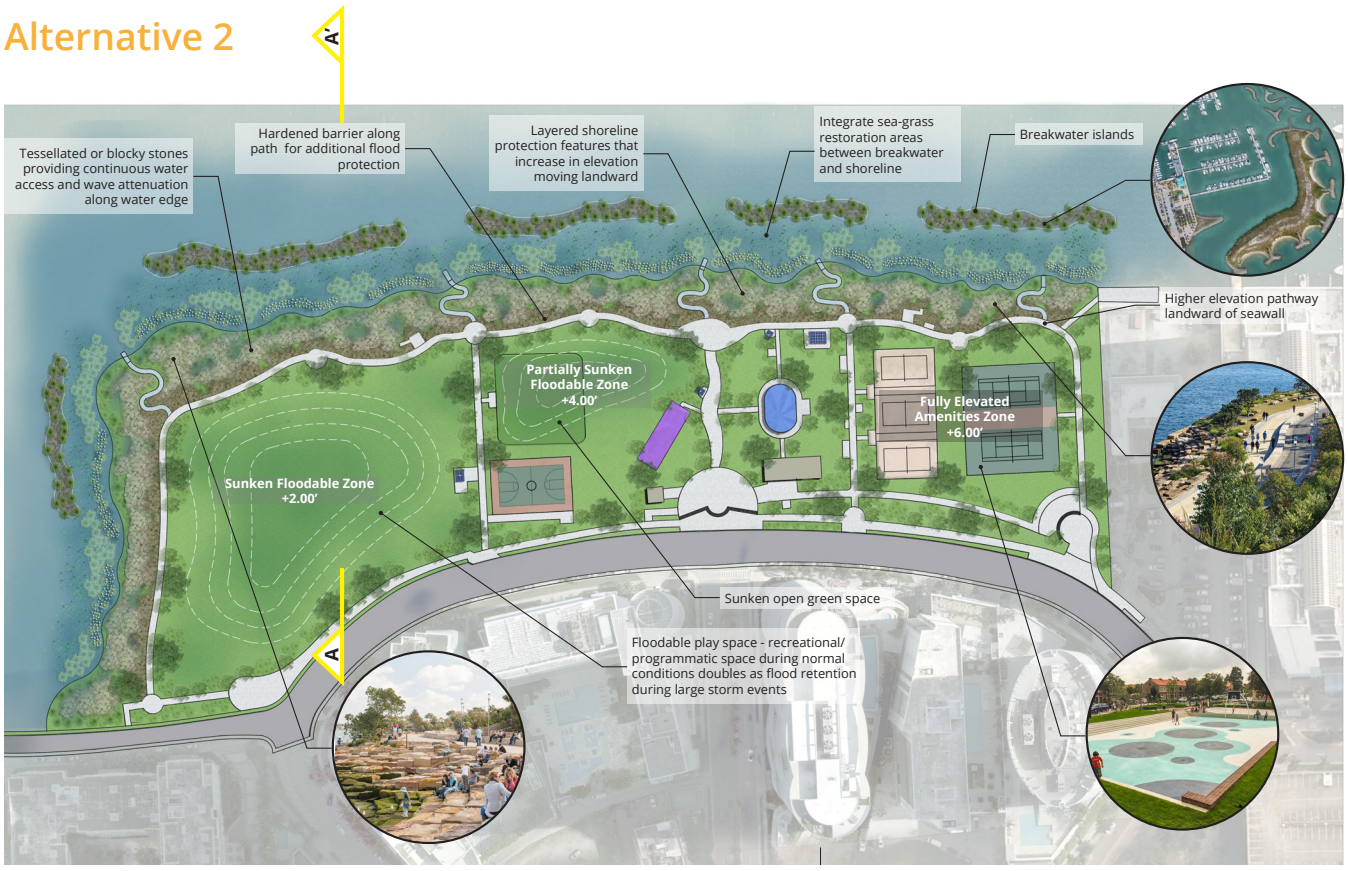


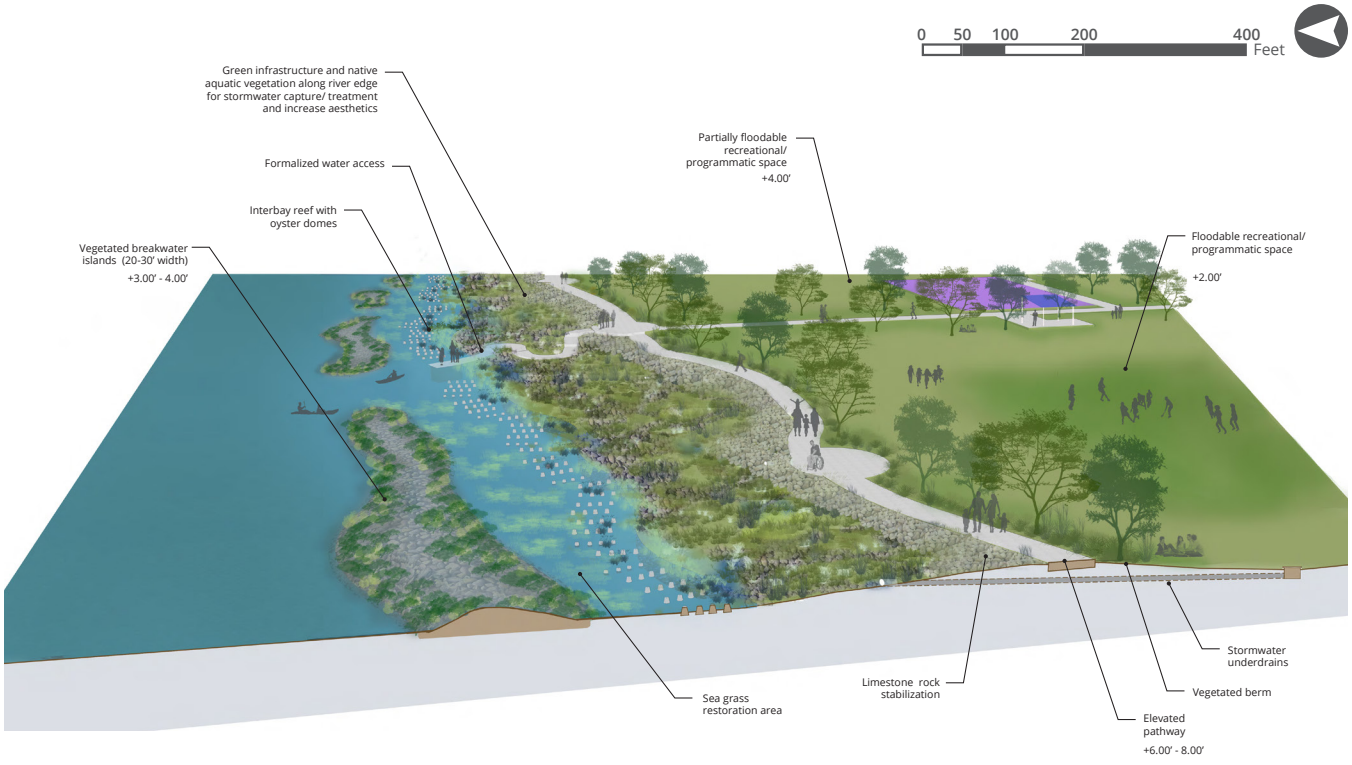


Section A-A'

Figure 4-10: Park on Bayfront - Margaret Pace Park: Alternative 1

Alternative 2





Section A-A'

Figure 4-11: Park on Bayfront - Margaret Pace Park: Alternative 2

Alternative Summaries

Less Intervention Lower Complexity More Gray/Traditional		More Intervention Higher Complexity More Green/Nature-based

Alternative 1	Alternative 2
Theme: Elevated shoreline with increased accessibility and transitional habitat	
Wave Attenuation	
• Interbay Reef with Oyster Domes	• Breakwater Islands landward of navigation channel (could tie design into the Pace Picnic Islands)
Elevated Shoreline	
• Elevated shoreline doubling as a walkway • Integrate water access paths or steps into elevated shoreline • Incorporate native vegetation into edge design	• Layered shoreline features and elevations that increase moving landward • Tessellated or blocky stones providing continuous water access and wave attenuation along water edge • Integrate aquatic vegetation and transitional habitats along shoreline in water edge design • Elevated pathway along first elevation tier of shoreline • Added small seawall/raised planters for additional flood protection • Higher elevation pathway landward of seawall/planters
Floodable Space	
• Floodable open space – recreational/ programmatic space during normal conditions, but doubles as flood retention during large storm events • Series of elevated water storage features that doubles as art or water feature (e.g., fountains) in park	• Floodable open space – recreational/ programmatic space during normal conditions, but doubles as flood retention during large storm events • Series of elevated water storage features that doubles as art or water feature (e.g., fountains) in park

4.5 Cost/Benefit Evaluation of Design Typologies

This section presents high-level cost estimates and the varying benefits of the alternatives of each alternative for each typology. Cost estimates for each alternative took the following into account: site preparation and infrastructure, stormwater improvements, landscape improvements, shoreline improvements, as well as park structures, amenities, and signage. Studies have shown that improved community amenities, such as parks, enhanced recreational access and/or improved shoreline access can lead to several local benefits, such as public health benefits, property value increases, and avoided economic losses. The benefits have been evaluated qualitatively for each alternative presented for the typologies using FEMA's Ecosystem Service Values for "urban green open space".[1] These categories, or "Ecosystem Services", are:

- Aesthetic Value
- Air Quality
- Climate Regulation
- Erosion Control
- Flood Hazard Risk Reduction
- Habitat
- Pollination
- Recreation and Tourism

Each typology achieves several of these benefits. These benefits have been combined into categories for evaluation, in addition to two other benefits relating to increasing accessibility (for all typologies) and bike and pedestrian infrastructure improvements (for end-of-road typologies only). These benefits were all selected as they align with those considered for state and federal funding opportunities for green space and green and/or resilient infrastructure investments. For example, the Florida Communities Trust Parks & Open Space program looks for projects which further outdoor recreation and provide natural resource protection, while the Resilient Florida Program funds projects which address flooding and sea-level rise, including seawall elevation, living shorelines, and drainage improvements in parks. Federal green infrastructure funding, including grants from the EPA, NFWF, FEMA, and HUD, also assess projects for public health benefits to the community, resilience to climate change and hazard mitigation, and preservation of outdoor recreation, especially in underserved neighborhoods. To further demonstrate the impact of these green spaces, each typology also includes a map showing the access level of service (5-10-minute walk). Using HUD's Low- and Moderate-Income Summary Dataset (LMISD), the proportion of residents who would be low- or moderate-income was also calculated for each walkshed.

In addition to a qualitative assessment of the benefits of each alternative for the four typologies, an estimate of the total monetized benefits was calculated at the typology-scale using the "Total Estimated Benefits" from FEMA Ecosystem Service Value Updates (2022), valued at $15,541 per acre per year ($2022). Across all typologies, it is possible that the benefits offered are higher or lower than the FEMA estimate calculated. This value is also a national value and has not been tailored to City of Miami conditions. Furthermore, for the typologies where urban parks already exist (typologies 3 and 4), the marginal benefit of the design update would vary depending on the benefits provided by the already existing green space there; the marginal benefit has not been calculated here. While monetized benefits per alternative have not been quantified here, it is clear that updates to the City's waterfront areas could reduce both capital and operational expenses for repairs and flood mitigation. These interventions address coastal flooding and could avoid direct physical damages as well as avoid additional operational costs to the City spent on clean-up and repair.

The discussion on cost estimates and benefit evaluation for each typology is provided in the following pages.

Typology 1: End-of-Road on Riverfront (NE 5th St)

Depending on the alternative, the designs for the Riverfront end-of-road typology cost between $1.24 and $1.74 million. Total cost, cost per square footage of park, and total cost per linear foot of shoreline are included in the table below. All three alternatives include green space bisected by a pedestrian pathway that leads to the water's edge. The main differences among the alternatives come from the design of where the park meets the shoreline.

Alternative 1 includes an open plaza with bench seating bordered by a modified seawall, Alternative 2 includes a plaza with shaded bench seating and steps leading down to the water, while Alternative 3 features an elevated, ADA-accessible boardwalk in place of the pedestrian pathway and plaza space on previous alternatives, accompanied by shaded seating. All three alternatives provide significant public benefits. Based on FEMA Ecosystem Services' national value per acre for green space and the size of this area, the value of benefits in ecosystem services from Typology 1 estimated is approximately $2,333 annually [2].

Table 4-1: Typology 1 - End-of-Road on Riverfront Cost Estimates and FEMA Ecosystem Benefits

Typology 1: End-of-Road on Riverfront	Total Cost	Cost per SF of Park	Total Cost per LF of Shoreline
Alternative 1	**$1,243,158**	**$190**	**$20,380**
Alternative 2	**$1,371,501**	**$210**	**$22,484**
Alternative 3	**$1,744,223**	**$267**	**$28,594**

FEMA Ecosystem Services estimated annual value of benefits	**$2,333 per year**
Aesthetic Value	The end-of-road parklet designs create aesthetically pleasing and desirable green spaces that residents will appreciate and want to be close to.
Air Quality & Climate Regulation	The typology includes the planting of trees and creates green space, which sequesters carbon, helps address air pollution, and prevents urban heat islands from forming above areas of extended concrete. Seating also includes shade sails to protect park users.
Flood Hazard Risk Reduction & Erosion	The typology decreases runoff with permeable sidewalk and parking surfaces. Green infrastructure, bioswales and native aquatic vegetation capture and treat stormwater, while stormwater underdrains safely redirect runoff back into the water body rather than inland. The typology also includes a modified seawall and an armored shoreline with aquatic vegetation along the seawall designed to prevent rising water levels from overwhelming the park and nearby areas. The stormwater outlets also include mechanisms for tidal backflow prevention.
Habitat & Pollination	By replacing concrete with grass, shrubs, and trees, the typology also provides a space for pollinators and can help increase urban biodiversity.
Recreation/ Tourism	The typology provides space and resources for art installation and educational signage. Depending on the alternative, the plaza, water access, and boardwalk provide an open recreational space.

In addition to these Ecosystem Services, the typology also provides the following benefits that are aligned with state and federal grant funding criteria:

- Increasing accessibility: The typology ensures that the parking lot, pathways, seating, and plaza or boardwalk space are all ADA-accessible.
- Bike and pedestrian infrastructure: The typology adds bike racks. All walkways in the park are for pedestrians, encouraging walking and exercise.

The different alternatives for Typology 1 also provide varying levels of benefit, as shown below:

Table 4-2: Typology 1 - End-of-Road on Riverfront Benefits

Benefit	Alt. 1	Alt. 2	Alt. 3	Reasoning
Aesthetic Value	✓	✓	✓	All three alternatives increase the aesthetic value of the area.
Air Quality & Climate Regulation	✓	✓	✓	Alternatives 3 includes more shade trees and groundcover than Alternatives 1 and 2.
Flood Hazard Risk Reduction & Erosion Control	✓	✓	✓	Alternatives 1 has fewer drainage inlets and outflows than Alternatives 2 and 3. Alternatives 3 includes a more substantial seawall alternatives than Alternatives 1 and 2.
Habitat & Pollination	✓	✓	✓	All three alternatives create green space where it previously did not exist.
Recreation / Tourism	✓	✓	✓	Alternatives 2 includes water access and Alternatives 3 includes an elevated boardwalk.
Increasing accessibility	✓	✓	✓	All three alternatives include the same ADA pathways, parking, and crosswalks.
Bike and pedestrian infrastructure	✓	✓	✓	All three alternatives include the same provisions for bike and walking infrastructure.

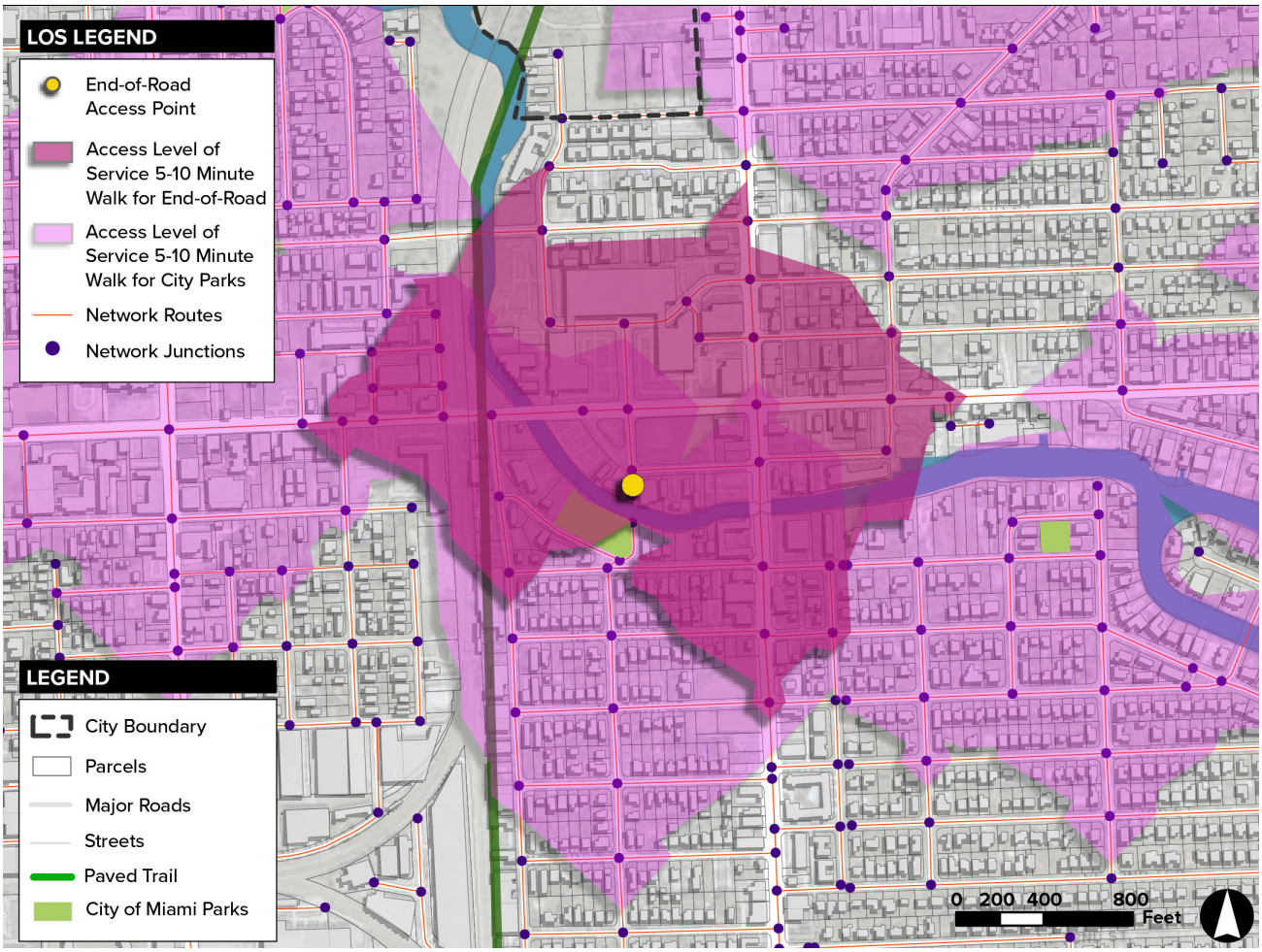
Matrix Key:

- — Indicates *No* benefits
- ✓ Indicates *Fewer* benefits compared to the other alternatives
- ✓ Indicates *Moderate* or the same benefits as other alternatives
- ✓ Indicates *More* benefits than the other alternatives

Additional End-of-Road Benefits: Improved Walkable Access to Open Space

With the development of end-of-road typologies, the City of Miami has the opportunity to add public parkland and open space while improving access level of service in key areas of the City. Walkable access to open space, particularly waterfront access, is becoming increasingly important to City residents. The implementation of the design typology at the end-of-road on the Riverfront can provide waterfront access and unique recreation experiences for many residents that currently have limited access to these resources. The figure below illustrates how the end-of-road parklet improves walkable access in the adjacent neighborhoods (dark pink), expanding on the 5–10 minute level of service walksheds currently provided by City of Miami Parks (light pink). The 5-10 minute walkshed for the end-of-road design on the Riverfront is located mostly in two different Census Tracts (13.01 and 13.02) and overlaps seven different Census Block Groups in those tracts. Of those seven Block Groups, the residents in six are majority low- and moderate-income (ranging between 62.9% of residents to 91% of residents).

Map 4-1: Access Level of Service for Typology 1 for End-of-Road on Riverfront (5-10 Minute Walk)



Typology 2: End-of-Road on Bayfront (NE 26th St)

Depending on the alternative, the designs for the Bayfront end-of-road typology cost between $1.24 million and $1.43 million. Total cost, cost per square footage of park, and total cost per linear foot of shoreline are included in the table below. All three alternatives include a combination of green space and pathways leading to the water's edge. The main differences among the alternatives come from the design where the park meets the shoreline. Alternative 1 features a pathway bordered by the seawall and aquatic vegetation, Alternative 2 includes an ADA-compliant, shaded platform deck with an observation platform and seating, and oyster domes located beneath the platform, while Alternative 3 features shaded seating along an elevated boardwalk leading to concrete steps into the water.

Table 4-3: Typology 2 - End-of-Road on Bayfront Cost Estimates

Typology 2: End-of-Road on Bayfront	Total Cost	Cost per SF of Park	Total Cost per LF of Shoreline
Alternative 1	**$1,239,424**	**$237**	**$17,706**
Alternative 2	**$1,468,170**	**$281**	**$20,974**
Alternative 3	**$1,431,241**	**$274**	**$20,445**

FEMA Ecosystem Services estimated annual value of benefits	**$1,866 per year**
Aesthetic Value	The end-of-road parklet designs create aesthetically pleasing and desirable green spaces that residents will appreciate and want to be close to.
Air Quality & Climate Regulation	The typology includes the planting of trees and creates green space, which sequesters carbon, helps address air pollution, and prevents urban heat islands from forming above areas of extended concrete. Seating also includes shade sails to protect park users.
Flood Hazard Risk Reduction & Erosion	The typology decreases runoff with permeable sidewalk and parking surfaces. Green infrastructure, bioswales and flood-tolerant shade trees absorb and treat stormwater, while stormwater underdrains safely redirect runoff back into the water body rather than inland. The typology also includes a modified seawall and an armored shoreline with aquatic vegetation along the seawall designed to prevent rising water levels from overwhelming the park and nearby areas. The stormwater outlets also include mechanisms for tidal backflow prevention.
Habitat & Pollination	By replacing concrete with grass, shrubs, and trees, the typology also provides a space for pollinators and can help increase urban biodiversity. The typology also includes an alternative for vegetated oyster domes to help restore the shoreline.
Recreation/ Tourism	The typology provides space and resources for art installation and educational signage. Depending on the alternative, the walkway, observation platform deck, and elevated boardwalk with water access all offer an open recreational space.

All three alternatives provide significant public benefits. Based on FEMA Ecosystem Services' national value per acre for green space and the size of this area, the value of benefits in ecosystem services from Typology 2 estimated is approximately $1,866 per year.[3]

In addition to these Ecosystem Services, the typology also provides the following benefits that are aligned with state and federal grant funding criteria:

- Increasing accessibility: The typology ensures that the parking lot, pathways, seating, and walkway, platform, or boardwalk space are all ADA-accessible.
- Bike and pedestrian infrastructure: The typology adds bike racks. All walkways in the park are for pedestrians, encouraging walking and exercise.

The different alternatives for Typology 2 also provide varying levels of benefit, as shown below:

Table 4-4: Typology 2 - End-of-Road on Bayfront Benefits

Benefit	Alt. 1	Alt. 2	Alt. 3	Reasoning
Aesthetic Value	✓	✓	✓	All three alternatives increase the aesthetic value of the area.
Air Quality & Climate Regulation	✓	✓	✓	Alternative three includes more shade trees and groundcover than Alternatives 1 and 2.
Flood Hazard Risk Reduction & Erosion Control	✓	✓	✓	Alternative 1 has fewer drainage inlets and outflows than Alternatives 2 and 3. All 3 alternatives include similar protections against sea-level rise.
Habitat & Pollination	✓	✓	✓	All three alternatives create green space where it did not previously exist. Alternative 2 is the only alternative with custom oyster domes.
Recreation / Tourism	✓	✓	✓	Alternative 2 includes an observation deck and Alternative 3 includes water access.
Increasing accessibility	✓	✓	✓	All three alternatives include the same ADA pathways, parking, and crosswalks.
Bike and pedestrian infrastructure	✓	✓	✓	All three alternatives include the same provisions for bike and walking infrastructure.

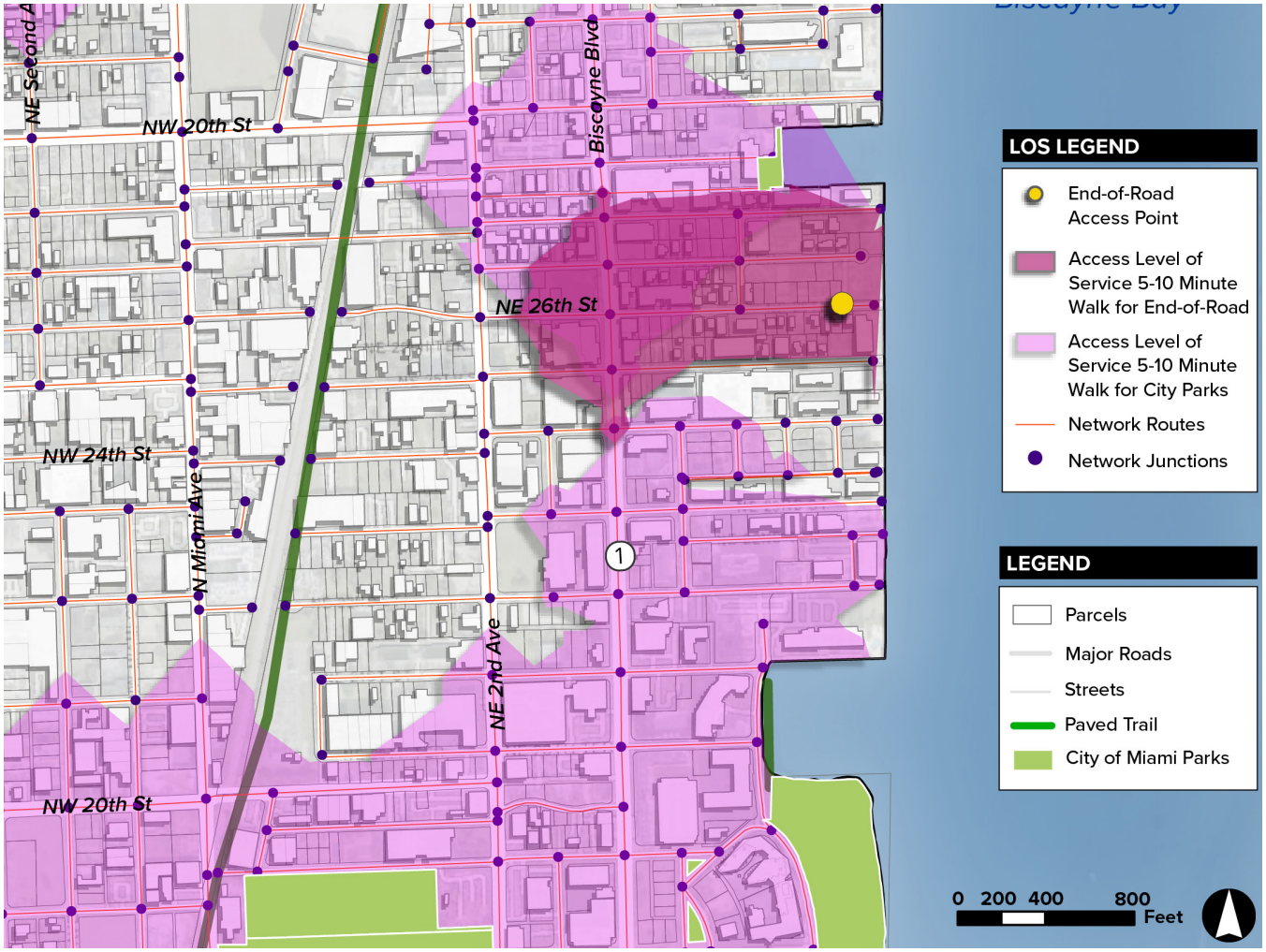
Matrix Key:

- — Indicates *No* benefits
- ✓ Indicates *Moderate* or the same benefits as other alternatives
- ✓ Indicates *Fewer* benefits compared to the other alternatives
- ✓ Indicates *More* benefits than the other alternatives

Additional End-of-Road Benefits: Improved Walkable Access to Open Space

Similar to Typology 1, with the development of end-of-road typologies, the implementation of the design typologies at the end-of-road Bayfront can provide waterfront access and unique recreation experiences for many residents that currently have limited access to these resources. The figure below illustrates how the end-of-road parklet improves walkable access in the adjacent neighborhoods (dark pink), expanding on the 5–10 minute level of service walksheds currently provided by City of Miami Parks (light pink). The entirety of the 5-10 minute walkshed for the end-of-road design on the Bayfront is located within one Census Block Group, in one Census Tract (27.06). HUD LMISD indicates that 57.75% of residents in this Block Group are low- and moderate-income persons.

Map 4-2: Access Level of Service for Typology 2 for End-of-Road on Bayfront (5-10 Minute Walk)



Typology 3: Park on Riverfront (E.G. Sewell Park)

Depending on the alternative, the designs for the Riverfront park typology cost between $7.82 million and $11.04 million. Total cost, cost per square footage of park, and total cost per linear foot of shoreline are included in the table below. All three alternatives are redesigns for the currently existing E.G. Sewell Park, which contains green space with a loop trail running through the park. The main differences among the alternatives come from differences in water access, flood features and vegetation, and shoreline features. Alternative 1 features the loop trail atop a formal shoreline with water access points, including a kayak launch, and a recreational space with berms and mounds. Alternative 2 includes a pulled back shoreline, floodable loop trail, and an elevated boardwalk over a floodable area stabilized with rocks and vegetation. Alternative 3 features the same

Table 4-5: Typology 3 - Park on Riverfront Cost Estimates

Typology 3: Park on Riverfront	Total Cost	Cost per SF of Park	Total Cost per LF of Shoreline
Alternative 1	**$7,817,675**	**$1,737,261**	**$9,090**
Alternative 2	**$12,244,255**	**$2,720,939**	**$14,237**
Alternative 3	**$11,040,844**	**$2,453,521**	**$12,838**

FEMA Ecosystem Services estimated annual value of benefits	**$69,935 per year**
Aesthetic Value	Improvements on the park will make it even more desirable of a space for residents to be close to.
Air Quality & Climate Regulation	The typology includes the planting of trees and improves the existing green space, which sequesters carbon, helps address air pollution, and prevents urban heat islands from forming.
Flood Hazard Risk Reduction & Erosion	The typology decreases runoff with permeable pathways and uses green infrastructure and native vegetation to capture stormwater. Depending on the alternative, the recreation space features berms and mounds, rocks and vegetation, or a sunken retention area to absorb stormwater. The park includes drainage inlets in retention areas, sub-surface drainage infrastructure, and outflows with tidal backflow preventers.
Habitat & Pollination	By increasing grass, shrubs, and trees coverage, the typology also can help increase urban biodiversity and pollination.
Recreation/ Tourism	The typology includes several features for recreational use, including a trail loop across all three alternatives, a floodable recreational space in alternatives 1 and 3, an elevated boardwalk in alternatives 2 and 3, and water access pathways and a canoe and kayak launch in alternatives 1 and 2. These spaces encourage walking and outdoor exercise, beneficial to public health, and increase residents' quality of life. There are also locations for educational signage for residents to learn about the surrounding habitat.

pulled back shoreline, floodable loop trail, and elevated boardwalk, but with a floodable recreational space that doubles as flood retention.

All three alternatives provide significant public benefits. Based on FEMA Ecosystem Services' national value per acre for green space and the size of this area, the value of benefits in ecosystem services from Typology 3 estimated is approximately $69,935 annually.[4]

In addition to these Ecosystem Services, the typology also provides the following benefits that are aligned with state and federal grant funding criteria:

- Increasing accessibility: The typology also increases the accessibility of the existing park by ensuring that the loop trail and boardwalk (alternatives 2 and 3) are all ADA-accessible.

The different alternatives for Typology 3 each also provide varying levels of benefit, as shown below:

Table 4-6: Typology 3 - Park on Riverfront Benefits

Benefit	Alt. 1	Alt. 2	Alt. 3	Reasoning
Aesthetic Value	✓	✓	✓	All three alternatives increase the aesthetic value of the area.
Air Quality & Climate Regulation	✓	✓	✓	All three alternatives include similar levels of green space coverage.
Flood Hazard Risk Reduction & Erosion Control	✓	✓	✓	All three alternatives appear to offer similar protections against flooding.
Habitat & Pollination	✓	✓	✓	All three alternatives offer similar potential increases in habitat and pollination.
Recreation / Tourism	✓	✓	✓	Alternative 2 includes both an elevated boardwalk and a canoe/kayak launch.
Increasing accessibility	✓	✓	✓	All three alternatives include similar accessibility provisions.

Matrix Key:

- — Indicates *No* benefits
- ✓ Indicates *Fewer* benefits compared to the other alternatives
- ✓ Indicates *Moderate* or the same benefits as other alternatives
- ✓ Indicates *More* benefits than the other alternatives

Typology 4: Park on the Bayfront (Margaret Pace Park)

Depending on the alternative, the designs for the Bayfront park typology cost between $13.29 million and $14.89 million. Total cost, cost per square footage of park, and total cost per linear foot of shoreline are included in the table below. All three alternatives are redesigns for the currently existing Margaret Pace Park. The main differences among the alternatives are differences in infrastructure. Alternative 2 includes a stabilized shoreline, wave attenuation structure, and new high-visibility crosswalks that are left out of Alternative 1.

The value of benefits in ecosystem services from Typology 4 estimated is approximately $124,328 annually.[5]

Typology 4: Park on Bayfront	Total Cost	Cost per SF of Park	Total Cost per LF of Shoreline
Alternative 1	**$13,288,706**	**$1,661,088**	**$7,383**
Alternative 2	**$14,886,725**	**$1,860,841**	**$8,270**

FEMA Ecosystem Services estimated annual value of benefits	**$124,328 per year**
Aesthetic Value	Improvements on the park will make it even more desirable of a space for residents to be close to.
Air Quality & Climate Regulation	The typology includes the planting of trees and improves the existing green space, which sequesters carbon, helps address air pollution, and prevents urban heat islands from forming.
Flood Hazard Risk Reduction & Erosion	The typology implements green infrastructure and native aquatic vegetation along the shoreline for stormwater capture and includes partially floodable green space as well as a permeable pathway to decrease runoff. The designs also include stormwater infrastructure improvements: drainage inlets in retention areas, sub-surface drainage infrastructure, and outflows with tidal backflow preventers. Alternative 2 includes vegetated breakwater islands which further insure against flooding. The typology also includes an elevated shoreline and walking pathway, vegetated berms and fully elevated park amenities zone to address sea-level rise.
Habitat & Pollination	By increasing grass, shrubs, and trees coverage, the typology also can help increase urban biodiversity and pollination. The typology includes interbay reef with oyster domes which not only provide wave attenuation but also a habitat to revive coastal oyster and other marine populations.
Recreation/ Tourism	The typology including an elevated, permeable pathway which follows the perimeter of the park, water access paths, a fully elevated amenities and the addition of a volleyball court, relocation of a dog park, and relocation of a basketball court. These provide multiple alternatives for local residents to enjoy recreation.

In addition to these Ecosystem Services, the typology also provides the following benefits that are aligned with state and federal grant funding criteria:

- Increasing accessibility: The typology also increases the accessibility of the existing park by ensuring that permeable pathway and other park features are ADA-accessible. Alternative 2 also includes ADA-accessible new crosswalks with high-visibility markings, which also better protect pedestrians in the park vicinity.

The different alternatives for Typology 4 each also provide varying levels of benefit, as shown below:

Table 4-8: Typology 4 - Park on Bayfront Benefits

Benefit	Alt. 1	Alt. 2	Reasoning
Aesthetic Value	✓	✓	Both alternatives increase the aesthetic value of the area.
Air Quality & Climate Regulation	✓	✓	Both alternatives offer similar benefits and landscape improvements.
Flood Hazard Risk Reduction & Erosion Control	✓	✓	Alternative 2 includes vegetated breakwater islands and greater shoreline improvements.
Habitat & Pollination	✓	✓	Both alternatives include similar potential increases in habitat and pollination. Both alternatives also include interbay reefs with oyster domes that help to revive marine populations.
Recreation / Tourism	✓	✓	Both alternatives include similar recreational amenities.
Increasing accessibility	✓	✓	Alternative 2 includes ADA-accessible new crosswalks.

Matrix Key:

- — Indicates *No* benefits
- ✓ Indicates *Fewer* benefits compared to the other alternatives
- ✓ Indicates *Moderate* or the same benefits as other alternatives
- ✓ Indicates *More* benefits than the other alternatives

PERMITTING REQUIREMENTS

5

Compliance with regulatory requirements is an integral part of the design process. The following pages provides a summary of key regulatory and permitting requirements necessary to achieve the desired outcomes of this project. These requirements derive from Federal, State, County, and City agencies. The summary is based on agency insights, a desktop review of requirements, and previous experience designing and building waterfront infrastructure. These requirements inform the specifics of the design alternatives, as well as the City of Miami's next steps in the implementation process.

5.1 Regulatory and Permitting Requirements

Federal Permits

U.S. Army Corps of Engineers Department of the Army Permits

The U.S. Army Corps of Engineers (USACE) regulates placement of structures and activities in navigable waterways, as well as the discharge of dredged and fill material into all Waters of the U.S. The USACE is responsible for issuing the following permits applicable to waterfront design alternatives:

- Section 10 Placement of Structures in Navigable Waters permits (Rivers and Harbors Act);
- Section 404 Clean Water Act (CWA) permits
- Section 408 Civil Works review and permit.

Section 10 / 404 Permit

The USACE issues permits by combining Section 10 of the Rivers and Harbors Act of 1899 and Section 404(e) of the CWA. Depending on the size and scope of the project, the USACE will authorize a Letter of Permission (LOP), Nationwide Permit (NWP), or a Standard or Individual Permit (IP). If a project does not qualify for a either a LOP or NWP, the project will be permitted through an IP.

Letter of Permission

LOPs may be used where, in the opinion of the district engineer, the proposed work would be minor, would not have significant individual or cumulative impacts on environmental values, and should encounter no appreciable opposition. In such situations, the proposal is coordinated with Federal and State resource agencies, and in most cases, adjacent property owners who might be affected by the proposal. However, the public at large is not notified. The public interest review process is central to the decision-making process for LOP. The type of permit application and process suited to the project will be discussed with the USACE during pre-application meetings. There are no fees associated with a LOP, and the estimated duration for permit receipt is approximately 6 months after a complete application is accepted. Taken together, the design elements in each design alternative under each typology likely will not qualify for a LOP.

Nationwide Permit 13 Bank Stabilization

NWPs authorize a category of activities throughout the nation and is valid only if the conditions applicable to the permit are met. Nationwide 13 allow bank stabilization activities necessary for erosion control or prevention, such as vegetative stabilization, bioengineering, sills, rip rap, revetment, gabion baskets, stream barbs, and bulkheads, or combinations of bank stabilization techniques. NWP 13 is subject to restrictions, some of which include:

- No material is placed in excess of minimum needed for erosion protection;
- The activity is no more than 500 feet in length along the bank;
- The activity will not exceed an average of one cubic yard per running foot;
- Does not authorize dredge and fill material into special aquatic sites; and
- Native plants appropriate for current site conditions, must be used for bioengineering or vegetative bank stabilization.

If the project meets the restrictions the project can proceed under a NW permit. Additionally, NWPs satisfy public notice requirements. There are no fees associated with NWPs, and the estimated duration for receipt of permit verification is approximately 9 months to 12 months after a complete pre-construction notification is accepted.

Nationwide Permit 54 Living Shorelines

NWP 54 allows the construction of living shorelines. Use of NWP 54 is subject to the following restrictions:

- The structures and fill areas, including sand fills, sills, breakwaters, or reefs, cannot extend into the waterbody more than 30 feet from the mean low water line in tidal waters;
- The activity is no more than 500 feet in length along the bank;
- Coir logs, coir mats, stone, native oyster shell, native wood debris, and other structural materials must be adequately anchored, of sufficient weight, or installed in a manner that prevents relocation in most wave action or water flow conditions, except for extremely severe storms;
- Discharges of dredged or fill material into waters of the U.S., and oyster or mussel reef structures in navigable waters, must be the minimum necessary for the establishment and maintenance of the living shoreline; and
- Native plants appropriate for current site conditions, must be used.

Similar to NWP 13, there are no fees associated with NWP 54 and the estimated duration for receipt of permit verification is approximately 9 months to 12 months after a complete pre-construction notification is accepted.

Where applicable, the advancement of the design elements in the alternatives through more detailed design and engineering may wish to take the conditions for NWPs into consideration. This will help ensure that estimated durations remain within the typical time limits and reduce the risk for design revisions. This may be particularly beneficial on projects with budget limitations and tight schedules.

Individual Permit

Should project impacts exceed the restrictions for the NWP 13 and 54 the project will require an IP. IPs are required to undergo a 30-day Public Notice period. This process includes listing the project on USACE's website and sending notice to adjacent property owners of the delineated project boundary. Review time of an IP would be approximately 12-18 months from submittal of a complete application. The USACE may request additional information until an application is deemed complete. There is a $100 fee required once the permit is issued.

In light of the unique nature of the projects considered, an IP may be preferable for authorization, as it would not have the same set of limiting conditions and restrictions that the

NWPs would have. An IP also grants a project-specific permit authorization period (5 years from issuance) and can be modified if needed, unlike an NWP.

Public Notice

Under an IP review, the project will undergo a 30-day Public Notice period. This includes listing the project on USACE's website and sending notice to adjacent property owners of the delineated project boundary, federal consulting agencies, State Historic Preservation Office (SHPO), Native American tribes of Florida, and other interested parties that have requested notifications.

Section 408 Authorization

Section 408 review may be required if the project will alter, occupy, or use a USACE federally authorized Civil Works Project. There are no fees associated with this permit and permit application review may take up to a year. In South Florida, numerous large canals (including much of the C-7/Little River Canal and C-6/ Miami River Canal) require 408 authorization as part of the Central and Southern Florida Flood Control Project (CSFFC), as do any projects within 100 feet of the Intra Coastal Waterway (ICWW). Applications are usually submitted by the State (described below) on behalf of the applicant as the State and the USACE have overlapping jurisdiction. Section 408 authorization will be required for all design alternatives under typologies 1 and 3.

Federal Consultation

ESA Section 7 Consultation (NOAA PRD)

The Endangered Species Act (ESA), as amended (16 U.S. Code [U.S.C.] 1532 et. seq.), provides designation and protection of endangered and threatened species and their critical habitat. An endangered species is a species in danger of extinction throughout all, or a significant portion, of its range. A threatened species will likely become endangered within the foreseeable future throughout all, or a significant portion, of its range. Critical habitat as defined by the ESA is a specific geographic area with physical and/ or biological features that are essential for the

conservation of endangered and threatened species and may require special management considerations or protection. If a project has the potential to affect a federally listed species, or their habitat, consultation is required.

The federal agency tasked with protecting marine threatened and endangered species is the National Oceanic and Atmospheric Administration (NOAA) Protected Resource Division (PRD). The USACE must consult with the PRD when any action the agency carries out, funds, or authorizes activities that may affect either a species listed as threatened or endangered under the ESA, or any designated critical habitat. If the Federal agency taking the action (USACE) determines the project is Not Likely to Adversely Affect (NLAA) listed species and/or critical habitat, they submit an informal consultation request to NOAA PRD (referred to as the "Consulting Agency" under section 7) for concurrence. NOAA PRD will provide a Letter of Concurrence to the action agency if it agrees with the action agency's NLAA determination. NOAA PRD will provide written concurrence or non-concurrence with the Federal agency's determination typically within 60 days (or longer based on workload) once they receive enough information to make a determination. Once the concurrence letter is issued, the consultation process is terminated, and no further action is necessary. If consultation cannot be concluded informally due to adverse effects anticipated to listed species, the action agency must request formal consultation.

To initiate formal consultation, USACE must provide information to NOAA Fisheries PRD specified in 50 Code of Federal Regulation (CFR) 402.14(c) and (d); this includes information regarding the proposed project and species, or critical habitat likely affected, generally included in a Biological Assessment (BA). If NOAA PRD determines the species or critical habitat may be adversely affected, it will prepare a BA that analyzes the effects of the proposed project on a listed species or critical habitat, and states whether the USACE has ensured the proposed project will not likely jeopardize the continued existence of that listed species and/or result in destruction or adverse modification of critical habitat (Section 7 of ESA). A BA includes

conservation recommendations to further the recovery of listed species, and may include reasonable and prudent measures, as needed, to minimize any "take" (harassment) of listed species.

USACE Jacksonville's District Programmatic Biological Opinion (JaxBO)

NOAA PRD has issued a programmatic BO for certain routine activities within the USACE Jacksonville District of JaxBO allows the USACE to make determinations for frequently occurring or routine activities, without additional consultation with NOAA PRD, if projects meet certain impact thresholds. A project is required to meet specific criteria outlined in the JaxBO to satisfy consultation with NOAA PRD under the programmatic BO. These criteria are known as project design criteria (PDC), and specify how a project must be sited, constructed, or otherwise carried out to avoid or minimize adverse effects to ESA-listed species or designated critical habitat.

There are both general and specific PDC's for shoreline stabilization (Activity 1) required by JaxBO. General PDC's include instructions for all construction personnel to be aware of species that could be encountered, responsibility of all vessel operators to watch for ESA species in the area, reporting requirements, and BMP's to be used to control turbidity. Specific PDC's for shoreline stabilization include:

- A limitation of 500 feet of shoreline;
- The repair, and replacement of seawalls and footers cannot extend any further waterward than 1.5 ft (18 in) from the wet face of the existing seawall or mean high water (MHW) unless necessary to align with 1 or more adjacent seawalls.
- Shoreline stabilization materials may consist of riprap, articulating blocks or mats, and sand cement, geotextile/ filter fabric and mattresses. Installation of new shoreline stabilization materials where none previously existed may not extend more than 10 ft waterward of MHW (including the toe of the riprap).

Activity 7 provides PDC's for Aquatic Habitat Enhancement, Establishment, and Restoration Activities including living shorelines. Specific PDC's for Activity 7 include:

- Only native plants can be planted;
- Oyster reef materials shall be placed and constructed in a manner that ensures that materials will remain stable and that prevents movement of materials to surrounding areas (e.g., oysters will be contained in bags or attached to mats and loose cultch must be surrounded by contained bagged oysters or another stabilizing feature);
- Oyster reef materials must be placed in designated locations only (i.e., the materials shall not be indiscriminately or randomly dumped or allowed to spread outside of the reef structure);
- Living shorelines can only be constructed in unvegetated, nearshore water along shorelines to create tidal marshes or mangrove habitat for the purpose of shoreline erosion control or aquatic habitat enhancement. Native plants can be placed along the shoreline or between the shoreline and the living shoreline structure; and
- Both living shoreline and oyster reefs must have 5-foot gaps at least every 75 feet in length, as measured parallel to the shoreline and at the sea floor, to allow for tidal flushing and species movement.

In addition, JaxBO does not apply to projects that may affect, directly or indirectly, ESA-listed corals. The applicability of utilizing JaxBO to satisfy Section 7 consultation with NOAA PRD will be reviewed during the planning phase of any project and once ESA involvement is better understood through data review and site-specific surveys.

ESA Section 7 Consultation (U.S. Fish and Wildlife Service)

As described above under consultation with NOAA PRD, the USACE will also consult with USFWS for federally listed wildlife species or designated critical habitat under ESA Section 7. This includes nesting sea turtles, shore/coastal birds, and manatees. A BA would be required if the project could not be designed to fit within the Activity 1 or Activity 7 PDC and if formal consultation is required, USFWS will prepare a BO regarding the project's potential impact on listed species or their habitat. Early consultation with lead agencies is important to confirm timeframes and expectations under specific project circumstances.

Magnuson-Stevens Act Consultation for EFH (NOAA HCD)

The Magnuson-Stevens Act sets forth several mandates for NOAA Fisheries Habitat Conservation Division (HCD) to identify and protect important marine and fish habitat, and to delineate Essential Fish Habitat (EFH) for all managed species. The U.S. Congress has defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802[10]).

Section 303(a)(7) of the amended Magnuson-Stevens Act directs NOAA HCD, under the authority of the Secretary of Commerce, to describe EFH and identify EFH in each fishery management plan; minimize to the extent practicable, the adverse effects of fishing on EFH; and identify other actions to encourage the conservation and enhancement of EFH. NOAA HCD and its eight regional fisheries management councils are responsible for the management and protection of fisheries and habitat essential for the survival of managed species. The U.S. Secretary of Commerce, acting through NOAA Fisheries and in coordination with the South Atlantic Fishery Management Council (SAFMC) has been delegated this authority under the provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). The SAFMC is responsible for the management

of fish stocks and EFH within U.S. territorial waters. Federal agencies must consult with the Secretary of Commerce on any action that may adversely affect EFH.

The EFH definition includes:

- Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate;
- Substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities;
- Necessary means that the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem; and
- Spawning, breeding, feeding, or growth to maturity covers a species' full life cycle.

The entire coast of Florida has designated EFH. The EFH consultation process is as follows:

- The USACE provides notification of the action to NOAA HCD.
- The USACE submits an EFH Assessment (typically prepared by the Applicant) to NOAA HCD.
- NOAA HCD reviews the EFH Assessment, and, if necessary, provides EFH conservation recommendations to the USACE within 30-60 days, or longer based on workload.
- The USACE responds to NOAA HCD within 30 days with information on how it will proceed with the action.

An EFH Assessment would document the project activities, baseline conditions in the action area, and protective measures proposed to avoid or reduce impacts to EFH. Early consultation with NOAA HCD during project planning and design is recommended.

Historical Resources

Section 106 of the National Historic Preservation Act of 1966 requires federal agencies to consider the impacts of their undertakings on historic properties and archaeological resources. The Florida State Historic Preservation Office (SHPO), through the Florida Division of Historical Resources (FDHR), is the state agency that identifies and protects historic buildings, districts, structures, and archaeological sites in the state of Florida. Consultation with SHPO will occur during the USACE and state permitting process.

Historic properties may include prehistoric or historic districts, sites, buildings, structures, objects (including shipwrecks), sacred sites, and traditional cultural places, that are included in, or eligible for inclusion in, the National Register for Historic Places. The SHPO may require an analysis (i.e. survey) of known and potential cultural resources near the project area if other cultural resources have been previously identified on or near the project area.

State Permitting

Statewide Environmental Resource Permit

Chapter 62-330, Florida Administrative Code (FAC), establishes the types of activities that require a permit, activities that do not require a permit, the procedures for processing a permit, the conditions for issuance of a permit, general permit conditions, and the forms associated with applications, notices, and permits. Under 62-330 the state provides an exemption for repair and replacement of seawalls. In addition, there are general permits for placement of rip-rap (62-330.431) and a general permit for Restoration, Establishment and Enhancement of Low Profile Oyster Habitat (62-330.632).

The applicant must meet all the conditions of an exemption or a general permit for the project to be reviewed and approved. The general permit contains conditions for specific activities and

restricting impacts. If the project cannot comply with all of the general permit conditions, the project will require an Individual Permit from the South Florida Water Management District (SFWMD). Taken in conjunction with other improvements, such as stormwater treatment facilities, an individual permit for each design alternative under each typology is likely to be required.
The review process will analyze project direct, secondary, and cumulative impacts. Mitigation will be required for impacts to protected resources that cannot be avoided. The SFWMD adheres to detailed timeframes for the review of permits. Once an SWERP application is received, the department has up to 30 days to determine if the application is complete, or to issue a Request for Additional Information (RAI) if more information is needed. When the application is deemed complete, the department has 60 days to either issue a permit (or a Notice of Intent to Issue) if the activity meets the SWERP permitting criteria or issue a Notice of Denial (or Notice of Intent to Deny) if the activity does not. The estimated duration for permit review is approximately 6 months to 9 months after a complete application is accepted. An Individual Permit likely required for all alternatives and typologies under consideration. Individual permit fees from SFWMD are $2,000 for projects less than 10 acres in size that do not include boat slips.

Sovereignty Submerged Lands (SSL)

Activities located on SSL also require a proprietary authorization from the Board of Trustees. Review of proprietary authorization occurs concurrently with the Statewide Environmental Resource Permitting (SWERP) process and review. The approval or denial of an individually processed SWERP application is linked with the approval or denial of any required state-owned submerged lands application under Section 373.427, F.S. Under 18-21.004(C)(5), F.A.C., construction, or replacement, of bulkheads, seawalls, or other such shoreline stabilization structures that extend no more than three feet waterward of the line of mean or ordinary high water are exempt. Should any activity extend beyond 3 feet of the mean-high water line (MHWL), SSL authorization may be required.

Activities that require an individually processed ERP cannot become complete until all required state-owned submerged lands information has been submitted as part of the permit application. In addition, the ERP cannot be issued unless a determination has been made that the related state-owned submerged lands application also can be issued. If an activity meets all the requirements for issuance of an ERP but does not meet all the requirements for issuance of

the state-owned submerged lands authorization, the ERP must be denied. Authorization to use SSL will include an easement fee assessed by the Board of Trustees.

The USACE and the Florida Department of Environmental Protection (FDEP) have an Operating Agreement to coordinate the exchange of information between these agencies (and the State's water management districts) regarding permitting, compliance, and enforcement of activities regulated under Part IV of Chapter 373, F.S. The operating agreement details how issuance of an SWERP (including a general permit) also constitute a water quality certification under the CWA (Section 401) for the required USACE permit.

CWA Section 401 Water Quality Certification

The USACE and the Florida Department of Environmental Protection (FDEP) have an Operating Agreement to coordinate the exchange of information between these agencies (and the State's water management districts) regarding permitting, compliance, and enforcement of activities regulated under Part IV of Chapter 373, F.S. The operating agreement details how issuance of an SWERP (including a general permit) also constitute a water quality certification under the CWA (Section 401) for the required USACE permit.

South Florida Water Management District Right-of-Way Permit

The SFWMD defines right of way (ROW) as those properties or facilities that have been designated as "Works of the SFWMD" by the SFWMD's Governing Board. The most common ROW are those lands associated with canals and levees and in which the SFWMD has a fee (outright ownership) or easement (subject to someone else owning the property) interest. Use of SFWMD ROW is subject to the ROW Occupancy Permitting Program pursuant to Chapter 40E-6, FAC. The Miami River (C-6 canal) and the Little River Canal (C-7 canal) are works of the SFWMD. Permit applications, typically require very specific engineering drawings (permit sketches) showing only the work proposed in SFWMD ROW. In addition, once an application for a ROW Occupancy Permit has been deemed complete, including submission of any information required for the USACE to perform the Section 408 review, the SFWMD will submit a copy of the application and supporting documents to the USACE. All alternatives under typologies 1 and 3 will require authorization from the SFWMD ROW Office, due to their location on SFWMD ROW canals.

The proposed work would fall under SFWMD ROW permit fee category "SP-3," which carries a fee of $625.00. SFWMD ROW Permit review typically ranges from 6 to 9 months.

Local Permits

Miami-Dade County Department of Environmental Resources Management

Miami-Dade County Department of Environmental Resources Management (DERM) implements a regulatory program to protect water quality and natural resources within the County. Two separate permits would likely be required from DERM.

A Class I permit is required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County (Miami-Dade County Code of Ordinances Section 24-48). This permit is likely required for all design alternatives under all typologies due to the location of the proposed work. Application and permitting fees are based on estimated construction costs. Application fees can be as high as $28,750 for projects with construction costs of $1,000,000 or more. A separate permit fee (approximately equivalent in magnitude to the application fee) is typically waived for public projects under Miami-Dade County Code of Ordinances Section 24-48.8. Class I permit review time is widely variable, ranging from 3 to 12 months and is largely dependent on project complexity.

A Class II permit is needed to control stormwater discharge to any surface water in Miami-Dade County. If a project is designed in such a way that 100% of the stormwater is retained on-site it may be possible to avoid the need for this permit. Class II fees are also based on estimated construction costs. Class II permits have a lower application fee (typically $490) than Class I permit applications. As with the Class I, the Class II permit fee can be high depending on construction cost estimates, but local governments are able to request a waiver of the permit fee under Sec 24-48.8. Class II permit turnaround is typically 30-60 days but may be held back from issuance until the issuance of the Class I permit.

Planning and Zoning

Any landscaping plans must comply with the Miami-Dade County Landscaping Ordinance (Chapter 18A). Under the landscaping ordinance, the County requires landscaping buffers and the use of Florida friendly landscaping principles. This requirement would be for all design alternatives under each typology.

City Permits

Considering the amenities and facilities featured in the design alternatives, several city departments might be involved in the permitting process. These departments include the Buildings Department, Planning Department, Department of Resilience and Public Works, and Parks and Recreation Department. Permits are obtained by submitted the scope of work to the ePlan permit portal and generating a process number. This then generates a list of departments that need to review the plans, as well as where the project stands in the permitting process. The following is a summary of potential departments involved and their scope of review:

- The Building Department enforces code and regulations related to the construction, alteration, and maintenance of buildings and structures, which would be relevant for the construction of recreation facilities, among other structures.
- The Planning Department is made up of several distinct divisions that might play a role in the regulation process, including Arts in Public Places (AIPP), Historic Preservation, Land Development, and Urban Design. These divisions may be involved in certain projects where amenities and facilities in a project need to conform certain standards.
- The Department of Resilience and Public Works oversees the infrastructure, maintenance, and construction activities in the City's public right-of-way, which might influence the environmental restoration element of the designs, among others. This department would be the primary reviewer in the case of most EOR projects.
- The Parks and Recreation Department manages the 100+ parks in the City, and they will likely have a role in the regulation and permitting requirements, particularly at projects involving parks or sites that may be converted parks.

REGULATORY AND PERMITTING REQUIREMENTS

Table 5-1: Permitting Summary Matrix			AGENCIES				
			COUNTY			STATE	
Typology	Location	Alternative	Miami-Dade Division of Environmental Resource Management Class I	Miami-Dade Division of Environmental Resource Management Class II	Planning and Zoning	SFWMD Environmental Resource Permit	SFWMD District Right-of-Way
Typology 1 End-of-road on Riverfront	NE 5th Ave	Design Alternative 1	Required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County	Required to control stormwater discharge to any surface water in Miami-Dade County	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	Required for work within and adjacent to SFWMD ROW (C-7/ Little River Canal)
		Design Alternative 2	Required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County	Required to control stormwater discharge to any surface water in Miami-Dade County	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	Required for work within and adjacent to SFWMD ROW (C-7/ Little River Canal)
		Design Alternative 3	Required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County	Required to control stormwater discharge to any surface water in Miami-Dade County	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	Required for work within and adjacent to SFWMD ROW (C-7/ Little River Canal)
Typology 2 End-of-road on Bayfront	NE 26th Ave	Design Alternative 1	Required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County	Required to control stormwater discharge to any surface water in Miami-Dade County	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	N/A
		Design Alternative 2	Required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County	Required to control stormwater discharge to any surface water in Miami-Dade County	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	N/A
		Design Alternative 3	Required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County	Required to control stormwater discharge to any surface water in Miami-Dade County	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	N/A

	AGENCIES					
STATE	FEDERAL					
Sovereign Submerged Lands	US Army Corps of Engineers 404 (Dredge and Fill)	US Army Corps of Engineers Section 408	US Fish and Wildlife Services	National Marine Fisheries Protected Resources Division	National Marine Fisheries Essential Fish Habitat Division	State Historic Preservation Office, Florida Division of Historical Resources
Review of use of all submerged lands. Completed in conjunction with ERP review	Required for dredge and fill within tidal surface waters (riprap). Likely qualifies under NWP 54 and 13	Engineering review conducted by the USACE to confirm that a proposed work will not adversely affect civil works of the District. Required for work in Little River Canal	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters and substrate providing habitat. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process
	Required for dredge and fill within tidal surface waters (riprap). Likely qualifies under NWP 54 and 13	Engineering review conducted by the USACE to confirm that a proposed work will not adversely affect civil works of the District. Required for work in Little River Canal	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters and substrate providing habitat. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process
Review of use of all submerged lands. Completed in conjunction with ERP review	Required for dredge and fill within tidal surface waters (riprap). Likely qualifies under NWP 54 and 13	Required for work in Little River Canal	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters and substrate providing habitat. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process
Review of use of all submerged lands. Completed in conjunction with ERP review	Required for dredge and fill within tidal surface waters (riprap). Likely qualifies under NWP 54 and 13	N/A	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters and substrate providing habitat. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process
	Required for dredge and fill within tidal surface waters (riprap). Likely qualifies under NWP 54 and 13	N/A	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters and substrate providing habitat. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process
Review of use of all submerged lands. Completed in conjunction with ERP review	Required for dredge and fill within tidal surface waters (riprap). Likely qualifies under NWP 54 and 13	N/A	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters and substrate providing habitat. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process

			AGENCIES				
			COUNTY			STATE	
Typology	Location	Alternative	Miami-Dade Division of Environmental Resource Management Class I	Miami-Dade Division of Environmental Resource Management Class II	Planning and Zoning	South Florida Water Management District Environmental Resource Permit	South Florida Water Management District Right-of-Way
Typology 3 Park on Riverfront	Sewell Park	Design Alternative 1	Required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County	Required to control stormwater discharge to any surface water in Miami-Dade County	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	Required for work within and adjacent to SFWMD ROW (C-6/ Miami River Canal)
		Design Alternative 2	Required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County	Required to control stormwater discharge to any surface water in Miami-Dade County.	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	Required for work within and adjacent to SFWMD ROW (C-6/ Miami River Canal)
		Design Alternative 3	Required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County	Required for drainage into surface waters.	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	Required for work within and adjacent to SFWMD ROW (C-6/ Miami River Canal)
Typology 4 Park on Bayfront	Margaret Park	Design Alternative 1	Required for any work in, on, over or upon tidal waters or coastal wetlands of Miami-Dade County or any municipality within the County	Required to control stormwater discharge to any surface water in Miami-Dade County	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	N/A
		Design Alternative 2	N/A	Required to control stormwater discharge to any surface water in Miami-Dade County	Landscaping Requirements	Required for drainage, placement of riprap, and upland work. Individual Permit anticipated	N/A

	AGENCIES					
STATE	FEDERAL					
Sovereign Submerged Lands	US Army Corps of Engineers 404 (Dredge and Fill)	US Army Corps of Engineers Section 408	US Fish and Wildlife Services	National Marine Fisheries Protected Resources Division	National Marine Fisheries Essential Fish Habitat Division	State Historic Preservation Office, Florida Division of Historical Resources
Review of use of all submerged lands. Completed in conjunction with ERP review	Required for dredge and fill within tidal surface waters (riprap). Likely qualifies under NWP 54 and 13	Engineering review conducted by the USACE to confirm that proposed work will not adversely affect civil works of the District. Required for work in Miami River	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters and substrate providing habitat. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process
N/A	Required for dredge and fill within tidal surface waters (riprap). Likely qualifies under NWP 54 and 13	Engineering review conducted by the USACE to confirm that proposed work will not adversely affect civil works of the District. Required for work in Miami River	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters and substrate providing habitat. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process
Review of use of all submerged lands. Completed in conjunction with ERP review	Required for dredge and fill within tidal surface waters (riprap). Likely qualifies under NWP 54 and 13	review conducted by the USACE to confirm that proposed work will not adversely affect civil works of the District. Required for work in Miami River	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters, substrate, vegetation. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process
Review of use of all submerged lands. Completed in conjunction with ERP review	Required for dredge and fill within tidal surface waters (riprap). Likely qualifies under NWP 54 and 13	N/A	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters and substrate providing habitat. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process
Review of use of all submerged lands. Completed in conjunction with ERP review	Required for dredge and fill within tidal surface waters (riprap). Likely to require a Standard Permit	N/A	Review of potential impacts to threatened and endangered species: West Indian Manatee. Consultation through USACE permitting process	Review of potential impacts to marine threatened and endangered species. Consultation through USACE permitting process	Identify and protect Essential Fish Habitat: waters and substrate providing habitat. Consultation through permitting process	Review of potential effects of the project on historic properties and archaeological resources. Consultation through USACE permitting process

5.2 Agency Meetings

Four regulatory agencies provided insight and feedback regarding the permitting requirements for the alternative design solutions. The four agencies are Miami-Dade County's Department of Environmental Resources Management/ Regulatory & Economic Resources, the City of Miami, South Florida Water Management District, and the United States Army Corps of Engineers.

Miami-Dade County Department of Environmental Resources Management/ Regulatory & Economic Resources

Miami-Dade County's Department of Environmental Resources Management (DERM) oversees the restoration, monitoring, education, regulatory, and land management programs aimed at protecting the County's natural resources. The County's Department of Regulatory & Economic Resources (RER) manages regulatory strategies and business expansion efforts.

In a pre-application permitting meeting, the County had comments related to water control and coastal resources. First, in terms of water control, the elevation of proposed project elements needs to be at or about the current levels of County flood data. Furthermore, any dry retention areas need to be above the high-water table. The grading and drainage design of these dry retention areas needs to follow County flood criteria, as well as water quality requirements. The County will meet again to discuss elevations in grading and drainage plans once designs are advanced to include engineering drawings. Also, any outfalls will require both a Class II permit and manatee grates. Considering the amount of green infrastructure in most of the designs, however, it is unlikely outfalls will be required in the project scope.

In terms of coastal resources, all proposed designs involve wetland areas that discharge into tidal waters. The County advises that the project team determines whether the designs will be filled with riprap or organic material to support plantings. If the project team pursues riprap to fill the designs, all riprap should not exceed 10 feet waterward and they need to be greater than one foot in diameter at a minimum.

Also, the designs need to meet wetland management requirements, including dredge and fill criteria. Dredge and fill is reviewed by the Environmental Quality Control Board, and if a variance is needed, then the County Commission needs to approve it. Mitigation is required for any fill, and filling waterward of the mean water line is considered filling of tidal waters. Designs should end at the edge of the existing sea wall and the project team should grade back into the site for infrastructure improvements like steps or oyster domes.

If pursuing oyster domes, then the design requires a variance from the County Commission, as oyster domes would be considered filled tidal waters. These variances typically extend the application process by an additional 60 days. The Sewell Park kayak launch proposed oyster domes but ultimately removed them from the application because of the needed BOCC approval and extended timeline.

For constructed wetlands, the project team needs to create barriers between neighbors to prevent flooding and wetland encroachment on adjacent properties. Transitioning an area to a wetland is subject to County jurisdiction and will require a Class I permit. A Class I permit is also needed for maintenance (i.e., Mowing, construction, etc.) of any areas that flood with tidal waters, as they are considered wetlands. Ultimately, the limit on what is considered a wetland is determined by the wetland delineation rule (62-340) established by Florida's Department of Environmental Protection.

In terms of living shorelines and proposed plantings, the County will provide a list of suggested and preferred plant material and grasses. The County particularly prefers the use of mangroves for living shorelines. Generally, mangrove trimming would require additional permitting and red mangroves require a +1' elevation for planting. The smallest mangroves are 6' but that is likely not ideal for the project scope, so the size will be dependent on the nature of the project.

On the other hand, planting landward of a seawall would not be considered fill. The Virginia Key Beach Park project provided native plantings landward of a seawall. While it was designed to flood, it was not considered filling in tidal waters nor a wetland because the plants were planted in planters.

Generally, seawalls require a 6" grade change landward. Concrete seawalls, however, are limited to 12" water face and steel seawalls are limited to 18" water face. Although the County can review some projects for the State and some projects for the Army Corps of Engineers, the County does not have the authority to review or issue a permit for a project that involves any filling waterward of a seawall. The County also does not have the authority to issue a permit for the Army Corps for projects within 100 feet of a federal channel.

City of Miami

Although there is no existing checklist of needed permits, the City of Miami provided insight into departments and contacts potentially needed for the projects moving forward. In many cases where County permits are needed, the City facilitates the submission and processing of files between the project team and the County.

The City also noted that the various departments across the City's government has different requirements, rules, and regulations. First, all designs must obtain a master permit from the City of Miami's Building Department. The master permit includes requirements related to structural and floodplain management, mechanical and plumbing, electrical, fire, trees, and public right-of-way permits. The Parks and Recreation Department needs to also review all plans.

Also, the City has an Archaeological division that is mandated by the City and backed by the City and the State; a review process with this division is dependent on the severity of the findings. This division differs from the City's Historic Preservation division, which has different requirements and prerequisites. The City's Planning Department can determine if the project area falls under a historic area or an archaeological area; thus, they can indicate which division the project team needs to work with moving forward.

The City's Planning Department can also assist in tree preservation plans, and it can explain how the designs and projects relate to any existing master plan. The Planning Department and the Zoning Office can also replat and rezone land as park and public use. They can help define the steps for rezoning and clearly outline what would need to happen for the EOR pilot sites. This is relevant because the interior of the park and the Riverwalk would be zoned differently because of these projects.

South Florida Water Management District

The South Florida Water Management District (SFWMD) is a regional governmental agency that oversees Miami's water resources. In a pre-application permit meeting with SFWMD representatives, they advised that when pursuing a permit for a project, it is prudent to ensure that there are no existing permits on the site already. Also, rather than a conceptual permit for multiple sites, they recommend permitting each project individually. With each permit, there are three different reviewers, so the project team should be prepared for the three different perspectives upon review.

SFWMD also provided more targeted insights related to engineering, water, and property. In terms of engineering, SFWMD advised that

implementing permeable pavement would require an O&M (Operations and Management) plan, and engineering would be more interested in stormwater work on upland portions of the sites.

From a water perspective, although SFWMD does not see anything in the project plan that is not permittable, they advise the project team confirms that the project aligns with the regulations for the Biscayne Aquatic Preserve. Also, the project team should ensure the designs, particularly breakwaters, do not impact the Sovereign Submerged Lands. The breakwaters would have the greatest potential impact, but the project could still be achieved with an easement. An easement, however, is a lengthy process. The projects should also implement signage and/or barriers to discourage boat access to the tessellated stones at the EORs.

Also, a site visit would be required to identify and assess the impacts the projects could have on seagrasses, mangroves, and wetlands. Creating wetlands would require a monitoring and maintenance plan; Section 10 of the Applicant's handbook provides more detailed information on that plan. Relatedly, the project team would need to coordinate with the FWC to evaluate the impacts to manatees and sea turtles in the area.

With reference to property, SFWMD advises that if there are any city-owned properties impacted by the projects, the project team will need to acquire the deed for the property, obtain a boundary survey, and identify any easements on the property.

United States Army Corps of Engineers

In a pre-application permitting meeting with the United States Army Corps of Engineers (USACE), they recommended that any projects moving toward implementation should start with an existing resource survey. This survey will help the project team understand how the existing resources would either be enhanced or negatively impacted by projects and designs.

For example, the USACE indicated that because most of the proposed designs impede into the water, there are potential negative impacts to navigable waterways. USACE's mandate is to protect the navigable waterways. All projects impending into the waterway will need justification for how the proposed design elements, like riprap and vegetation, will improve the waterway and its resources. From the USACE's perspective, examples of improvements include maintaining and creating habitats.

REGULATORY AND PERMITTING REQUIREMENTS

The project team can avoid issues regarding impeding waterways by pulling the shoreline back from its current position. If this solution is pursued, however, the USACE would need more details because pulling the shoreline landward would create a new mean higher high water (MHHW) area. This could still trigger the need for a permit.

There have been similar living shoreline projects in Miami-Dade County, including City of Miami Beach's Brittany Bay Park and Jose Marti Park, that have had limited extension into the water and involved pulling back the shoreline. These projects have been reviewed and approved by the USACE. Brittany Bay Park has an overlook in the design, but it was pulled more landward to reduce impacts on the navigable waterways.

Another design element that could affect existing water resources is the current configuration of the tessellated stones. All the designs should strike a balance between ensuring navigable waterways and improving the shoreline.

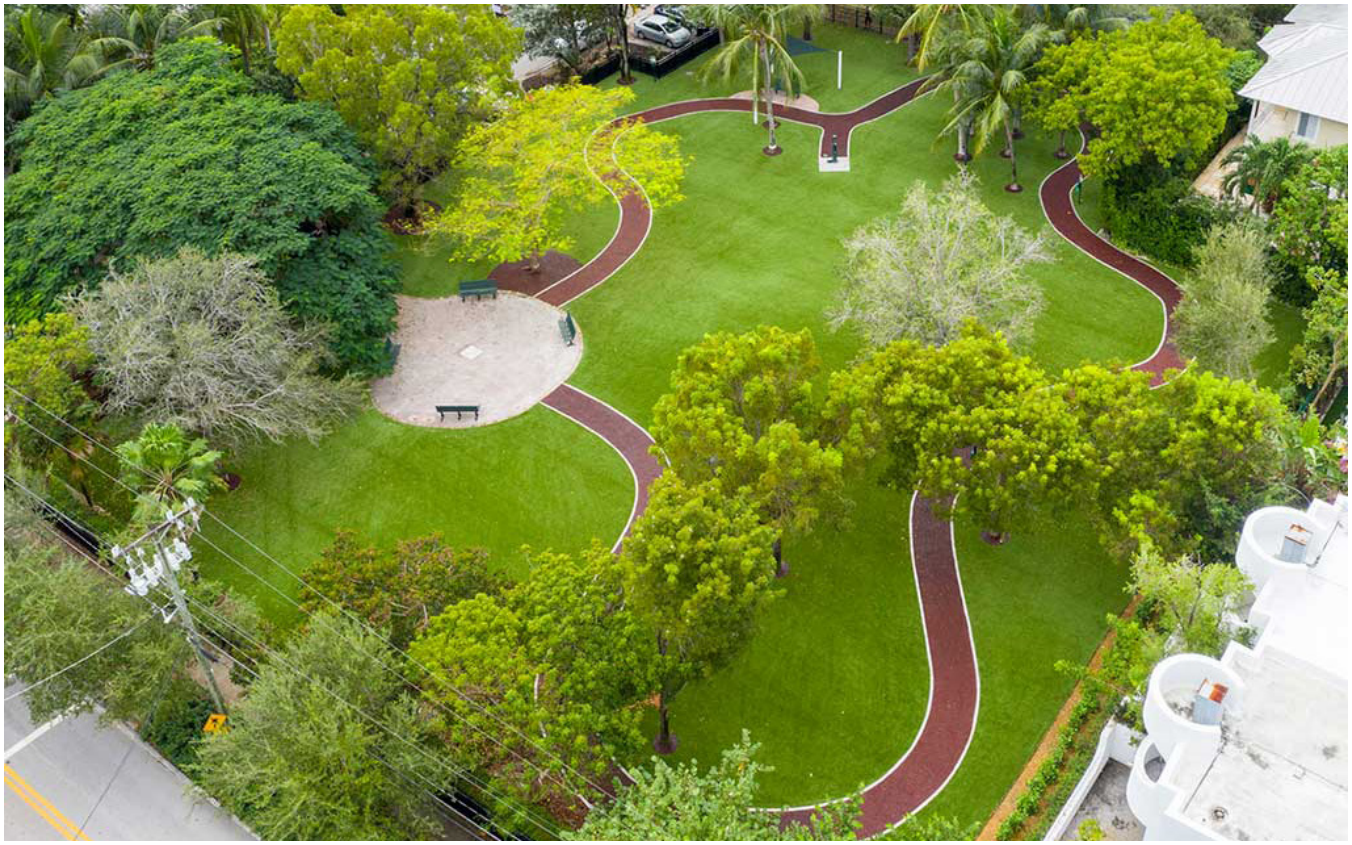
The USACE also had site-specific feedback regarding the design alternatives. They noted that any projects in the Little River would need a consultation to evaluate impacts to manatees.

Also, the USACE has not seen many examples of implementing oyster reefs as shoreline protection, and they suggest that this element may not be very successful. Instead, they recommend mangroves planted into riprap or in PVC pipes as an alternative. Also, they note that Margaret Pace Park will have a lot of permitting restrictions because of the existing seagrasses within Biscayne Bay. Breakwater islands may be difficult to permit in Biscayne Bay, and would require extensive resource evaluation and analysis of potential benefits.

5.3 Summary of Design Considerations

Based on the discussions during the permitting, several design considerations would need to be integrated into the alternatives during the next phase of design.

- Stormwater underdrains may not be necessary on sites where impervious surfaces are reduced and on-site mitigation is present
- In most cases, designs should not encroach waterward of the mean high-water line
- Seawalls adjacent to neighboring properties would likely be needed when constructed wetlands are included in the sites
- Resource surveys would be needed at most projects
- Waterward strategies such as oyster domes or breakwater islands may not necessarily be discouraged, however, substantial justification for benefits would be needed



REGULATORY AND PERMITTING REQUIREMENTS

IMPLEMENTATION STRATEGIES

6

Effective implementation is a critical component to carrying forward the design alternatives presented in this plan. While permitting requirements are the primary focus of the previous chapter, the Implementation Chapter provides additional considerations and strategies that will help ensure that the planning, design, development, and maintenance of shoreline enhancements will continue to be at the forefront of sustainable and resilient design.

The considerations and strategies included in the Implementation Chapter are intended to provide achievable steps for the realization of the ideas developed through the project process. In order to maintain continuity with this process, this chapter was developed through an Implementation Workshop with the project team and City staff, as well as additional feedback from City Department Directors and external stakeholders.

6.1 Summary of Strategies

Additional Considerations

While the permitting analysis provides many of the regulatory requirements for projects of this nature, there are additional regulatory considerations that should be noted. End-of-road projects would typically be implemented in areas that are currently public right-of-way (ROW). Once developed, these sites would either remain public ROW, or the ROW would be closed and vacated, with the land use and zoning designation potentially changing. This transfer would also have implications on the future maintenance of the property. The City should develop guidelines for these decisions that help address these issues on a case-by-case basis.

Environmental remediation and potential contamination are also common concerns in large cities, particularly in urban waterfront areas. Typical contamination includes industrial discharge, vehicular discharge, residential/commercial wastewater, polluted stormwater, and solid waste. Recent projects at Gerry Curtis Park and Jose Marti Park have revealed contamination issues similar to those listed above. Additionally, a recent survey of all City-owned properties indicated that 11 to 15 of them may have some level of contamination. Due to these developments, a Phase 1 environmental assessment of all potential projects along the waterfront is recommended prior to design and construction.

Phasing

When considering waterfront properties, as well as some of the more complex solutions presented in the design alternatives, projects incorporating these elements will likely require significant financial resources to implement. Phasing projects such as these are often necessary from a funding standpoint, but also provides constructability benefits by allowing the City to utlize multiple design and construction methodologies at one site.

The City of Miami has completed several waterfront parks that implemented the following phasing strategies:

- Water's edge: The portion of the project that impacts the water and/or immediate shoreline. This typically includes any shoreline stabilization, seawall replacement, or plantings.
- Shoreline: Improvements and amenities immediately landward of the waterline or seawall. This typically includes baywalk, riverwalk, seating areas, shade, signage and public art.
- Interior: Improvements located throughout the remaining areas of the site. These vary depending on the site selected and the intended use of the space.

Additional phases could also be implemented at larger park sites to maintain the functionality of some areas of the park while others are under construction. For EOR projects, it is recommended that water's edge improvements always be implemented first, and other improvements be phased in as needed.

Design and Construction Methodologies

Given the complex nature of many of the elements in the design alternatives, utilizing the most applicable design and construction methodologies will help ensure projects are implemented successfully and efficiently. The City typically uses a range of options for design and construction depending on the cost, complexity, and specialization needed for a project. For small projects under a certain cost threshold and with relatively simple scopes, a Job Order Contract (JOC) can be issued. This could be applied to phased portions of small parks or EORs using a design criteria package to obtain competitive bids from contractors for the project.

For larger and more complex projects, the City typically issues an RFQ for a development plan and goes through a full design process. This begins with additional public engagement and finalization of the concept. The project would then proceed through a design-build route, or a design-bid-build route. In a design-build project, the contractor building the project is also the designer. The City has historically used this option for specialized areas of projects that require particular expertise in design or construction. This approach is likely to be applicable to many of the concepts in the design alternatives, particularly along the waterfront. For other areas of the projects, particularly on the interior, projects are more likely to follow the design-bid-build route. In this case, the project is designed by a design team, and the construction work is competitively bid before a contractor is selected.

All three of these methodologies could potentially be utilized in projects incorporating the design alternatives, and the approach should be evaluated on a case-by-case basis.

Funding

A variety of funding mechanisms are available for waterfront projects that help improve resilience and conserve open space. Historically, the City has been successful in implementing projects through general fund appropriations, general obligation bonds, grants, impact fees, and private funds. These funding sources will continue to be viable alternatives for additional projects that focus on parks, sustainability, conservation, and resilience. Below is a table highlighting funding sources for recent City of Miami Projects.

In recent years, grants for projects that promote conservation, improve sustainability and resilience, and help mitigate impacts from climate change have become more available. There are a variety of grants available at the local, state, and federal levels that can be applied to the projects that incorporate concepts in the plan. A summary of potential grants can be found below:

Resilient Florida Program (state funds)

Selected grants are awarded to public entities to address impacts of flooding and sea-level rise. Eligible participants receiving funds can use them for planning studies as well as project implementation for adaption and mitigation strategies.

- Administered by the Florida Department of Environmental Protection 's (FDEP) Office of Resilience and Coastal Projection
- More information here: https://floridadep.gov/Resilient-Florida-Program/Grants

Florida Communities Trust: Parks & Open Space program (state funds)

Funded projects are intended to further outdoor recreation and provide natural resource protection. An emphasis is placed on funding projects in low-income, disadvantaged neighborhoods and providing areas for direct water access that are open to the public

- Administered by the FDEP's Division of State Lands
- No explicit Cost-Benefit Analysis (CBA) requested in application
- Allows projects an area to mention "project excellence" not included in evaluation criteria already, such as if the project has strong community-based support
- Application: https://floridadep.gov/sites/default/files/FCT_Grant_Application_Instructions_Final_2020.9-22.pdf
- Annual report: https://floridadep.gov/lands/land-and-recreation-grants/content/parks-and-open-space-florida-forever-grant-program-0

Florida Communities Trust: Working Waterfronts program (state funds)

Projects funded are meant to restore and preserve working waterfronts used for commercial fishermen, aquaculturists, or business entities, or for facilities that provide waterfront access to these entities, or land for exhibitions, educational venues, civic events, and other purposes that educate the public about Florida's heritage and traditional working waterfronts

- Administered by the Florida Department of Economic Opportunity and funded by FDEP, Florida Coastal Management Program, and the National Oceanic and Atmospheric Administration
- Application: https://floridadep.gov/sites/default/files/SMWW.APP_GUIDE_2022-2023_web.pdf

Florida Recreation Development Assistance Program (state funds)

Grants provide financial assistance to public agencies to develop or acquire land for public outdoor recreation. Participants awarded funding are responsible for offering outdoor recreation for the general public.

- Administered by the FDEP's Division of State Lands
- No explicit CBA requested in application
- Funded projects are meant for public outdoor recreation use or the construction of recreational trails
- More information here: https://floridadep.gov/lands/land-and-recreation-grants/content/frdap-assistance

Land and Water Conservation Fund (LWCF) (federal funds)

Projects funding through the LWCF provide assistance for acquisition or development of land for public outdoor recreation. The goal of this fund is to promote natural, cultural, wildlife, and recreational management throughout the US.

- Administered by the US Department of the Interior's Bureau of Land Management
- Applicants may not submit the same application to FRDAP, LWCF, and RTP in the same cycle. If an entity has already received funds from one of the three, they cannot apply to the others
- More information here: https://www.nps.gov/subjects/lwcf/index.htm

Recreational Trails Program (federal funds)

The US Department of Transportation utilizes this program to provide funding for projects that promote the development of recreational trails and further improve non-motirized connectivity in a variety of community contexts.

- Administered by Florida Department of Environmental Protection in coordination with DOT FHWA
- Funds are meant for development or maintenance of recreational trails, trail construction or maintenance, or trailhead and trailside facilities
- No explicit CBA, but project is asked to address how:
  - It is related to or addresses issues and goals identified in the State Comprehensive Outdoor Recreation Plan
  - How it addresses issues and goals in the State Greenways and Trails Plan
  - How the project improves accessibility and use for persons with disabilities
  - How the project provides access to or between public parks, recreational lands/facilities, existing intermodal transportation corridors, residential populated areas, and areas of historic cultural, or other significance
  - Whether it supports both motorized / nonmotorized use + mixed-use recreational trail opportunities
- More information here: https://floridadep.gov/sites/default/files/FY2023-24%20OGT-10.RTP23.Application_0.pdf

Outdoor Recreation Legacy Partnership Program (federal funds)

Funded projects provide support for urban communities that are economically disadvantaged with little to no access to public open space for recreational activities. Matching grants can be utilized for all manners of outdoor recreation activities.

- Administered by the National Park Service
- Support the creation of significant renovation of state / locally-owned parks and outdoor recreation spaces. Funds are meant to help the public access / re-connect with the outdoors, specifically targeting economically disadvantaged neighborhoods that lack adequate parks and recreational opportunities
- More information here: https://www.nps.gov/subjects/lwcf/outdoor-recreation-legacy-partnership-grants-program.htm

Miami-Dade County GREEN Grants

The Growing Roots for Environmentally Equitable Neighborhoods (GREEN) program provides funding to encourage native planting on public lands to help reach the goal of 30 percent urban tree canopy in Miami-Dade County.

- Administered by Miami-Dade County Parks, Recreation and Open Spaces
- Funds are for planting native / Florida-friendly trees on public land, including parks; goal is to make investments on public land. Grant applications are judged on (1) existing tree canopy and income level, (2) project enhancements, (3) resiliency/impact, and (4) community outreach
- More information here: https://www.miamidade.gov/global/service.page?Mduid_service=ser1540844322968915

National Fish & Wildlife Foundation (funding varies by grant and partnerships)

Provides grants for projects that protect and conserve fish, wildlife and plant habitats across the Unites States through a variety of programs. This funding helps build partnerships between private corporations and government agencies, nonprofits, and individuals that promote environmental resiliency.

- Grants are funded through various partnerships and administered by the National Fish and Wildlife Foundation
- Potential applicable programs include the Five Star and Urban Waters Restoration Grant Program, and the National Coastal Resilience Fund
- Rejuvenating coastal areas, enhancing water quality, and improving community resilience
- More information here: https://www.nfwf.org/apply-grant

Policy and Practice Updates

The Resilient Waterfront Enhancement Plan is intended to work in conjunction with the suite of planning and design documents evaluated in Chapter 2. These documents, along with parks design criteria, stormwater guidelines, and recently adopted WEDG guidelines, should be considered when implementing any components of the design alternatives.

As stated in the Regulatory and Permitting Requirements section, the primary policy needed for successful implementation of the design alternatives is a formal selection and improvement evaluation process for potential sites. The sites selected for the typologies in this plan were four of many candidates owned by the City of Miami. The large percentage of waterfront owned by the City of Miami provides the potential for significant redundancy of resilient infrastructure, strengthening the City's ability to mitigate the impacts from climate change. The City should develop a protocol for selecting and prioritizing sites for improvements, determining the level of strategies and amenities that are included, assessing land use or ownership changes, and identifying maintenance responsibilities. This decision-making process will help streamline the implementation process moving forward.

Operations and Maintenance Considerations

The long-term success of nature-based solutions relies on proper operation and maintenance. Many of the strategies incorporated in the design alternatives are intended to help reduce certain maintenance issues caused by flooding, storm surge and other climate-related impacts on the potential sites and surrounding context. However, some of the strategies utilized require specialized, intensive maintenance to ensure they retain their functionality and viability. This is particularly true with native plantings, constructed wetlands, living shorelines, bioretention areas, and permeable pavement. Many of the strategies also will require specialized maintenance practices that go beyond the typical responsibilities of City staff. These services will likely need to be contracted out to a specialist, a practice the City is already utilizing for waterfront areas.

An additional concern expressed by City staff was the tendency for waterfront projects with green infrastructure to become capture areas for trash and marine debris. This factor, coupled with staffing shortages, is straining the City's ability to keep waterfront areas clear of debris. Any new projects that incorporate nature-based resilient shoreline strategies will need to have maintenance plans that identify the potential need for specialized, contract maintenance, as well as the level of additional maintenance required by City staff. Projects should also undergo a thorough evaluation of projected maintenance costs, as well as a funding plan to ensure that providing the necessary maintenance for these improvements. These steps will help ensure that green

infrastructure is well-maintained, highly functional, and aesthetically beneficial for the community.

Potential Stakeholder Engagement

Much like the policy and practice updates, stakeholder engagement is intended to ensure consistent collaboration across the City.

Elected Officials

Elected officials serve as the primary decision-makers and public policy developers for the City. The City's officials, as well as their staff, will be made familiar with the main components of the plan and how the strategies are intended to be incorporated into potential projects. Collaboration with elected officials will be critical to the incorporation of resilient design strategies into potential projects, as well as generating support for these projects with the community.

Private Developers

While the plan focuses on strategies that can be implemented at City-owned properties, comprehensive resilience along the waterfront will require coordination with private developers. This can be achieved by implementing policies and ordinances that encourage sustainable and resilient design in private development projects, as well as emphasizing the benefits of nature-based, resilient design strategies. This will advance the ideas from the plan and encourage a cohesive waterfront that provides City-wide resilience.

Local Organizations

The sites that were selected to represent the typologies, as well as many other potential sites, fall within areas that would require coordination with local organizations such as the Miami River Commission and the Downtown Development Authority (DDA). Any project on the rivers would require review and coordination with the Miami River Commission to ensure they meet aesthetic guidelines. The same is true for the DDA with any projects on the bay, as the DDA serves as the stewards of the baywalk.

6.2 CONCLUSION

The City of Miami has taken great strides in planning for a resilient future by recognizing that waterfront enhancements provide unique opportunities for resilient infrastructure and meaningful public spaces. Through the process of demonstrating potential strategies at the selected pilot sites, the City has developed practical alternatives that serve as guides for future development. Implementation off the Resilient Waterfront Enhancement Plan will prepare the City for future climate conditions, conserve natural areas, provide new parks and open spaces, and enhance the overall resilience of Miami.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Chapter 5

[1]https://www.fema.gov/sites/default/files/documents/fema_ecosystem-service-value-updates_2022.pdf

[2]Calculated using FEMA's 2022 Total Estimated Benefits value for Urban Green Open Space ($15,541 per acre) and the assumption that the parklet is approximately 6,540 square feet or 0.15 acres.

[3]Calculated using FEMA's 2022 Total Estimated Benefits value for Urban Green Open Space ($15,541 per acre) and the assumption that the parklet is approximately 5,230 square feet or 0.12 acres.

[4] Calculated using FEMA's 2022 Total Estimated Benefits value for Urban Green Open Space ($15,541 per acre) and the assumption that Sewell Park is approximately 4.5 acres. Note that, because Sewell Park does offer some pre-existing greenspace, the marginal benefit of the design updates alone may be lower than this value.

[5] Calculated using FEMA's 2022 Total Estimated Benefits value for Urban Green Open Space ($15,541 per acre) and the assumption that Margaret Pace Park is approximately 8 acres. Note that, because Margaret Pace Park does offer some pre-existing urban open green space, the marginal benefit of the design updates alone may be lower than this value.

Cost Estimates

City of Miami Waterfront Resilience Enhancement Plan					
Waterfront Typologies - Benefit/Cost Analysis Costs (2022)					
Typology 1: End of Road on Riverfront					
Location: NE 5th Ave					
	Unit	**Quantity**	**Unit Cost**		**Subtotal**
Typology 1: Alternative 1					
Site Prep and Infrastructure					
Vacant Lot / Easement Acquisition where necessary	Acre	0.25	$500,000		$125,000
Sitework and Preparation	Acre	0.15	$100,000		$15,000
New Crosswalks (ADA accessible, high-visibility	Each	1	$30,000		$30,000
Modified Seawall	LF	61	$1,000		$61,000
ADA Permeable Pathway	SF	1895	$60		$113,700
ADA Permeable Car Parking	SF	450	$75		$33,750
Utility Upgrades	Allowance	1	$50,000		$50,000
Stormwater Improvements					
Drainage inlets in retention areas	Each	3	$5,000		$15,000
Sub-surface drainage infrastructure	LF	100	$100		$10,000
Outflows with tidal backflow preventers	Each	1	$3,000		$3,000
Landscape Improvements					
Shade Trees	Each	23	$400		$9,200
Shrubs	Each	50	$150		$7,500
Grasses and Groundcover	SF	3240	$12		$38,880
Shoreline Improvements					
Aquatic Vegetation	SF	610	$20		$12,200
Stabilizing Rocks	SF	305	$10		$3,050
Park Structures and Amenities					
Sculptural bench seating	Each	3	$5,000		$15,000
New Trash cans	Each	2	$1,500		$3,000
Dog stations	Each	2	$800		$1,600
Pedestrian level security lighting	Each	7	$7,500		$52,500
Art Installations	Allowance	1	$25,000		$25,000
Additional Signage (Wayfinding, educational)	Allowance	1	$40,000		$40,000
Enhanced Park Entry					
Bike racks (including pad)	Each	1	$1,500		$1,500
Park entry sign	Each	1	$20,000		$20,000
Total Direct Cost					**$685,880**
Mobilization and General Conditions	ls	10%			$68,588
Bonds, Insurance and Overhead	ls	5%			$34,294
Profit	ls	10%			$68,588
Contingency	ls	20%			$137,176
Total Direct Construction Cost					**$994,526**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$248,632
Total Cost					**$1,243,158**
Total Cost per SF of Park					**$190.26**
Total Cost per LF of Shoreline					**$20,379.63**

Typology 1: Alternative 2					
Site Prep and Infrastructure					
Vacant Lot / Easement Acquisition where necessary	Acre	0.25	$500,000		$125,000
Sitework and Preparation	Acre	0.15	$150,000		$22,500
New Crosswalks (ADA accessible, high-visibility	Each	1	$30,000		$30,000
Modified Seawall	LF	61	$1,000		$61,000
ADA Permeable Pathway	SF	1421	$60		$85,260
ADA Permeable Car Parking	SF	450	$75		$33,750
Tessellated Stone Steps	SF	745	$40		$29,800
Utility Upgrades	Allowance	1	$50,000		$50,000
Stormwater Improvements					
Drainage inlets in retention areas	Each	4	$5,000		$20,000
Sub-surface drainage infrastructure	LF	100	$100		$10,000
Outflows with tidal backflow preventers	Each	1	$3,000		$3,000
Landscape Improvements					
Shade Trees	Each	23	$400		$9,200
Shrubs	Each	50	$150		$7,500
Grasses and Groundcover	SF	3240	$12		$38,880
Shoreline Improvements					
Aquatic Vegetation	SF	610	$20		$12,200
Park Structures and Amenities					
Sculptural bench seating	Each	3	$5,000		$15,000
Shade Structure for Seating	Each	2	$30,000		$60,000
New Trash cans	Each	2	$1,500		$3,000
Dog stations	Each	2	$800		$1,600
Pedestrian level security lighting	Each	7	$7,500		$52,500
Art Installation	Allowance	1	$25,000		$25,000
Additional Signage (Wayfinding, educational)	Allowance	1	$40,000		$40,000
Enhanced Park Entry					
Bike racks (including pad)	Each	1	$1,500		$1,500
Park entry sign	Each	1	$20,000		$20,000
Total Direct Cost					**$756,690**
Mobilization and General Conditions	ls	10%			$75,669
Bonds, Insurance and Overhead	ls	5%			$37,835
Profit	ls	10%			$75,669
Contingency	ls	20%			$151,338
Total Direct Construction Cost					**$1,097,201**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$274,300
Total Cost					**$1,371,501**
Total Cost per SF of Park					**$209.90**
Total Cost per LF of Shoreline					**$22,483.62**

Typology 1: Alternative 3					
Site Prep and Infrastructure					
Vacant Lot / Easement Acquisition where necessary	Acre	0.25	$500,000		$125,000
Sitework and Preparation	Acre	0.15	$250,000		$37,500
New Crosswalks (ADA accessible, high-visibility	Each	1	$25,000		$25,000
Modified Seawall (Decorative)	LF	95	$1,200		$114,000
Modified Seawall (Naturalized)	LF	55	$650		$35,750
ADA Permeable Pathway	SF	273	$60		$16,380
ADA Boardwalk	SF	1203	$200		$240,600
ADA Permeable Car Parking	SF	450	$50		$22,500
Utility Upgrades	Allowance	1	$30,000		$30,000
Stormwater Improvements					
Drainage inlets in retention areas	Each	2	$5,000		$10,000
Sub-surface drainage infrastructure	LF	100	$100		$10,000
Outflows with tidal backflow preventers	Each	2	$5,000		$10,000
Landscape Improvements					
Shade Trees	Each	25	$400		$10,000
Shrubs	Each	50	$150		$7,500
Grasses and Groundcover	SF	3400	$12		$40,800
Shoreline Improvements					
Aquatic Vegetation	SF	610	$20		$12,200
Stabilizing Rocks	SF	650	$10		$6,500
Park Structures and Amenities					
Sculptural bench seating	Each	3	$5,000		$15,000
Shade Structure for Seating	Each	1	$50,000		$50,000
New Trash cans	Each	2	$1,500		$3,000
Dog stations	Each	2	$800		$1,600
Pedestrian level security lighting	Each	7	$7,500		$52,500
Art Installation	Allowance	1	$25,000		$25,000
Additional Signage (Wayfinding, educational)	Allowance	1	$40,000		$40,000
Enhanced Park Entry					
Bike racks (including pad)	Each	1	$1,500		$1,500
Park entry sign	Each	1	$20,000		$20,000
Total Direct Cost					**$962,330**
Mobilization and General Conditions	ls	10%			$96,233
Bonds, Insurance and Overhead	ls	5%			$48,117
Profit	ls	10%			$96,233
Contingency	ls	20%			$192,466
Total Direct Construction Cost					**$1,395,379**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$348,845
Total Cost					**$1,744,223**
Total Cost per SF of Park					**$266.95**
Total Cost per LF of Shoreline					**$28,593.82**

City of Miami Waterfront Resilience Enhancement Plan					
Waterfront Typologies - Benefit/Cost Analysis Costs (2022)					
Typology 2: End of Road on Bayfront					
Location: NE 26th St					
	Unit	**Quantity**	**Unit Cost**		**Subtotal**
Typology 2: Alternative 1					
Site Prep and Infrastructure					
Vacant Lot / Easement Acquisition where necessary	Acre	0.25	$500,000		$125,000
Sitework and Preparation	Acre	0.12	$200,000		$24,000
Modified Seawall	LF	70	$1,000		$70,000
ADA Permeable Pathway	SF	2060	$60		$123,600
ADA Permeable Car Parking	SF	450	$75		$33,750
Utility Upgrades	Allowance	1	$75,000		$75,000
Stormwater Improvements					
Drainage inlets in retention areas	Each	2	$500		$1,000
Sub-surface drainage infrastructure	LF	90	$100		$9,000
Outflows with tidal backflow preventers	Each	1	$3,000		$3,000
Landscape Improvements					
Shade Trees	Each	20	$400		$8,000
Shrubs	Each	40	$150		$6,000
Grasses and Groundcover	SF	2360	$12		$28,320
Shoreline Improvements					
Aquatic Vegetation	SF	650	$20		$13,000
Stabilizing Rocks	SF	305	$10		$3,050
Park Structures and Amenities					
Sculptural bench seating	Each	1	$7,500		$7,500
New Trash cans	Each	2	$1,500		$3,000
Dog stations	Each	2	$800		$1,600
Pedestrian level security lighting	Each	9	$7,500		$67,500
Additional Signage (Wayfinding, educational)	Allowance	1	$60,000		$60,000
Enhanced Park Entry					
Bike racks (including pad)	Each	1	$1,500		$1,500
Park entry sign	Each	1	$20,000		$20,000
Total Direct Cost					**$683,820**
Mobilization and General Conditions	ls	10%			$68,382
Bonds, Insurance and Overhead	ls	5%			$34,191
Profit	ls	10%			$68,382
Contingency	ls	20%			$136,764
Total Direct Construction Cost					**$991,539**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$247,885
Total Cost					**$1,239,424**
Total Cost per SF of Park					**$237.11**
Total Cost per LF of Shoreline					**$17,706.05**

Typology 2: Alternative 2					
Site Prep and Infrastructure					
Vacant Lot / Easement Acquisition where necessary	Acre	0.25	$500,000		$125,000
Sitework and Preparation	Acre	0.12	$200,000		$24,000
Modified Seawall	LF	70	$1,000		$70,000
ADA Permeable Pathway	SF	1525	$60		$91,500
ADA Platform Deck	SF	385	$75		$28,875
ADA Permeable Car Parking	SF	450	$75		$33,750
Utility Upgrades	Allowance	1	$75,000		$75,000
Stormwater Improvements					
Drainage inlets in retention areas	Each	2	$5,000		$10,000
Sub-surface drainage infrastructure	LF	90	$100		$9,000
Outflows with tidal backflow preventers	Each	2	$3,000		$6,000
Landscape Improvements					
Shade Trees	Each	22	$400		$8,800
Shrubs	SF	40	$150		$6,000
Grasses and Groundcover	SF	3500	$12		$42,000
Shoreline Improvements					
Aquatic Vegetation	SF	650	$20		$13,000
Custom Oyster Domes	Each	12	$500		$6,000
Park Structures and Amenities					
Sculptural bench seating	Each	3	$7,500		$22,500
Shade Structure for Seating	Each	1	$50,000		$50,000
New Trash cans	Each	2	$1,500		$3,000
Dog stations	Each	2	$800		$1,600
Pedestrian level security lighting	Each	9	$7,500		$67,500
Art Installation	Allowance	1	$35,000		$35,000
Additional Signage (Wayfinding, educational)	Allowance	1	$60,000		$60,000
Enhanced Park Entry					
Bike racks (including pad)	Each	1	$1,500		$1,500
Park entry sign	Each	1	$20,000		$20,000
Total Direct Cost					**$810,025**
Mobilization and General Conditions	ls	10%			$81,003
Bonds, Insurance and Overhead	ls	5%			$40,501
Profit	ls	10%			$81,003
Contingency	ls	20%			$162,005
Total Direct Construction Cost					**$1,174,536**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$293,634
Total Cost					**$1,468,170**
Total Cost per SF of Park					**$280.87**
Total Cost per LF of Shoreline					**$20,973.86**

Typology 2: Alternative 3					
Site Prep and Infrastructure					
Vacant Lot / Easement Acquisition where necessary	Acre	0.25	$500,000		$125,000
Sitework and Preparation	Acre	0.12	$300,000		$36,000
Modified Seawall w/ Concrete Path	LF	70			$0
ADA Permeable Pathway	SF	980	$60		$58,800
ADA Boardwalk (low)	SF	710	$120		$85,200
Stone Steps	SF	450	$150		$67,500
ADA Permeable Car Parking	SF	450	$75		$33,750
Utility Upgrades	Allowance	1	$75,000		$75,000
Stormwater Improvements					
Drainage inlets in retention areas	Each	2	$5,000		$10,000
Sub-surface drainage infrastructure	LF	90	$100		$9,000
Outflows with tidal backflow preventers	Each	2	$3,000		$6,000
Landscape Improvements					
Shade Trees	Each	25	$400		$10,000
Shrubs	Each	40	$150		$6,000
Grasses and Groundcover	SF	3400	$12		$40,800
Shoreline Improvements					
Aquatic Vegetation	SF	650	$20		$13,000
Park Structures and Amenities					
Sculptural bench seating	Each	2	$7,500		$15,000
Shade Structure for Seating	Each	2	$30,000		$60,000
New Trash cans	Each	2	$1,500		$3,000
Dog stations	Each	2	$800		$1,600
Pedestrian level security lighting	Each	7	$7,500		$52,500
Art Installation	Allowance	0	$35,000		$0
Additional Signage (Wayfinding, educational)	Allowance	1	$60,000		$60,000
Enhanced Park Entry					
Bike racks (including pad)	Each	1	$1,500		$1,500
Park entry sign	Each	1	$20,000		$20,000
Total Direct Cost					**$789,650**
Mobilization and General Conditions	ls	10%			$78,965
Bonds, Insurance and Overhead	ls	5%			$39,483
Profit	ls	10%			$78,965
Contingency	ls	20%			$157,930
Total Direct Construction Cost					**$1,144,993**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$286,248
Total Cost					**$1,431,241**
Total Cost per SF of Park					**$273.81**
Total Cost per LF of Shoreline					**$20,446.29**

City of Miami Waterfront Resilience Enhancement Plan					
Waterfront Typologies - Benefit/Cost Analysis Costs (2022)					
Typology 3: Park on Riverfront					
Location: Sewell Park					
	Unit	**Quantity**	**Unit Cost**		**Subtotal**
Typology 3: Alternative 1					
Site Prep and Infrastructure					
Sitework and Preparation	Acre	4.5	$100,000		$450,000
Stabilized Shoreline	LF	860	$450		$387,000
ADA Permeable Pathway	SF	23000	$45		$1,035,000
Water Access Pathways	Each	3	$10,000		$30,000
Canoe, Kayak Launch	Each	1	$50,000		$50,000
Utility Upgrades	Allowance	1	$150,000		$150,000
Stormwater Improvements					
Drainage inlets in retention areas	Each	6	$5,000		$30,000
Sub-surface drainage infrastructure	LF	1500	$100		$150,000
Outflows with tidal backflow preventers	Each	4	$3,000		$12,000
Landscape Improvements					
Shade Trees	Each	40	$400		$16,000
Shrubs	SF	250	$150		$37,500
Grasses and Groundcover	SF	90000	$12		$1,080,000
Shoreline Improvements					
Aquatic Vegetation	SF	11000	$20		$220,000
Additional Rock Features	SF	11000	$10		$110,000
Park Structures and Amenities					
Seating	Each	10	$5,000		$50,000
New Trash cans	Each	5	$1,500		$7,500
Dog stations	Each	4	$800		$3,200
Pedestrian level security lighting	Each	50	$7,500		$375,000
Additional Signage (Wayfinding, educational)	Allowance	1	$120,000		$120,000
Total Direct Cost					**$4,313,200**
Mobilization and General Conditions	ls	10%			$431,320
Bonds, Insurance and Overhead	ls	5%			$215,660
Profit	ls	10%			$431,320
Contingency	ls	20%			$862,640
Total Direct Construction Cost					**$6,254,140**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$1,563,535
Total Cost					**$7,817,675**
Total Cost per Acre of Park					**$1,737,261.11**
Total Cost per LF of Shoreline					**$9,090.32**

Typology 3: Alternative 2					
Site Prep and Infrastructure					
Sitework and Preparation	Acre	4.5	$100,000		$450,000
ADA Permeable Pathway	SF	23000	$45		$1,035,000
ADA Boardwalk	SF	8500	$150		$1,275,000
Water Access Pathways	Each	3	$10,000		$30,000
Canoe, Kayak Launch	Each	1	$50,000		$50,000
Utility Upgrades	Allowance	1	$250,000		$250,000
Stormwater Improvements					
Drainage inlets in retention areas	Each	6	$5,000		$30,000
Sub-surface drainage infrastructure	LF	1500	$100		$150,000
Outflows with tidal backflow preventers	Each	4	$3,000		$12,000
Landscape Improvements					
Shade Trees	Each	10	$400		$4,000
Shrubs	Each	300	$150		$45,000
Grasses and Groundcover	SF	150000	$12		$1,800,000
Shoreline Improvements					
Aquatic Vegetation	SF	11000	$20		$220,000
Stabilizing Rocks	SF	100000	$10		$1,000,000
Park Structures and Amenities					
Seating	Each	10	$5,000		$50,000
New Trash cans	Each	5	$1,500		$7,500
Dog stations	Each	4	$800		$3,200
Pedestrian level security lighting	Each	62	$7,500		$465,000
Additional Signage (Wayfinding, educational)	Allowance	1	$120,000		$120,000
Total Direct Cost					**$6,996,700**
Mobilization and General Conditions	ls	10%			$699,670
Bonds, Insurance and Overhead	ls	5%			$0
Profit	ls	10%			$699,670
Contingency	ls	20%			$1,399,340
Total Direct Construction Cost					**$9,795,380**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$2,448,845
Total Cost					**$12,244,225**
Total Cost per Acre of Park					**$2,720,938.89**
Total Cost per LF of Shoreline					**$14,237.47**

Typology 3: Alternative 3					
Site Prep and Infrastructure					
Sitework and Preparation	Acre	4.5	$10,000		$45,000
Stabilized Shoreline	LF	850	$450		$382,500
ADA Permeable Pathway	SF	23000	$45		$1,035,000
ADA Boardwalk	SF	8500	$150		$1,275,000
Utility Upgrades	Allowance	1	$30,000		$30,000
Stormwater Improvements					
Drainage inlets in retention areas	Each	6	$10,000		$60,000
Sub-surface drainage infrastructure	LF	1500	$100		$150,000
Outflows with tidal backflow preventers	Each	4	$3,000		$12,000
Landscape Improvements					
Shade Trees	Each	40	$400		$16,000
Shrubs	SF	250	$150		$37,500
Grasses and Groundcover	SF	120000	$12		$1,440,000
Shoreline Improvements					
Aquatic Vegetation	SF	10640	$20		$212,800
Stabilizing Rocks	SF	75000	$10		$750,000
Park Structures and Amenities					
Seating	Each	10	$5,000		$50,000
New Trash cans	Each	5	$1,500		$7,500
Dog stations	Each	4	$800		$3,200
Pedestrian level security lighting	Each	62	$7,500		$465,000
Additional Signage (Wayfinding, educational)	Allowance	1	$120,000		$120,000
Total Direct Cost					**$6,091,500**
Mobilization and General Conditions	ls	10%			$609,150
Bonds, Insurance and Overhead	ls	5%			$304,575
Profit	ls	10%			$609,150
Contingency	ls	20%			$1,218,300
Total Direct Construction Cost					**$8,832,675**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$2,208,169
Total Cost					**$11,040,844**
Total Cost per Acre of Park					**$2,453,520.83**
Total Cost per LF of Shoreline					**$12,838.19**

City of Miami Waterfront Resilience Enhancement Plan					
Waterfront Typologies - Benefit/Cost Analysis Costs (2022)					
Typology 4: Park on Bayfront					
Location: Margaret Pace Park					
	Unit	**Quantity**	**Unit Cost**		**Subtotal**
Typology 4: Alternative 1					
Site Prep and Infrastructure					
Sitework and Preparation	Acre	8	$100,000		$800,000
ADA Permeable Pathway	SF	23000	$45		$1,035,000
Wave Attenuation Structure - Interbay Reef with Oyster Domes	Each	1500	$150		$225,000
Water Access Pathways	Each	5	$10,000		$50,000
Relocated Basketball Court	Each	1	$75,000		$75,000
Additional Volleyball Court	Each	1	$50,000		$50,000
Relocated Dog Park	Each	1	$60,000		$60,000
Utility Upgrades	Allowance	1	$150,000		$150,000
Elevating Existing Park Elements	Allowance	1	$250,000		$250,000
Stormwater Improvements					
Drainage inlets in retention areas	Each	6	$5,000		$30,000
Sub-surface drainage infrastructure	LF	1500	$1,000		$1,500,000
Outflows with tidal backflow preventers	Each	4	$3,000		$12,000
Landscape Improvements					
Shade Trees	Each	110	$400		$44,000
Shrubs	SF	500	$150		$75,000
Grasses and Groundcover	SF	150000	$10		$1,500,000
Shoreline Improvements					
Aquatic Vegetation	SF	20000	$12		$240,000
Stabilizing Rocks	SF	65000	$10		$650,000
Park Structures and Amenities					
Seating	Each	10	$5,000		$50,000
New Trash cans	Each	5	$1,500		$7,500
Dog stations	Each	4	$800		$3,200
Pedestrian level security lighting	Each	50	$7,500		$375,000
Additional Signage (Wayfinding, educational)	Allowance	1	$150,000		$150,000
Total Direct Cost					**$7,331,700**
Mobilization and General Conditions	ls	10%			$733,170
Bonds, Insurance and Overhead	ls	5%			$366,585
Profit	ls	10%			$733,170
Contingency	ls	20%			$1,466,340
Total Direct Construction Cost					**$10,630,965**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$2,657,741
Total Cost					**$13,288,706**
Total Cost per Acre of Park					**$1,661,088.28**
Total Cost per LF of Shoreline					**$7,382.61**

Typology 4: Alternative 2					
Site Prep and Infrastructure					
Sitework and Preparation	Acre	8	$75,000		$600,000
New Crosswalks (ADA accessible, high-visibility	Each	1	$25,000		$25,000
ADA Permeable Pathway	SF	23000	$45		$1,035,000
Stabilized Shoreline	LF	1800	$450		$810,000
Wave Attenuation Structure - Interbay Reef with Oyster	Each	1500	$150		$225,000
Wave Attenuation Structure - Vegetated Breakwater Islands	LF	1800	$750		$1,350,000
Water Access Pathways	Each	5	$10,000		$50,000
Relocated Basketball Court	Each	1	$75,000		$75,000
Additional Volleyball Court	Each	1	$50,000		$50,000
Relocated Dog Park	Each	1	$750,000		$750,000
Utility Upgrades	Allowance	1	$30,000		$30,000
Elevating Existing Park Elements	Allowance	1			$0
Stormwater Improvements					
Drainage inlets in retention areas	Each	6	$5,000		$30,000
Sub-surface drainage infrastructure	LF	1500	$100		$150,000
Outflows with tidal backflow preventers	Each	4	$3,000		$12,000
Landscape Improvements					
Shade Trees	Each	110	$400		$44,000
Shrubs	SF	500	$150		$75,000
Grasses and Groundcover	SF	150000	$12		$1,800,000
Shoreline Improvements					
Aquatic Vegetation	SF	20000	$20		$400,000
Additional Rock Features	SF	40000	$10		$400,000
Park Structures and Amenities					
Seating	Each	10	$5,000		$50,000
New Trash cans	Each	5	$1,500		$7,500
Dog stations	Each	4	$800		$3,200
Pedestrian level security lighting	Each	50	$7,500		$375,000
Additional Signage (Wayfinding, educational)	Allowance	1	$160,000		$160,000
Total Direct Cost					**$8,506,700**
Mobilization and General Conditions	ls	10%			$850,670
Bonds, Insurance and Overhead	ls	5%			$0
Profit	ls	10%			$850,670
Contingency	ls	20%			$1,701,340
Total Direct Construction Cost					**$11,909,380**
Planning, Design, Permitting, and CA/CM Fees	ls	25%			$2,977,345
Total Cost					**$14,886,725**
Total Cost per Acre of Park					**$1,860,840.63**
Total Cost per LF of Shoreline					**$8,270.40**


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