MIAMI-DADE COUNTY, FLORIDA

Miami-Dade Back Bay

COASTAL STORM RISK MANAGEMENT

Final Integrated Feasibility Report and

Environmental Assessment

July 2024

US Army Corps of Engineers ®
Norfolk District

MIAMI-DADE COUNTY

EXECUTIVE SUMMARY

This Final Integrated Feasibility Report and Environmental Assessment (IFR/EA) is for the Miami-Dade Back Bay Coastal Storm Risk Management (CSRM) Feasibility Study. Miami-Dade County is the nonfederal sponsor for the study. Cooperating agencies for the study are the Florida Department of Transportation (FDOT), the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), and the United States Environmental Protection Agency (USEPA).

According to the 2022 census estimate, Miami-Dade County comprises a metropolitan area of approximately 2.7 million people and 34 municipalities. Miami-Dade County is diverse, with two national parks and natural resources supporting a large tourism industry as well as a densely populated and dynamic urban core.

Miami-Dade County is important to the nation for several reasons. The area is a leader in economic activity and international trade. Miami-Dade County is considered a gateway for the nation to Latin America and the Caribbean. The Port of Miami (PortMiami) and Miami International Airport (MIA) are leaders in their respective categories. MIA handles the most international freight and ranks third in the United States for the most international passengers, recording 50.7 million travelers in 2022. More than 26.5 million tourists visited Miami-Dade County in 2022, contributing $20.8 billion to the local economy. PortMiami creates approximately $41 billion in economic activity and indirectly supports 320,000 jobs throughout Miami-Dade County and the State of Florida through international import and export trade.

The Biscayne Bay Aquatic Preserve and Biscayne National Park, flanking Miami's eastern shores, provide habitat for many rare, threatened, and endangered species and provide substantive recreational opportunities, including fishing, swimming, and boating. Miami-Dade County was recently designated as the leader of the South Florida Climate Resilience Tech Hub by the United States Department of Commerce's Economic Development Administration. In addition to being home to the one-of-a-kind Everglades, the County recently conducted the 2023 update of the Biscayne Bay economic study that determined the overall contributions of Biscayne Bay–related activities amount to a substantial $64 billion in economic output, providing $24 billion in income, 448,000 jobs, and $4 billion in tax revenue for Miami-Dade County (Hazen and Sawyer 2023). This underscores the adage that our environment is our economy.

Miami-Dade County and the United States Army Corps of Engineers (USACE) are long-time partners in making crucial investments in water resources management projects, such as beach nourishment and ecosystem restoration, and are large organizations working to advance comprehensive, integrated, and innovative strategies to navigate complex challenges. Today, USACE may have more ongoing studies in Miami-Dade County than in any other local government jurisdiction in the United States. The federal government's economic and environmental interests in Miami-Dade County's world-class beaches, cruise ship and cargo seaport, the Central and Southern Florida (C&SF) regional water management system, and the Everglades are abundantly clear and growing.

In addition to the goal of transforming and improving large-scale features of the landscape to support and build climate resilience, USACE and Miami-Dade County must also address the hyper-local vulnerabilities in the community's many low-lying neighborhoods and work to improve the existing quality of life community members enjoy. In addition to thousands of individual homes, Miami-Dade County is made up

of thousands of individual homes, businesses, and critical facilities, such as fire and police stations and wastewater pump stations, evacuation routes, and the roadways and transportation infrastructure that connect them. Lifeline services support both life and safety throughout the social fabric and unique environmental conditions of the community, and these services must be resilient to shocks and natural hazards.

Miami-Dade County is increasingly at risk from flooding and damage from coastal storms because of the effects of climate change, including sea level change. The area is densely populated and relatively flat, with an average elevation of approximately five feet using the North American Vertical Datum of 1988 (NAVD88) and a natural high point at 25 feet NAVD88 (U.S. Geological Survey (USGS) 2016). The low elevation, tropical location, and hydrologic connections to Biscayne Bay through canals place a significant percentage of Miami-Dade County at risk to flooding from hurricanes and other storms. Exacerbating the flooding is the phenomenon of sea level change. Miami-Dade County experiences a combination of rising sea levels and groundwater levels that amplify all other types of flood hazards. South Florida is documented as having a significant rate of sea level change, which is expected to increase future flood risk.

Under current conditions, there are dozens of neighborhoods increasingly exposed to heavy rainfall events, as well as storm surge flooding from hurricanes, tropical storms, and nontropical systems. Several inches of rain in a short time period, punctuated by seasonally high king tides, can cause major disruption, along with moderate to severe damage to natural and built environments that impact the social stability and mental health of residents. Miami-Dade County has also experienced the devastating impacts of multiple major Category four and five hurricanes that have made landfall close to the community over the past several decades, which have had their own significant indirect impacts. Miami-Dade County understands that action must be taken now to manage the growing flood risk in communities with the greatest need. As sea levels change and population growth continues in the County's extensive floodplain, these compounding flood and coastal storm risks are anticipated to increase. Bold yet flexible planning and investments are needed to equitably adapt to changing conditions while striving for multiple benefits, instead of pursuing single-purpose projects.

Study Framework and Water Resources Development Act Cycles

The Comprehensive Everglades Restoration Plan (CERP), authorized by Congress through the 2000 Water Resource Development Act (WRDA), is a testament to the potential for large-scale interventions to build resilience into a complex system. The CERP initiative is driven by ecological and risk-informed science and has undergone dozens of cycles of planning, design, and construction as part of an adaptive management approach. Learning along the way with various pilot projects, the CERP framework has allowed billions to be invested to date and brought the Everglades significantly closer to its natural state, while providing numerous benefits for the ecosystem and the human-built environment alike. The relationships and collaboration among tribal, local, state, and federal governments, along with communities and other stakeholder groups, have been key to the CERP's success and can serve as a strong model and starting point for addressing other pressing issues such as future flood risk.

Known to the nation as a hub for culturally diverse and environmentally complex communities, Miami-Dade County recognizes the need to use a CERP-style approach to address challenges moving forward. As

a nonfederal sponsor and larger community, Miami-Dade County stands ready to fulfill its role as a partner engaged with USACE to develop and implement the Comprehensive Framework for CSRM described in Section 2. The Framework will be made up of three pillars—multiple lines of defense, adaptive management, and integration—which will ensure success for continuing a study aimed at reducing flood risks, pursuing maximum net public benefits, and becoming a future-ready community.

This Final Report is an interim response to identified coastal storm flood risks from storm surge flooding. The study develops and evaluates CSRM alternatives for Miami-Dade County as part of a multiphased risk management approach that takes advantage of the WRDA cycles, including potential WRDAs in 2024 and beyond. Study guidance from USACE headquarters instructed the current, interim study effort to focus on seeking authorization for the CSRM of CI and vulnerable communities as soon as possible, meaning WRDA 2024, while identifying further study efforts for Miami-Dade County that would take additional time to investigate. Each of these independent study efforts would provide solutions with independent utility, but the culminating feasibility reports' recommendations would work collectively toward managing coastal storm risk more broadly for the study area (consistent with the initial, larger multiple-lines-of-defense approach). This study effort focuses recommended measures on managing risk to CI, residential buildings, and nonresidential buildings using primarily nonstructural measures, such as elevating and floodproofing. These measures are formulated to manage risk from storm surge flooding to residents, industries, businesses, and infrastructure that are critical to the nation's economy. USACE describes resilience as "the ability to anticipate, prepare for, respond to, and adapt to changing conditions and to withstand and recover rapidly from disruptions with minimal damage." The long-term strategy for resilience in Miami-Dade County is a layered solution that includes projects executed by the nonfederal sponsor, other federal agencies, the State of Florida, and nongovernmental organizations (NGOs), in addition to the recommendations for implementation by this USACE study.

This study seeks not only to manage coastal storm risk, but also to build resilience by implementing strategic approaches that address identified stressors from major storms, along with their impact on residents and economic activity. To accomplish and provide significant near-term CSRM for Miami-Dade County, this feasibility report focuses on risk management measures that can be carried forward in time for the 2024 WRDA. This study does not directly address nuisance or compound flooding, and residual risks remain. At the same time, the nonstructural recommended measures including building elevation and floodproofing are very likely to have the added benefit of managing risk to rainfall-induced flooding in addition to storm surge flooding. USACE and Miami-Dade County intend to partner on additional studies and further analyses to fully address the extent of existing CSRM and flooding problems in the study area and to evaluate the feasibility of more complex structural measures.

Study Focus Area

Because of the large geographic scale of the study, and the desire to address CSRM for residential and nonresidential structures and critical infrastructure (CI) in the near term, Miami-Dade County and USACE coordinated extensively with municipalities, resource agencies, and other key stakeholders. These coordinated efforts led to the identification of the areas and communities considered to be at high risk to coastal storms because of frequent extensive damages from storm surge inundation. Socioeconomic and environmental justice factors also contribute to these communities being historically and

disproportionately adversely impacted by coastal storm risks. The process and formulation decisions that led to the defining of the study Focus Area are fully described in Section 1, Introduction.

Recommended Plan

The study follows policies and guidelines for consideration of economic, environmental, cultural, and social impacts. The Recommended Plan (RP) is formulated and designed to elevate residential buildings 12' above existing ground elevation and floodproof nonresidential buildings and CI 4' above existing ground elevation. The USACE High Curve was used to approximate anticipated future sea level change projections.

The RP includes a total of 2,057 residential buildings being elevated and 403 nonresidential buildings being dry floodproofed. A total of 27 CI facilities are recommended for floodproofing. To assist with better understanding of the components of the RP, the following paragraphs describe nonstructural measures, including CI, which are part of the RP.

Nonstructural CSRM measures are permanent or contingent measures applied to a structure and/or its contents that prevent or provide resistance to damage from flooding. Nonstructural measures (which can be physical or nonphysical) differ from structural measures in that they focus on reducing the consequences of flooding instead of focusing on reducing the probability of flooding (USACE 2024). For this study, nonstructural CSRM measures considered include voluntarily elevating residential buildings and floodproofing nonresidential buildings, including a particular emphasis on CI.

Critical Infrastructure, as used within the context of this CSRM study, pertains to the facilities and infrastructure that, when damaged in a severe coastal storm event, have a quantifiable adverse life safety and/or human health safety impact to Miami-Dade County community members. CSRM measures were analyzed for CI facilities that were identified in partnership with Miami-Dade County and stakeholders to be particularly at risk of life safety–reducing damage during severe coastal storms. CI asset categories included fire stations, police stations, pump stations, communication buildings, shelters for evacuation, and emergency operation centers. Dry floodproofing was the recommended method of flood risk management provided to CI.

Recommended Plan Costs and Benefits

Project First Cost is estimated to be $2.66 billion. Project First Cost is the constant dollar cost of the RP at current price levels and is the cost used in the authorizing document for a project. Total Project Cost is the constant dollar cost fully funded with escalation to the estimated midpoint year of the construction schedule (2031). Total Project Cost is the cost estimate used in Project Partnership Agreements for design and construction of a project. Total Project Cost is the cost estimate provided to the nonfederal sponsor for their use in financial planning because it provides information regarding the overall nonfederal cost-sharing obligation. The Total Project Cost includes the value of lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs). The nonfederal sponsor is responsible for obtaining and providing all necessary LERRDs for the project, the value of which will be credited against the nonfederal share of project costs. Total LERRDs are estimated to be $165 million. **Table ES-1** shows the benefits and costs, **Table ES-2** shows Project First Cost apportionment, and **Table ES-3** shows Total Project Cost apportionment.

Table ES-1. Project Benefits and Costs

Total Average Annual Benefits	Annual Operation & Maintenance Costs	Total Average Annual Costs	Project First Cost	Annual Net Benefits	Benefit Cost Ratio
$62,000	$3,800	$121,100	$2,660,000	-59,100	0.51

October 2023 FY(24) Price Level, Period of Analysis: 50 years, Interest Rate 2.75%, $1,000s, rounded

Table ES-2. Project First Cost (Constant Dollar Basis) Apportionment (October 2023 Price Levels)

Project First Cost (Constant Dollar Basis)	$ 2,660,000,000
Federal Share (65%)	$1,729,000,000
Nonfederal Share (35%)	$931,000,000
Less: LERRDs Credit	$165,000,000
Nonfederal Cash Contribution	$766,000,000

Table ES-3. Total Project Cost (Fully Funded) Apportionment (October 2023 Price Levels)

Total Project Cost (Fully Funded)	$3,353,000,000
Federal Share (65%)	$2,179,000,000
Nonfederal Share (35%)	$1,174,000,000

The RP has an economic benefit-to-cost ratio of 0.51 under the USACE High sea level scenario, with a range of 0.19 - 0.51 over the plausible range of future sea level conditions as defined in USACE guidance; however, it maximizes comprehensive net public benefits. Should future sea level rise proceed more slowly than assumed in planning, both economic and comprehensive net public benefits of this plan will likely be lower than assumed. Furthermore, because roadway flooding was not evaluated in this plan, some floodproofing and elevations could occur in areas which will experience a persistently flooded state under a high sea level rise future condition, where access and evacuation could be challenging due to limited roadway access. The RP maximizes both the Other Social Effects and Regional Economic Development accounts, maximizes human life loss prevented, and promotes the highest inclusion of vulnerable environmental justice communities. Because it does not maximize National Economic Development (NED) benefits, the USACE team requested and was approved for an NED Policy Exception to affirm this plan as the agency's recommendation. The Assistant Secretary of the Army for Civil Works approved this exception request on June 24, 2024.

Potential Environmental Impacts Resulting from the Recommended Plan

Pursuant to the National Environmental Policy Act (NEPA) and its implementing regulations, federal agencies must consider the impacts to the environment of their proposed actions prior to making a decision. (42 USC § 4321 et. seq.) Regulations established by the Council on Environmental Quality (CEQ) to implement NEPA (40 Code of Federal Regulations [CFR] § 1501.3(b)) specify that the significance of an impact should be determined in relationship to both the affected environment and degree of effects. The assessment of potential impacts and the determination of their significance are based on the requirements of 40 CFR § 1501.3(b). Three levels of impact can be identified: no impact, less than significant impact, and significant impact. Less than significant impacts include negligible impacts (localized and not measurable or at the lowest level of detection), minor impacts (localized and slight but detectable), and moderate impacts (readily apparent and appreciable). Significant impacts are considered major impacts that are severely adverse or substantially beneficial. Impacts are further defined by context (duration or scale) based on whether temporary or permanent impacts are anticipated.

Potential impacts to the following resources were examined: wildlife resources and terrestrial habitats; wetlands and mangroves; special status species; geology, topography, and soils; bathymetry, hydrology, and tidal processes; water quality; floodplains; cultural resources, aesthetics, and visual resources; air quality, hazardous materials, and waste; noise; utilities; and socioeconomics, environmental justice, and recreation. The anticipated impacts resulting from the RP range from adverse to beneficial and temporary to permanent. There are no significant impacts to any resource areas evaluated (Sections 7.1 through 7.16).

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, USACE determined that RP may adversely affect historic properties. USACE will apply the provisions of the Jacksonville District's 2021 Programmatic Agreement (PA) among the United States Army Corps of Engineers, the Florida State Historic Preservation Officer, the Bureau of Ocean Energy Management, and the Advisory Council on Historic Preservation Regarding Compliance with Section 106 of the National Historic Preservation Act During Implementation of the United States Army Corps of Engineers, Jacksonville District Operations, Navigation, and Shore Protection Programs to this project. USACE and the Florida State Historic Preservation Officer, Bureau of Ocean Energy Management, and the Advisory Council entered into this PA on April 9, 2021. All terms and conditions resulting from the agreement will be implemented to minimize adverse impacts to historic properties.

Pursuant to Section 7 of the Endangered Species Act of 1973, as amended, USACE determined that the recommended plan may affect, but is not likely to adversely affect, the following federally listed species or their designated critical habitat: the Florida bonneted bat (*Eumops floridanus*). The standard USACE Jacksonville District best management practices (BMPs) for migratory and shorebirds and BMPs for the Florida bonneted bat identified in Section 9.9 of the IFR/EA will be adhered to during construction. Informal consultation with the United States Fish and Wildlife Service was completed on June 14, 2024.

There is no discharge of dredged or fill material associated with the RP; therefore, Section 404(b)(1) of the Clean Water Act (33 U.S.C. § 1344(b)(1)) is not triggered. Similarly, the RP will not result in any discharge from a point source into waters of the United States and therefore no certification pursuant to Section 401 of the Clean Water Act is required. (33 U.S.C. § 1341.) The level of detail in the IFR/EA is

sufficient to allow an informed decision among planning-level alternatives for the RP, and environmental compliance requirements have been achieved.

Future Surveys/Data Collection in Preconstruction, Engineering, and Design Phase

The final detailed designs and siting of project features would not occur until the Preconstruction, Engineering, and Design (PED) Phase of the project when more detailed surveys, such as geotechnical surveys, and data are available.

Programs for Authorization

In addition to and separate from the RP, the Final IFR/EA also proposes for authorization a Nature-Based Solutions (NBS) Pilot Program and a Nonstructural Program, described below and in more detail in Sections 5 and 6, respectively.

Nature-Based Solution Pilot Program

NBS are engineered features designed to act in concert with natural processes to provide risk management in coastal areas (Section 1184 of WRDA of 2016). Historically, incorporating NBS for managing coastal storm risk has been a challenge for feasibility studies because of the difficulty in quantifying the economic benefits, particularly those in accordance with the NED account associated with these measures. The NBS Pilot Program, with a recommended total cost of $180 million, seeks to provide a framework for identifying, evaluating, implementing, and monitoring a diverse set of NBS pilot demonstration projects within Miami-Dade County to inform the methodology for quantitative evaluation of economic and comprehensive benefits. Site-specific pilot demonstration projects would be identified and evaluated in the future, in coordination with Miami-Dade County, municipalities, and other stakeholders. The information collected under the NBS Pilot Program may be used to inform the evaluation and justification of NBS as a CSRM measure for other feasibility studies, and the NBS Pilot Program may serve as a model approach for broader application across the enterprise. Individual pilot projects to be implemented under the NBS Pilot Program would be designed to manage coastal storm risk, reduce uncertainties associated with the performance of NBS, and contribute to more resilient and healthy ecosystems.

Nonstructural Program

USACE nonstructural policy and practice continues to progress. There are certain types of buildings that are prevalent in Miami-Dade County, and other urban areas, for which the suite of current nonstructural interventions is still evolving. One example includes multifamily housing with more than four units, where a large proportion of the socially vulnerable and/or historically disenfranchised population resides. Furthermore, CI and unique assets identified throughout the County (e.g., hospitals) require more site-specific information than a feasibility level of analysis will allow. The first phase of the Nonstructural Program, with a recommended cost of $6 million, seeks to further assess and innovate nonstructural measures to vulnerable infrastructure and buildings for which USACE nonstructural policy is still being developed, specifically measures for multifamily housing and complex hospital facilities, to manage coastal storm risk and improve coastal resilience.

National Environmental Policy Act Requirements and Program Authorization

The IFR/EA serves as a first tier National Environmental Policy Act (NEPA) document for the NBS Pilot Program and the Nonstructural Program. Sections 7.17 (NBS Pilot Program) and 7.18 (Nonstructural Program) provide descriptions of the impacts to natural resources and the human environment. The detail included in the effects analysis is commensurate with the level of program details currently known and provides a generalized overview of the anticipated resource impacts necessary to inform the decision to authorize the NBS Pilot Program and the Nonstructural Program. At this time, no significant impacts are anticipated from implementation of the programs. Future tiered NEPA documentation for both programs would be prepared independently to evaluate alternatives and consider, in detail, the site-specific impacts associated with program implementation.

Public, Agency, and Tribal Coordination

Stakeholder involvement has and will continue to be a critical component of the study and the development of a countywide vision for managing coastal storm risk. The public and agency comment period for the release of the Draft IFR/EA began on April 23, 2024, and concluded on May 31, 2024, following a 1-week extension. Public and agency comments received during the public comment period were considered in the development of the Final IFR/EA and are provided along with USACE responses in Appendix A-6. Coordination with tribes, agencies, and the public has occurred throughout the feasibility study as documented in Section 10.

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Definition
µg/m^3	micrograms per cubic meter
AAA	Adaption Area Action
AAB	average annual benefits
AAC	average annualized cost
ACA	Atlantic Coastline Alternative
ACHP	Advisory Council on Historic Preservation
ACM	asbestos-containing material
ADA	Americans with Disabilities Act

Acronym or Abbreviation	Definition
AEP	annual exceedance probability
AGL	above ground level
AMT	adaptive management team
APE	area of potential effects
ASA(CW)	Assistant to the Secretary of the Army for Civil Works
ASCE	American Society of Civil Engineers
ASR	aquifer storage and recovery
BBA	Bipartisan Budget Act of 2018
BBCW	Biscayne Bay Coastal Wetlands
BBSEER	Biscayne Bay Southeastern Everglades Ecosystem Restoration
BCR	benefit-to-cost ratio
BFE	base flood elevation
BIL	Bipartisan Infrastructure Law
BMP	best management practice
C&SF	Central and Southern Florida
CAA	Clean Air Act
CAP	Criteria Air Pollutants
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resource System
CDMP	Comprehensive Development Master Plan
CEJST	Climate and Economic Justice Screening Tool
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERP	Comprehensive Everglades Restoration Plan

Acronym or Abbreviation	Definition
CFR	Code of Federal Regulations
CH_4	methane
CHL	Coastal and Hydraulics Laboratory
CI	critical infrastructure
CM	Construction Management
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	Carbon dioxide equivalent
COA	courses of actions
Compact	Southeast Florida Regional Climate Change
CRF	Capital Recovery Factor
CRS	Community Rating System
CSRM	Coastal Storm Risk Management
CSTORM-MS	Coastal Storm Modeling System
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DARPA	Defense Advanced Research Projects Agency
Dba	A-weighted decibels
DDF	depth damage function
DEO	Department of Economic Opportunity
DoD	Department of Defense
DoDI	Department of Defense Instruction
DWSE	design water surface elevation
EA	Environmental Assessment

Acronym or Abbreviation	Definition
ECoREEF	Engineer Coastal Resilience Through Hybrid Restoration
EEL	Environmentally Endangered Lands
EFH	Essential Fish Habitat
EFs	emission factors
EIS	Environmental Impact Statement
EJ	environmental justice
EO	Executive Order
EOC	emergency operations centers
EOP	Environmental Operating Principles
EQ	Environmental Quality
ER	Engineering Regulation
ERDC	Engineering Research and Development Center
ERP	Environmental Resource Permit
ESA	Endangered Species Act
EWN	Engineering With Nature
FAC	Florida Administrative Code
FBC	Florida Building Code
FCSA	federal cost share agreement
FDEM	Florida Division of Emergency Management
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FFE	first floor elevations
FIRM	Flood Insurance Rate Map

Acronym or Abbreviation	Definition
FIS	Flood Insurance Study
FONSI	Finding of No Significant Impact
FPL	Florida Power & Light Company
FPLOS	Flood protection level of service
Framework	Comprehensive Framework
FRM	flood risk management
ft	feet
ft^2	square feet
FTE	Full-time equivalent
FWC	Fish and Wildlife Conservation Commission
FWCA	Fish and Wildlife Coordination Act
FWOP	Future Without Project
FWP	Future with Project
g	grams
G2CRM	Generation 2 Coastal Risk Model
GHG	Greenhouse gases
GSA	General Services Administration
HTRW	hazardous, toxic, and radioactive wastes
HVAC	heating, ventilation, and air conditioning
IBC	International Building Code
ICLEI	International Council for Local Environmental Initiatives
IDC	Interest During Construction
IEBC	International Existing Building Code
IFR	Integrated Feasibility Report

Acronym or Abbreviation	Definition
IFR/EA	Integrated Feasibility Report and Environmental Assessment
IIJA	Infrastructure Investment and Jobs Act
IRA	Inflation Reduction Act
IRC	International Residential Code
IWG-SCGHG	Interagency Working Group on the Social Cost of Greenhouse Gases
LBP	lead based paint
lb	pounds
LEED	Leadership in Energy and Environmental Design
LERRDs	lands, easements, rights-of-way and relocations, and disposal areas
LMS	Local Mitigation Strategy
MAMP	Monitoring and Adaptive Management Plan
MBTA	Migratory Bird Treaty Act
MDFR	Miami-Dade Fire Rescue
MIA	Miami International Airport
MII	Micro-Computer Aided Cost Estimating System, Second Generation
mph	miles per hour
N_2O	Nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAB	net annual benefits
NAO	Norfolk District, U.S. Army Corps of Engineers
NAVD88	North American Vertical Datum of 1988
NBS	Nature-Based Solutions
NEAT	Net Emission Analysis Tool
NED	National Economic Development

Acronym or Abbreviation	Definition
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NFS	nonfederal sponsor
NGO	non-government organizations
NHC	National Hurricane Center
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NNBF	natural and nature-based features
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NRHP	National Register of Historic Place
NWS	National Weather Service
O_3	ozone
OASA(CW)	Office to the Assistant Secretary of the Army for Civil Works
OFW	Outstanding Florida Water
OMB	Office of Management and Budget
OMRR&R	Operation, maintenance, repair, replacement, and rehabilitation
OPA	Otherwise Protected Areas
OSE	Other Social Effects
PA	Programmatic Agreement
Pb	lead
PCBs	polychlorinated biphenyls
PDT	Project Delivery Team

Acronym or Abbreviation	Definition
PED	Preconstruction, Engineering, and Design
PFAS	Perfluoroalkyl and polyfluoroalkyl substances
PM	particulate matter
PM10	particulate matter 10
PM2.5	particulate matter 2.5
PPA	Project Partnership Agreement
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
RCAP	Regional Climate Action Plan
RED	Regional Economic Development
RER	Miami-Dade County Department of Regulatory and Economic Resources
ROG	Reactive Organic Gases
ROI	Region of Influence
RP	Recommended Plan
RSLC	relative sea level change
SACS	South Atlantic Coastal Study
SAJ	Jacksonville District, U.S. Army Corps of Engineers
SAV	submerged aquatic vegetation
SCC	social cost of carbon
SFLSSS	South Florida Storm Surge Study
SFWMD	South Florida Water Management District
SHPO	State Historical Preservation Office
SIP	State Implementation Plan

Acronym or Abbreviation	Definition
SO_2	sulfur dioxide
SO_x	sulfur oxides
SWMP	Stormwater Master Plan
TMDL	total maximum daily load
TPCS	Total Project Cost Summary
TSP	Tentatively Selected Plan
TWAE	Temporary Work Area Easement
U.S.C.	United States Code
UDB	urban development boundary
UF	University of Florida
U-LINK	University of Miami's Laboratory for Integrative Knowledge
URA	Uniform Relocation Act
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	Volatile Organic Compounds
WASD	Water and Sewer Department
WPA	Broward County Water Preserve Area
WRAP	Waterfront Recreation Access Plan
WRDA	Water Resources Development Act
WRRDA	Water Resources Reform and Development Act
yd^3	cubic yards

1 INTRODUCTION

1.1 Introduction

The U.S. Army Corps of Engineers (USACE), Norfolk District conducted the Miami-Dade Back Bay Coastal Storm Risk Management (CSRM) Feasibility Study. The study resulted in this Final Integrated Feasibility Report and Environmental Assessment (IFR/EA), which investigated potential nonstructural solutions for the purpose of CSRM. This CSRM study seeks to address storm surge and flood risk to vulnerable populations, property, ecosystems, and infrastructure along the coast. Miami-Dade County has high levels of risk and vulnerability to coastal storms, which will be exacerbated by sea level change over the study period.

Miami-Dade County, Florida, is the nonfederal sponsor (NFS) for this study. There are 34 municipalities within the County, the largest of which is the City of Miami. The municipalities will be key stakeholders and partners in the study. The feasibility cost share agreement (FCSA) for the study was signed on October 9, 2018. The study is fully federally funded.

The 40 Code of Federal Regulations (CFR) § 1501.8 (Council on Environmental Quality [CEQ] 2020) describes the role of cooperating agencies to provide for early coordination in the National Environmental Policy Act (NEPA) process. The following agencies were invited to serve as cooperating agencies: National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), United States (U.S.) Coast Guard, U.S. Environmental Protection Agency (USEPA), U.S. Federal Emergency Management Agency (FEMA), U.S. Fish and Wildlife Service (USFWS), Florida Department of Environmental Protection (FDEP), Florida Department of Transportation (FDOT), and the South Florida Water Management District (SFWMD). The following agencies accepted the invitation to serve as cooperating agencies for the study: NOAA, NMFS, FDOT, and USEPA. Cooperating agency correspondence is available in Appendix A-3.

The Miami-Dade Back Bay CSRM feasibility study was initiated in 2018 and was originally intended for completion in 2021. A draft report was released to the public in June 2020 and proposed a combination of CSRM measures, including structural measures, such as storm surge barriers and floodwalls; however, a final report was not developed. Because of the complexity of Miami-Dade County's water resources challenges, the unique sensitivity of the valuable environmental resources, and community-wide concerns with some of the proposed structural measures, the USACE Norfolk District in partnership with Miami-Dade County pursued an additional resource request for more study time and funds. Following approval by the Assistant Secretary of the Army for Civil Works (ASA(CW)) in August 2022, the request was approved and commenced a one-year re-evaluation period comprised of extensive collaboration with local subject matter experts, stakeholders, environmental resource agencies, and the public. In August 2023, the ASA(CW) approved further continuation of the study. To address the immediate CSRM needs of Miami-Dade County, the team received study guidance to evaluate and identify measures for authorization in a potential Water Resources Development Act (WRDA) of 2024 and develop a comprehensive study framework describing future investigations and potential future projects.

The IFR/EA evaluates the potential impacts resulting from the Recommended Plan (RP) and assesses their significance based on the requirements of 40 CFR § 1501.3(b). Chapter 10 provides discussion of the environmental compliance requirements achieved for the RP. Additionally, the IFR/EA serves as a first tier

NEPA document for the NBS Pilot Program and the Nonstructural Program. Sections 7.17 and 7.18 provide a general evaluation of the impacts to natural resources and the human environment resulting from implementation of the Nature-Based Solutions (NBS) Pilot Program and the Nonstructural Program, respectively. The detail included in the effects analysis is commensurate with the level of program details currently known. Future tiered NEPA documentation for both programs would be prepared independently to evaluate alternatives and consider, in detail, the site-specific impacts associated with program implementation. Additional tiered NEPA documents would be prepared following authorization of the NBS program and authorization of further study of the Nonstructural Program by Congress and subsequent funding by Congress through appropriations.

1.2 USACE Planning Process

USACE has a six-step iterative planning process described in Engineering Regulation (ER) 1105-2-103, Planning Policy for Conducting Civil Works Planning Studies. The steps are as follows:

- **Step 1:** Specify problems (undesirable conditions to be solved) and opportunities (positive conditions to be improved) and identify objectives and constraints.
- **Step 2:** Inventory, forecast, and analyze relevant conditions within the planning area related to the identified problems and opportunities.
- **Step 3:** Formulate alternative plans.
- **Step 4:** Evaluate the effects of the alternative plans.
- **Step 5:** Compare alternative plans.
- **Step 6:** Select a plan based upon the comparison of alternative plans.

This process allows the team to develop and evaluate alternatives that eventually lead to the selection of a recommended plan. This report was prepared in compliance with NEPA (42 United States Code [U.S.C.] § 4321 et seq.), CEQ's NEPA Regulations (40 CFR Parts 1500–1508), and 33 CFR Part 230, USACE's Procedures for Implementing NEPA.

1.3 Study Authority

The study authority is Public Law 84-71, June 15, 1955, which authorizes an examination and survey of the coastal and tidal areas of the eastern and southern United States, with reference to areas where severe damage has occurred from hurricane winds and tides. It also authorizes the inclusion of data on the behavior and frequency of hurricanes and the prevention of the loss of human lives and damage to property, with due consideration of the economics of proposed measures. This report is an interim response to the study authority.

Notwithstanding Section 105(a) of the Water Resources Development Act (WRDA) of 1986 (33 U.S.C. § 2215(a)), which specifies the cost-sharing requirements generally applicable to feasibility studies, Title IV, Division B of the Bipartisan Budget Act of 2018, Public Law 115-123, enacted February 9, 2018 (hereinafter "BBA 2018"), authorizes the government to conduct the study at full federal expense to the extent that appropriations provided under the "Investigations" heading of the BBA 2018 are available and used for such purpose.

1.4 Study Area

The geographic area of the IFR/EA is Miami-Dade County, Florida. **Figure 1-1** shows an overview of Miami-Dade County, which is at the southern end of the State of Florida. Section 1.10.1, Method for Identifying Focus Areas, shows and details the Focus Areas for the IFR/EA.

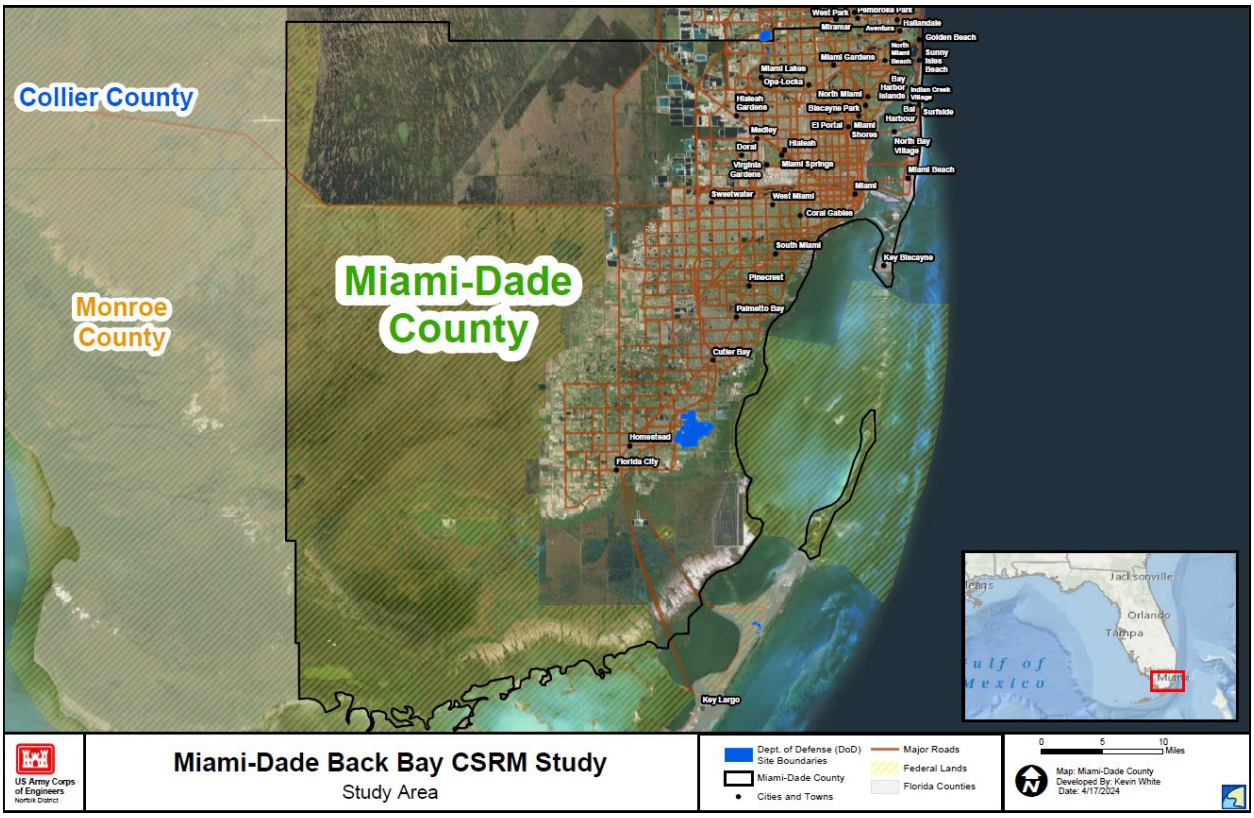


Figure 1-1. Geographic Area of the Study

According to Engineering Pamphlet 1100-2-1, Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation, the project area should be defined using the USACE High Sea Level Change Curve elevation at 100 years out, which will help identify the potential future affected area. Using LiDAR data, Miami-Dade County ground elevation has a mean of approximately five feet North American Vertical Datum of 1988 (NAVD88). Federal Emergency Management Agency's (FEMA) effective one percent annual exceedance probability (AEP) flood, more commonly referred to as the 100-year flood, ranges from 0.5 to 16.5 feet NAVD88 throughout the County, as shown in **Figure 1-2**. The one percent AEP results in xx% of Miami-Dade County being flooded.

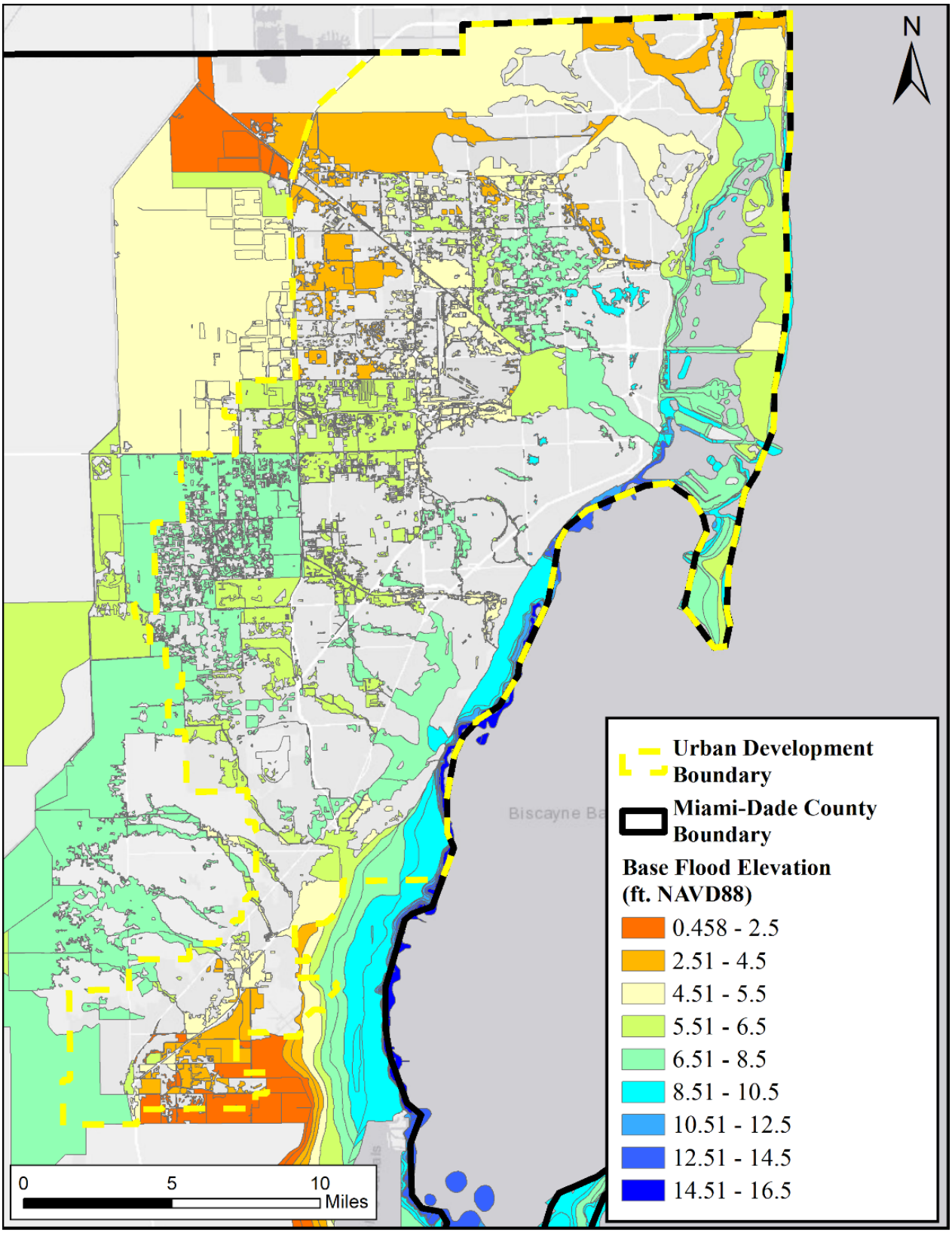


Figure 1-2. FEMA's Base Flood Elevation Map

The Vaca Key, Florida, gage in the USACE Sea-Level Change Curve Calculator estimates an additional 8.3 feet of sea level change in 100 years using the USACE High Curve. Appendix A-1 provides information about why the Vaca Key gage was used. This predicted water level, especially in the mid to upper range, would inundate the majority of the County.

Miami-Dade County is bordered by the Atlantic Ocean to the east, Monroe County to the south and west, Collier County to the northwest, and Broward County to the north, as shown in **Figure 1-3**. These areas also contain the Big Cypress National Park, Biscayne National Park, Everglades National Park, and Water Conservation Areas.

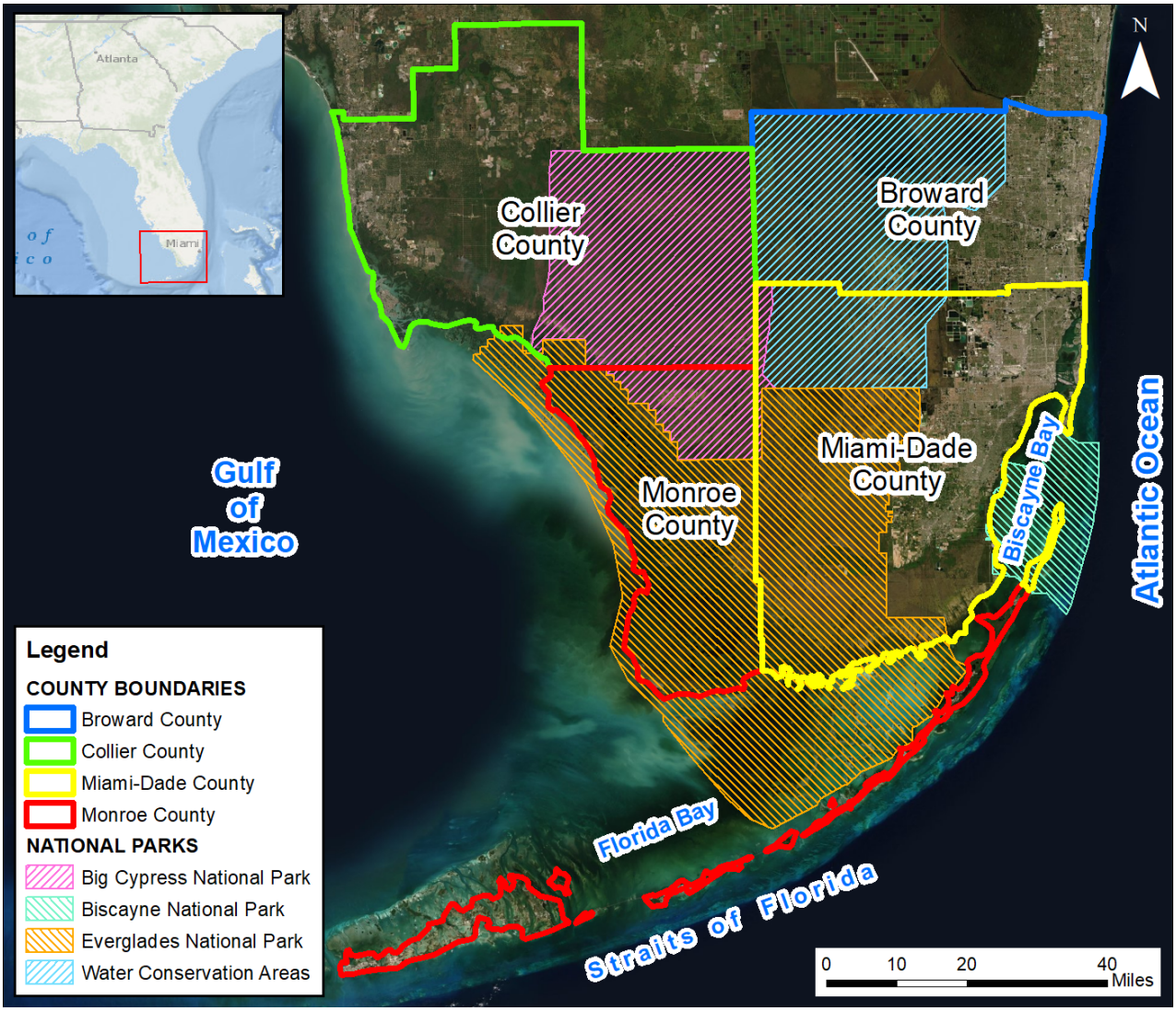


Figure 1-3. Miami-Dade County Vicinity Map

Miami-Dade County has 34 incorporated municipalities and an Unincorporated Municipal Service Area—areas of the County that do not fall within municipal boundaries. **Table 1-1** lists the 34 municipalities, their designation, the year of incorporation, and 2020 census population.

Table 1-1. Miami-Dade County Municipalities Data (Source: U.S. Census Bureau)

Name	Designation	Year Incorporated	2020 Population
Aventura	City	1995	40,237
Bal Harbour	Village	1947	3,091
Bay Harbor Islands	Town	1947	5,922
Biscayne Park	Village	1933	3,121
Coral Gables	City	1925	49,235
Cutler Bay	Town	2005	45,425
Doral	City	2003	75,875
El Portal	Village	1937	1,986
Florida City	City	1914	13,067
Golden Beach	Town	1929	959
Hialeah	City	1925	223,123
Hialeah Gardens	City	1948	23,069
Homestead	City	1913	80,734
Indian Creek Village	Village	1939	85
Key Biscayne	Village	1991	14,805
Medley	Town	1949	1,054
Miami	City	1896	442,260
Miami Beach	City	2015	82,888
Miami Gardens	City	2003	111,644
Miami Lakes	Town	2000	30,460
Miami Shores	Village	1932	11,565

Name	Designation	Year Incorporated	2020 Population
Miami Springs	City	1926	13,860
North Bay Village	City	1945	8,157
North Miami	City	1953	60,195
North Miami Beach	City	1927	43,667
Opa-locka	City	1926	16,469
Palmetto Bay	Village	2002	24,445
Pinecrest	Village	1996	18,387
South Miami	City	1927	12,026
Sunny Isles Beach	City	1997	22,342
Surfside	Town	1935	5,684
Sweetwater	City	1941	19,363
Virginia Gardens	Village	1947	2,362
West Miami	City	1947	7,236

1.4.1 Integration with Ongoing Studies

This study is one of many ongoing or recently completed USACE studies within the geographic area of Miami-Dade County. Each project plays a unique role in building community resilience. Community resilience means systems are adaptive to change and can overcome catastrophic events. Healthy ecosystems and water management infrastructure are the bases leading to more resilient water supply and, in conjunction with sustainable use of lands and robust transportation systems, enhance the resilience of economies and recreational opportunities, improving quality of life.

Building resilience requires coordinated efforts from all levels of government; no single entity can build resilience alone. The problems related to climate change are uncertain, broad, and complex. Therefore, it is essential to survey and assess relationships among all public and private sector deliverables and capabilities at local, regional, state, and federal levels, to determine the most appropriate and effective packaging of programs, projects, and services to accomplish resilience and sustainability objectives. Each level of government has an important part to play, and partners in Miami-Dade are already working on

their parts. USACE's ongoing and future projects across business lines are the leading edge of the federal government's part in the community resilience effort.

In low-lying areas like South Florida, the inland and coastal drivers of flooding must be viewed together to understand the risks to these coastal communities and to plan projects to increase community resilience. The inland drivers and coastal forcings tend to meet in the coastal ridge area, resulting in compounded water levels and increased damages. Increased rainfall runoff, caused by the loss of inland storage resulting from urbanization and loss of natural ecosystems, combines with higher ground water levels, exacerbated by sea level change, to negatively impact flood risk in these communities.

1.4.1.1 USACE Projects and Function in Resilience

To address flood risk across USACE business lines, the multiple-lines-of-defense concept is being used to combat different climate change variables and increase community resilience (**Figure 1-4**). USACE efforts from the coast to the inland areas work together to address the various sources of flooding, each playing its own role as follows:

- Beach CSRM studies tackle direct impacts of storm surge and sea level change.
- Back bay CSRM studies consider the back side of the barrier islands and bayfront impacts from storm surge and sea level change.
- Inland flood risk management (FRM) studies investigate effects of changed flood risk from urbanization and increased rainfall and the compounding effects of sea level change and storm surge.
- Aquatic ecosystem restoration studies explore ecosystem functions to provide water storage and filtration, helping prevent inland flood risk and enhancing habitat that can help coastal storm risk resilience.

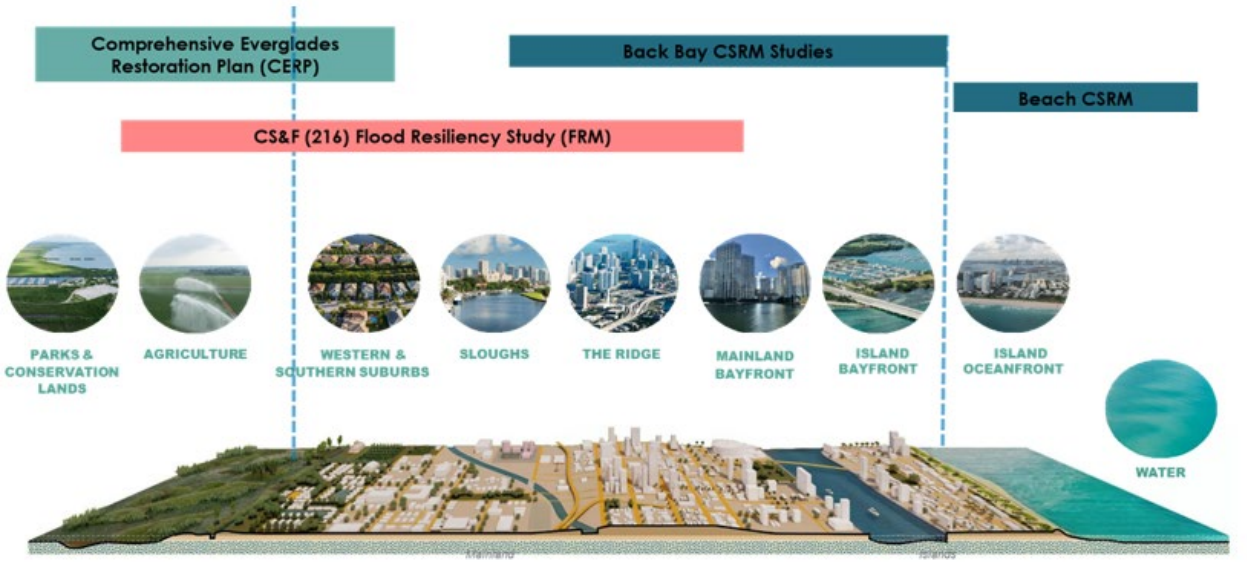


Figure 1-4. Multiple-Lines-of-Defense Concept with Focused Projects to Address Multiple Factors of Change Conditions

The water resource infrastructure is the connection between all functional areas. The backbone of that system in South Florida is the Central and Southern Florida (C&SF) Project. The C&SF Project is a large, multipurpose water resources project initially authorized by the Flood Control Acts of 1948 and 1954 for the purposes of providing flood control and water supply for municipal, industrial, and agricultural uses; preventing saltwater intrusion; recreation; groundwater recharge; water supply for Everglades National Park; and preserving fish and wildlife resources. The key infrastructure of this regional system includes approximately 2,200 miles of canals, 2,100 miles of levees/berms, 84 pump stations, and 778 water control structures, and serves a population of approximately 9 million residents. However, both the system and drivers of flood risk have drastically changed since the 1950s because of urbanization and climate change.

1.4.1.2 USACE Projects Integration

USACE has many ongoing projects across business lines in Southeast Florida, helping to build community resilience through support of the multiple-lines-of-defense concept to improve FRM and grow community resilience. With multiple studies ongoing in the region, it is critical to consider how each project may enhance or impact the others. Communicating these complexities to stakeholders cannot be done without effective collaboration.

As such, the various studies must coordinate activities and understand potential cumulative impacts that recommendations will have on the region and understand how each fit into the bigger community resilience puzzle. Local governments, including Miami-Dade County officials and the local community, must understand the diverse challenges being studied that are ongoing in their area. These projects, as shown in **Figure 1-5**, include:

1. Multiple beach CSRM-authorized projects along the east coast;
2. Miami-Dade Back Bay CSRM Study;
3. Navigation (Port Everglades, Miami Harbor) to enhance the transportation infrastructure;
4. Comprehensive Everglades Restoration Plan (CERP) ecosystem restoration (Biscayne Bay and Southeastern Everglades Ecosystem Restoration [BBSEER], Broward County Water Preserve Areas [WPAs], Biscayne Bay Coastal Wetlands [BBCW] Project); and
5. FRM (C&SF Operations, C&SF Flood Resiliency)

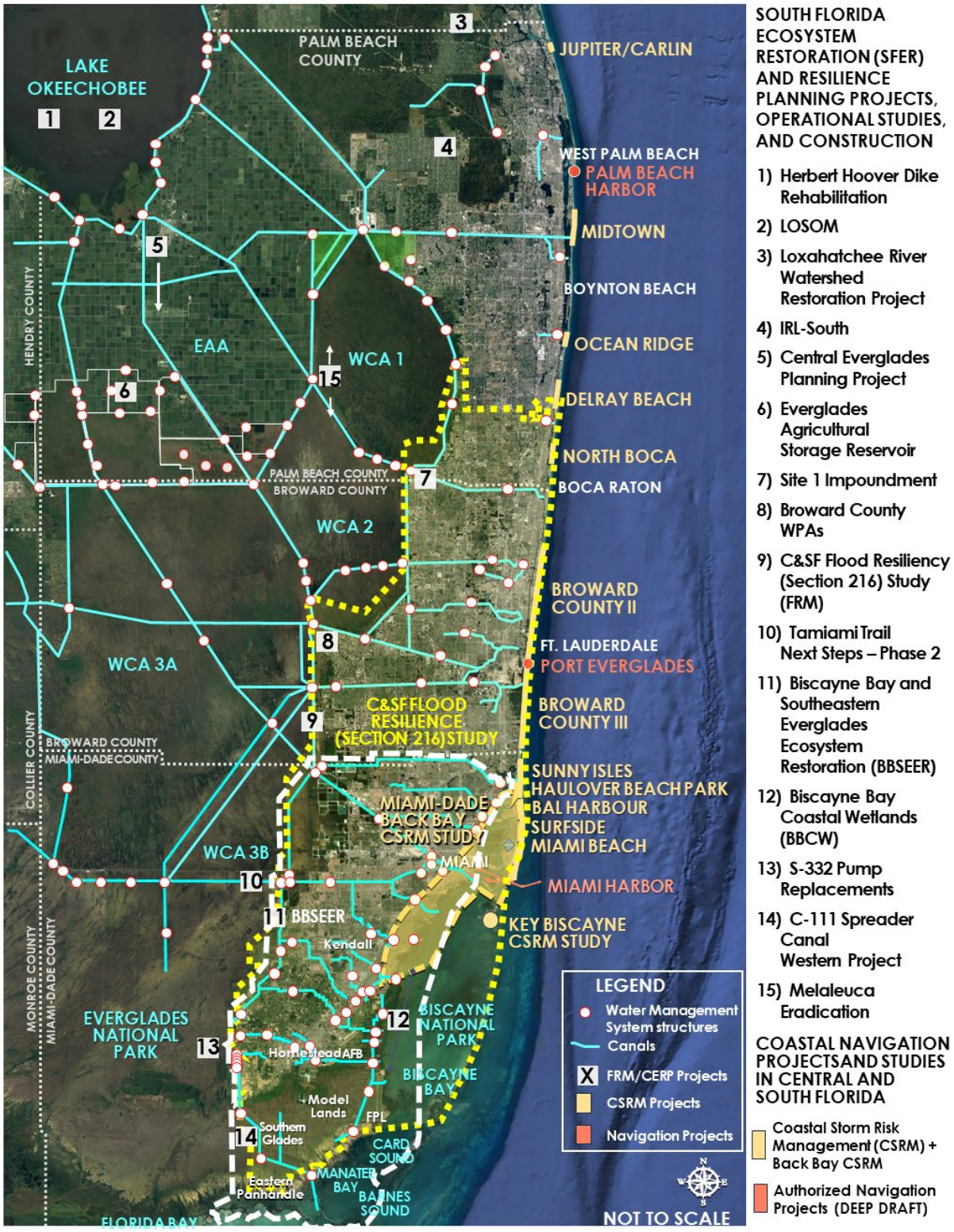


Figure 1-5. Ongoing USACE Projects in Broward and Miami-Dade Counties

The collaboration between projects is a focused effort through project integration. This is defined by coordinating the planning of multiple USACE Civil Works projects across multiple mission areas to ensure functionality of all projects. This includes integrating communications with internal and external stakeholders and technical support across projects. With a successful integration effort, the projects can be implemented and work in coordination to achieve each project's objectives and improve the resilience of South Florida. Additional information can be found at https://www.saj.usace.army.mil/Integration/.

1.4.1.3 Related USACE Projects

The following section describes the ongoing USACE projects in Miami-Dade County. The respective Project Delivery Team (PDT) members for all these efforts have held recurring multi-study coordination meetings for the purposes of identifying integration opportunities and to stay current on the respective studies. While all studies include Miami-Dade County, they are independent of one another and there were no overlapping areas to ensure there was no double counting of benefits.

Miami-Dade Coastal Storm Risk Management Study

Completed in 2022, the Miami-Dade County CSRM Main Segment Study focused on CSRM solutions for multiple reaches along 9.4 miles of the Atlantic Ocean coastline in Miami-Dade County, Florida, which included Bal Harbour, Surfside, and Miami Beach. Haulover Beach Park was not included because the area was generally accretional, had not been renourished since 1987, and was anticipated to remain stable into the future. The Key Biscayne Segment had initially been included in the Main Segment's draft report, but it was determined the ocean shoreline solution for Key Biscayne was incomplete. While erosion was the primary issue for the Main Segment, flooding was the main issue and damage driver for Key Biscayne. Under the study's analysis, benefits from the recommended ocean shoreline solution were expected to be cancelled by flooding from the back bay. The following site provides further information: https://www.saj.usace.army.mil/MiamiDadeCSRM/.

The Main Segment Study also recommended additional feasibility level analyses continue for the Village of Key Biscayne in a separate feasibility study which is further described below.

Key Biscayne Coastal Storm Risk Management Study

The Key Biscayne CSRM Study, conducted in partnership with Miami-Dade County, kicked off in late 2023 and will focus on providing solutions for coastal storm impacts to both the beach side and the bay side of Key Biscayne. The following site provides further information: https://www.saj.usace.army.mil/Missions/Civil-Works/Shore-Protection/Dade-County/Key-Biscayne-CSRM/.

Miami Harbor Improvements Feasibility Study

The Miami Harbor Improvements Feasibility Study focuses on navigation improvements such as widening and/or deepening specific areas within Miami's federally authorized channels to achieve transportation cost savings through increased economic efficiencies within Miami Harbor. The existing navigation restrictions contribute to delays and transportation cost inefficiencies, and the current channel depths and widths restrict vessels transiting Miami Harbor. This study received an exception with respect to Water Resources Reform and Development Act (WRRDA) of 2014 in 2022 for funds and time because of environmental compliance concerns. The study is scheduled for completion in June 2026. The following

site provides further information on the Miami Harbor Improvement Feasibility Study: https://www.saj.usace.army.mil/MiamiHarborNavigationImprovementStudy/.

South Atlantic Coastal Study

The South Atlantic Coastal Study (SACS) investigated coastal storm risk and its increase because of sea level change throughout USACE's South Atlantic Division, including North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Puerto Rico, and the U.S. Virgin Islands. The purpose was to better understand and describe risk and vulnerabilities from a regional perspective. This study includes the Miami-Dade County area. That study was completed in August 2022. The following site provides further information: https://www.sad.usace.army.mil/SACS/.

Biscayne Bay Coastal Wetlands

The BBCW Project is part of the CERP Generation 2 projects authorized by WRRDA 2014. The project purpose is to rehydrate coastal wetlands and reduce damaging point-source freshwater discharge to Biscayne Bay and Biscayne National Park. The BBCW Project will restore wetland and estuarine habitats and divert an average of 59 percent of the annual coastal structure discharge into freshwater and saltwater wetlands instead of direct discharges to Biscayne Bay and Biscayne National Park. The project comprises three components. The Deering Estate component has been completed and the remaining two components, L-31E Flow-way and Cutler Wetlands, are in construction, with a scheduled completion in 2028. The following site provides further information: https://www.saj.usace.army.mil/BBCW/.

Biscayne Bay and Southeastern Everglades Ecosystem Restoration

USACE is in the planning phase for the BBSEER Study, an important part of CERP. The SFWMD is the partner as the NFS for the study. The BBSEER Study focuses on formulating plans to restore parts of the South Florida ecosystem in freshwater wetlands of the Southern Glades and Model Lands, the coastal wetlands, and subtidal areas (including mangrove and seagrass areas) of Biscayne Bay, Biscayne National Park, Manatee Bay, Card Sound, and Barnes Sound. The following site provides further information: https://www.saj.usace.army.mil/BBSEER/.

Central and Southern Florida Flood Resilience (Section 216) Study

The USACE Jacksonville District and its NFS partner at the SFWMD began an FRM study initiated under the authority of Section 216 of the Flood Control Act of 1970 within the C&SF Project. The purpose of the study is to identify the solutions to provide continued FRM, reducing the most immediate risks to the C&SF Project because of the changing conditions, including climate change, sea level change, land development, and population growth in the lower east coast of Florida in Palm Beach, Broward, and Miami-Dade Counties. The study focuses on the coastal control structures and associated primary canals to improve conveyance. FRM measures to be evaluated may include a combination of structural, nonstructural, and Nature-Based Solutions (NBS). The current timing for study completion is 2028. The following site provides further information: https://www.saj.usace.army.mil/CSFFRS/.

1.4.2 Resilience Actions by Miami-Dade County

The following are some of the resilience actions by Miami-Dade County:

Increased Freeboard Requirements

FEMA defines freeboard as "An additional amount of height above the Base Flood Elevation (BFE) used as a factor of safety in determining the level at which a structure's lowest floor must be elevated or floodproofed to be in accordance with state or community floodplain management regulations."

Effective March 15, 2012, the Florida Building Code (FBC) required nonresidential structures in the effective FEMA 1 percent annual chance flood (also called 100-year floodplain or BFE) to be built with an additional 1 foot of freeboard above the effective BFE. Category IV structures (critical or essential facilities such as fire, rescue, ambulance, police, etc.) require 2 feet of additional freeboard above the effective FEMA BFE. Effective December 30, 2017, the 1 foot of freeboard was included for single-family residences, duplexes, triplexes, and townhomes three stories or less.

Freeboard requirements not only apply to new construction, but also to any substantial improvements, which is defined by FEMA as reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the start of construction of the improvement.

Miami-Dade County is taking steps to manage risk to future developments through a pending Stormwater Ordinance.

Southeast Florida Regional Climate Change Compact

Established in 2009, the Southeast Florida Regional Climate Change (Compact) is a partnership between Broward, Miami-Dade, Monroe, and Palm Beach Counties to work collaboratively to reduce regional greenhouse gas emissions, implement adaptation strategies, and build climate resilience across the Southeast Florida region. The Compact publishes a Regional Climate Action Plan (RCAP) that is updated every 5 years. The most recently published is the 2023 RCAP 3.0.

https://southeastfloridaclimatecompact.org/

The Compact also publishes a Unified Sea Level Rise Projection and accompanying implementation guidance document approximately every 5 years. The last projections were published in 2019 and are adopted by each Compact county to inform infrastructure design guidelines.

In addition, the County collaborates with the SFWMD on the Flood Resiliency Plan. Updated annually, the plan is the first District initiative to compile a comprehensive list of priority resiliency projects with the goal of reducing the risks of flooding, sea level change, and other climate impacts on water resources and increasing community and ecosystem resiliency in South Florida. This goal will be achieved by updating and enhancing water management infrastructure and implementing effective, resilient, integrated basin-wide solutions. This list of projects was compiled based upon assessments that have been ongoing for the past decade.

Sea Level Rise and Flood Resiliency Plan | South Florida Water Management District (sfwmd.gov)

Minimum Elevation of Roadways

Miami-Dade County requires the minimum elevation of roadways and lots to be equivalent to the 10-year groundwater table plus 3.5 feet of freeboard.

Participating in the National Flood Insurance Program

Community Rating System (CRS) is a voluntary program for communities that participate in the National Flood Insurance Program (NFIP). CRS was formed to provide incentives such as flood insurance premium discounts for communities that went beyond minimum floodplain management requirements. CRS uses a class system with ten being the lowest (no discount) and one the highest. Insurance premiums are discounted in five percent intervals for structures in the SFHA, therefore, a class of 9 would be a five percent discount and a class of 1 would be a 45 percent discount.

As of May 1, 2019, 23 of the 34 municipalities (plus Unincorporated Miami-Dade County) are part of the CRS Program, ranging from Class 3 to Class 9. In April 2024, Miami-Dade County was upgraded to a Class 3 community in the NFIP CRS. The upgraded classification is a direct result of the flood mitigation activities led by Miami-Dade County to protect lives, reduce property damage, and build resilience against flooding and sea level rise. Nationwide, only 19 of the communities participating in the CRS have earned a Class 3 or better, and Miami-Dade County is the largest among them.

According to the Miami-Dade County Local Mitigation Strategy, the following are some of the activities some municipalities in Miami-Dade County are performing to participate in CRS:

- Maintain Elevation Certificates for New/Substantially Improved Buildings
- Enforce Floodplain Management Regulations
- Inspect/Repair/Maintain Drainage Systems
- Preserve Open Space in Floodplain
- Provide Flood Protection Assistance
- Provide Flood Zone Information
- Keep Old and Current Flood Insurance Rate Maps (FIRMs)
- Produce/Distribute Property Protection Information to Repetitive Loss Areas
- Maintain Flood Protection Materials at Library

Resilient305

In the spring of 2019, Greater Miami and the Beaches released the Resilient305 Strategy, a living document that addresses resilience challenges prioritized through intergovernmental and community collaboration. Throughout the process—in public meetings, surveys, and focus groups—Greater Miami and the Beaches engaged thousands of stakeholders to help shape the strategy and make sure it reflected the input from a wide range of expertise, ages, ethnicities, cultures, income levels, and geographic areas. The Resilient305 Strategy will help prepare for an increasing occurrence of shocks (such as hurricanes) and infrastructure failures, as well as to better mitigate stresses (such as sea level rise and sunny day flooding, crippling traffic, and severe economic inequities). More information can be found at https://resilient305.com/.

Applying for Grants

Through the federal Infrastructure Investment and Jobs Act (IIJA), Bipartisan Infrastructure Law (BIL), and the Inflation Reduction Act (IRA), the County has received a cumulative total of $1,252,657,698 in federal and state grant funding and appropriations with matching funds in the amount of $363,023,057. These totals are for awards made directly to the County, and do not include municipal or nonprofit awards and allocations.

Local Mitigation Strategy

The Local Mitigation Strategy was developed to reduce or eliminate the long-term risk to human life and property from hazards. FEMA typically reviews and re-approves it every 5 years. FEMA approved the current strategy plan and maintains a list of projects that potentially could be funded in the future. Having a mitigation plan helps a CRS community obtain more points.

Sea Level Change

Miami-Dade County requires that all capital projects consider the impacts of sea level change, according to Resolution No. R-451-14.

Rapid Action Plan

Miami-Dade County completed the Rapid Action Plan in 2017. The plan assessed the vulnerability of more than 700 County-owned assets and ranked them based on criticality.

Beach Renourishment

USACE worked with Miami-Dade County as part of the Miami Hotspot Beach Renourishment project, which is part of the Miami-Dade County Beach Erosion Control and Hurricane Protection Project. Approximately 220,000 cubic yards of beach-quality sand was placed on more than 3,000 feet of critically eroded shoreline in two locations, near 46th Street and 54th Street. Between 18,500 and 22,000 truckloads of sand will be hauled from an upland sand mine to reduce the damages—economic, environmental, infrastructure, and human health and safety—of tropical storms and hurricanes. In 2022, the main segment of Miami Beach was reauthorized for another 30 years of renourishment. More than $100 million has been spent on renourishment since 2018.

Environmentally Endangered Lands

The Miami-Dade County Environmentally Endangered Lands (EEL) Program was established in 1990 because of growing concern about the continued loss of pine rocklands and other natural areas unique to Southeast Florida. Its focus is the protection and conservation of endangered lands. Miami-Dade County's EEL Program, spearheaded by Miami-Dade County Department of Regulatory and Economic Resources (RER), stands as a guardian for the region's ecological health. These critical lands play a multifaceted role, ensuring clean water, flood control, and storm surge protection—all vital services for a resilient Miami-Dade County. While EEL's core mission is environmental protection and regional restoration (including the restoration of the Greater Everglades system), its impact extends far beyond. The program empowers the County to adapt to the realities of sea level change, mitigating increased erosion, storm surges, saltwater intrusion, and threats to Biscayne Bay. It safeguards the County's clean water supply by facilitating aquifer

recharge, absorbing floodwaters, and combating the "heat island" effect plaguing urban areas. Most importantly, EEL acts as a carbon sink, absorbing and storing carbon dioxide (CO_2), a key in the fight against climate change. EEL's comprehensive approach tackles climate challenges head-on. The program meticulously identifies ecosystem vulnerabilities, connections, and interdependencies, maximizing efficiency through economies of scale and leveraging existing tools. This holistic strategy fosters effective planning, implementation, and integration of green infrastructure and environmental projects. The tangible results are undeniable. EEL currently manages more than 28,000 acres (11,332 ha), encompassing diverse ecosystems like pine rocklands (1,630 acres/660 ha), tropical hardwood hammocks (651 acres/264 ha), wetlands (25,524 acres/10,330 ha), and scrub habitats (19 acres/7 ha). Their efforts have secured more than $123 million worth of land in public ownership, preventing future development and ensuring a thriving, resilient Miami-Dade County. With more than 33,000 acres still on the EEL Acquisition List, the program's commitment to protecting the environment remains unwavering. By acquiring and managing these critical lands, the EEL Program safeguards not just Florida's natural heritage, but the very foundation of a healthy, sustainable Miami-Dade County.

Sea Level Rise Strategy

Miami-Dade County's Sea Level Rise Strategy was released in February 2021 and outlines the approach being taken to address this long-term challenge. The Year 1 Progress Update to the Sea Level Rise Strategy provides action updates to the original report, including actions in the Adaptation Action Areas (AAAs).

The Sea Level Rise Strategy provides Florida's history with water and illustrates a vision to adapt the communities to changing sea levels. It details key actions and capital projects that will advance adaptation goals, assist in recovery, and create local jobs. The Sea Level Rise Strategy also provides information on the key challenges, along with the many opportunities to accommodate more water gracefully and equitably.

The Sea Level Rise Strategy recommends 10 key actions to protect the community. Some actions are policy changes that have Countywide impacts on public and private developments. Others are County-led demonstration projects that, once built, can inspire the design, plan, and build for the future. Progress Updates | Miami-Dade County Sea Level Rise Strategy Draft (arcgis.com)

Adaptation Action Areas

The AAA program produces neighborhood scale adaptation plans for the most flooding and socially vulnerable communities in Miami-Dade County. These planning efforts address hazards at the local watershed scale rather than within the limits of municipal boundaries. This work coordinates Miami-Dade County departments, public agencies, municipalities, and community stakeholders. Following are the goals of the AAA program:

- Align relevant studies, data, and planned projects.
- Collaborate with and build capacity among community members, municipalities, and others to identify values, challenges, projects, and policies to adapt to sea level change and other stresses or shocks.
- Develop local adaptation plans that include policy recommendations and a list of resilience projects for potential funding and implementation.

The AAA program began with a pilot in the Arch Creek basin and has completed a full-scale plan for the Little River AAA. As a result, the Little River AAA was the pilot for a septic-to-sewer conversion in Miami-Dade County, with hundreds of homes connected to County's system. In 2024, inter-departmental and stakeholder engagement will begin for the Biscayne Canal AAA. As part of this effort, the County will continue engagement with the Little River AAA to build capacity for adaptation and adaptive management. The Office of Resilience participates in the Resilient305 Collaborative with academic and non-profit stakeholders to track the implementation of these adaptation strategies and to learn about public opinions and priorities regarding the adaptation program.

Climate Change Programs

Miami-Dade County has several initiatives to help against the impacts of climate change, some of which follow:

- Reduce greenhouse gas emissions 50 percent by 2030 and net zero by 2050.
- Miami International Airport (MIA) has made many changes to their facility that saves more than 9 million gallons of water each year, reduces energy by 35.2 million kilowatt hours per year. MIA is currently making more updates that will save an additional 9 million gallons of water each year. According to Miamidade.gov, all these changes have contributed to savings of more than $10 million and a reduction of 17 million tons of greenhouse gas emissions.
- Sustainable Buildings Program incorporates green building practices for County-owned, financed, and operated buildings. The County also requires new County-owned, leased, or managed construction projects to obtain the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) silver certification and remodeling and renovation projects to obtain basic LEED certification.
- Miami-Dade County partnered with Florida Power and Light (FPL) to install the largest floating solar array in the southeastern U.S. on January 28, 2020. According to FPL, the solar array generates 160 kilowatts of power and prevents 165 tons of CO2 emissions each year.
- According to the U.S. Department of Energy, Miami-Dade County has the third largest public hybrid fleet in the nation. These vehicles result in a reduction of approximately 500,000 gallons of gasoline, which prevents the release of more than 6,000 tons of greenhouse gas emissions into the environment. The County has made further commitments to have at least 50 percent of their buses electrically powered by 2035.

More initiatives and information within Miami-Dade County can be found at https://www.miamidade.gov/global/economy/resilience/county-climate-programs.page.

1.5 Background and History

1.5.1 Storm Damage History

According to the Miami-Dade Emergency Operations Center Comprehensive Emergency Management Plan Volume I (Florida Division of Emergency Management [FDEM] 2020), Southeast Florida has experienced 35 hurricanes between 1994 and 2016, of which nine were major hurricanes (Category 3 or above). Category 5 hurricanes require more than 1.9 million residents evacuate, which can become difficult because of the surrounding counties evacuating simultaneously, increasing clearance times.

Residents also tend to delay evacuation until the last minute, which results in further traffic jams and clearance times.

According to the Miami-Dade County Local Mitigation Strategy (LMS), Whole Community Hazard Mitigation, Part 1: The Strategy (Local Mitigation Strategy Working Group [LMSWG] 2018), Miami-Dade County has been impacted by many hurricanes and tropical storms, including the Great Miami Hurricane (1926), Lake Okeechobee Hurricane (1928), Hurricane King (1950), Hurricane Donna (1960), Hurricane Andrew (1992), Hurricane Katrina (2005), Hurricane Wilma (2005), Hurricane Sandy (2012), Tropical Storm Isaac (2012), Tropical Storm Matthew (2016), and Hurricane Irma (2017). **Table 1-2** shows hurricane data within the Miami-Dade County area taken from National Weather Service – Miami Forecast Office, NOAA National Hurricane Center/Tropical Prediction Center, Florida State University Meteorology Department, and Florida Hurricanes and Tropical Storms. **Table 1-2** lists the date of landfall for storms that made landfall in southern Florida. For bypassing storms, the date in **Table 1-2** reflects when their peak storm surge or maximum impact occurred. The category shown is the storm's highest category when passing over or near Miami-Dade County.

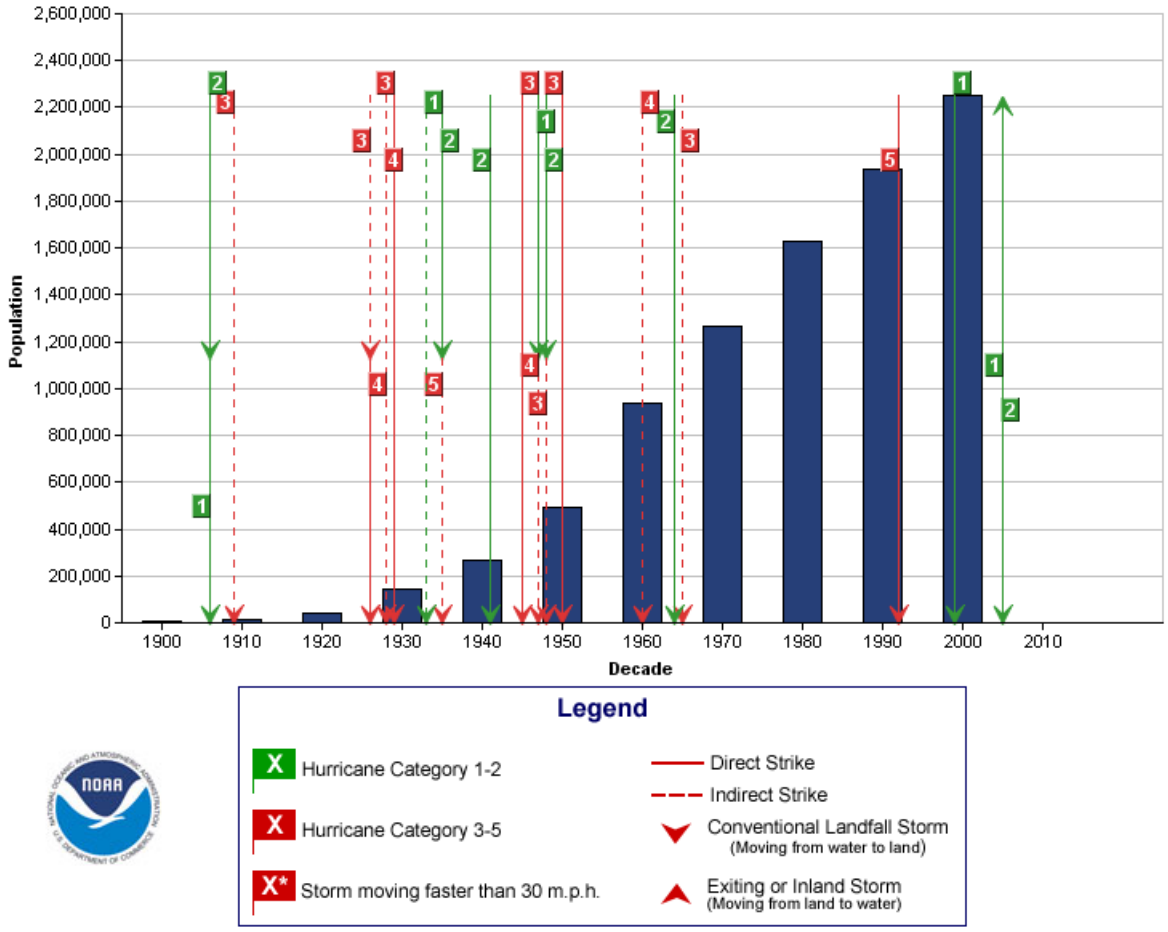
Table 1-2. South Florida Hurricanes and Storms 1906 through 2022

Date	Name	Category	Wind (miles per hour)	Surge (feet)	Deaths	Approximate Damage ($)
6/17/1906	Hurricane	1	80	Unknown	0	Unknown
10/18/1906	Hurricane #8	3	120	Unknown	164	0.16 million
10/11/1909	Hurricane #9	2	100	Unknown	0	Unknown
10/21/1924	Hurricane #7	Tropical Storm	70	Unknown	0	Unknown
9/18/1926	Hurricane #6	4	138	13.2	243	1.4 billion
10/21/1926	Hurricane #10	2	110	Unknown	0	Unknown
9/17/1928	Hurricane #4	4	132	10–15	2,500+	26 million
9/28/1929	Hurricane #2	2	100	Unknown	0	Unknown
9/3/1935	Hurricane #2	5	160	20+	408	6 million
11/4/1935	Hurricane #6	1	75	6	19	5.5 million
10/6/1941	Hurricane #5	3	120	8	5	0.7 million
9/16/1945	Hurricane #9	4	138	13.7	4	540 million
9/22/1948	Hurricane #7	2	98	8	0	Unknown
10/6/1948	Hurricane #8	2	105	6.2	0	5.5 million
8/27/1949	Hurricane #2	4	130	Unknown	2	52 million
10/18/1950	King	2	105	14	3	28 million
9/10/1960	Donna	4	136	13	50	1.8 billion
8/27/1964	Cleo	2	105	6	3	28 million
9/8/1965	Betsy	3	125	9	75	6.4 billion
10/4/1966	Inez	1	85	15.5	48	5 million
9/3/1979	David	2	98	3–5	5	10 million

Date	Name	Category	Wind (miles per hour)	Surge (feet)	Deaths	Approximate Damage ($)
8/24/1992	Andrew	5*	155	16.9	48	30 billion
11/16/1994	Gordon	Tropical Storm	52	3–5	0	90 million
9/25/1998	Georges	2	98	5–6	0	12.5 million
11/5/1998	Mitch	Tropical Storm	65	3–4	0	0.1 million
10/15/1999	Irene	1	75	3–5	4	800 million
10/3/2000	Leslie	Tropical Storm	35	2–4	0	500 million
9/3/2004	Frances	1	75	2–4	0	33 million
9/25/2004	Jeanne	Tropical Storm	50	2–4	0	10.4 million
8/25/2005	Katrina	1	80	2–4	0	800 million
9/18/2005	Rita	Tropical Storm	50	2–3	0	12 million
10/24/2005	Wilma	2	110	5–6	0	1.5 billion
8/27/2012	Isaac	Tropical Storm	29	1–2	0	Unknown
10/26/2012	Sandy	1	60	1–2	0	Unknown
6/6/2013	Andrea	Tropical Storm	65	2–4	0	Unknown
10/6/2016	Matthew	Tropical Storm	50	1–2	2	1,200,000
9/9/2017	Irma	1	99	4–6	5	800 million
10/28/17	Philippe	Tropical Storm	35	N/A	0	N/A
9/3/2019	Dorian	Tropical Storm	46	N/A	0	Unknown
9/28/2022	Ian	Tropical Storm	Unknown	N/A	0	Unknown

* The National Hurricane Center (NHC) reclassified Hurricane Andrew from a Category 4 storm to Category 5 in 2002.

As shown in **Figure 1-6,** the population of Miami-Dade County has been increasing every decade since 1900. Although Miami-Dade County has not had many direct hurricane strikes in the last 50 years, the figure brings attention to the fact that many did occur between the 1930s and 1960s when the population was, on average, a quarter of what it is today. A hurricane strike with today's growing population and infrastructure potentially could be disastrous. During the last few years there have been many models predicting major hurricane tracks headed directly toward Miami-Dade County, or within 150 miles, including Hurricane Matthew (2016), Hurricane Irma (2017), Hurricane Dorian (2019), and Hurricane Ian (2022).



Hurricane Strike Data Source: NHC

Population Data: U.S. Census Bureau

NOTE: Population values may be missing in some counties, particularly earlier periods. This is most often attributable to the fact that the County had not yet been established.

NOTE: There may be discrepancies between the strike data shown in this chart and the NHC's North Atlantic hurricane database strike data used in the Historical Hurricanes Tracks Tool. The NHC is currently updating the strike data used for these charts. For more information, visit http://www.aoml.noaa.gov/hrd/data_sub/re_anal.html.

NOTE: Population data are current as of the 2000 U.S. Census. The X-axis on graphs depict years through 2010 to illustrate storms that have occurred from 2000 through 2006.

Figure 1-6. Hurricane Strikes versus Population for Miami-Dade County, Florida

1.5.2 Historical Storms

Since 1857, there are many storms that have gone through or passed by Miami-Dade County. **Figure 1-7** shows the hurricane tracks for the 12 storms discussed in depth in this section.

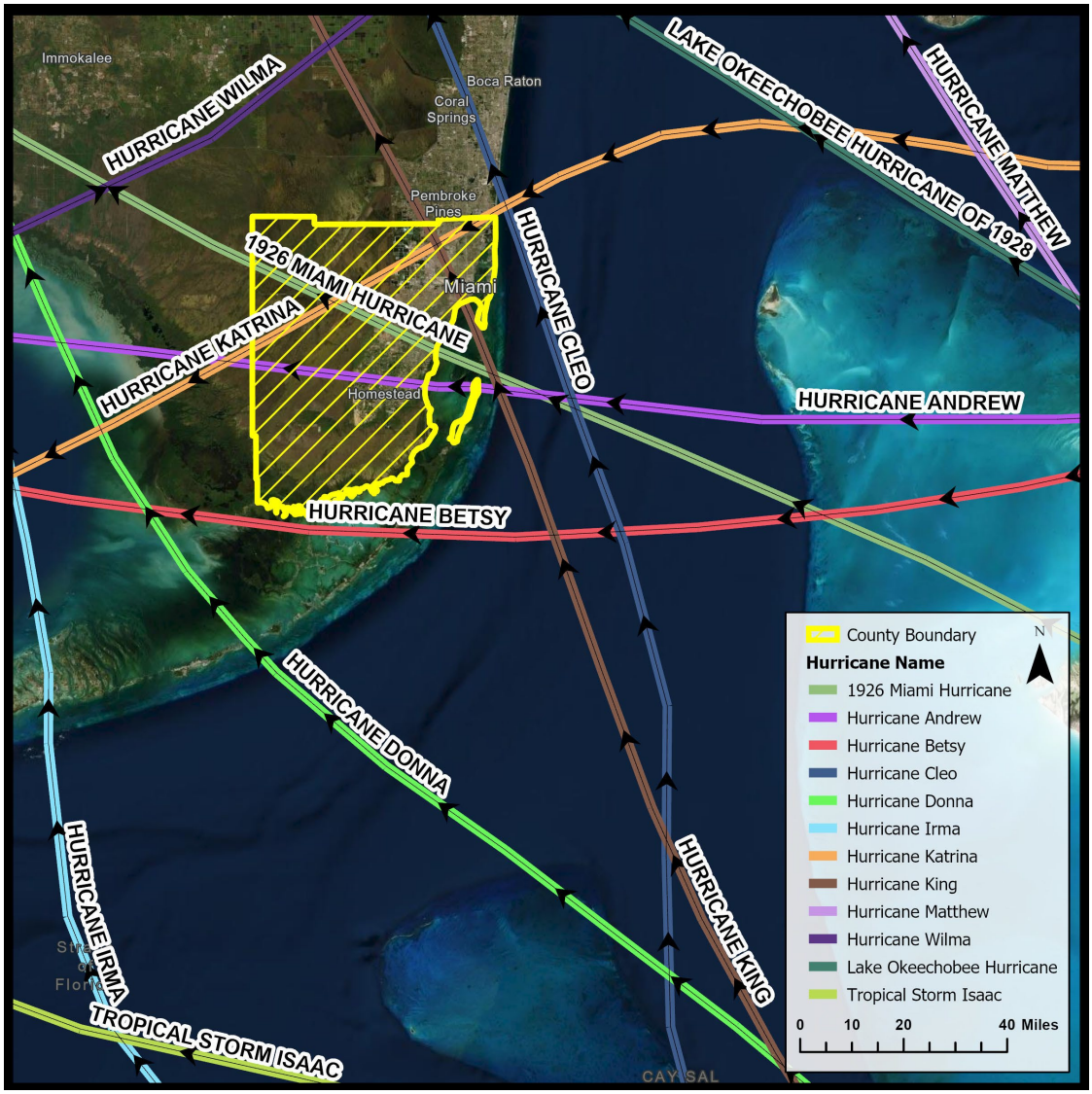


Figure 1-7. Historical Storm Tracks for the Miami-Dade County Area

The 1926 Miami Hurricane

Winds were reported to be nearly 150 mph as the Category four "Great Miami" hurricane passed over the Turks Islands and the Bahamas on September 16 and 17, respectively. The hurricane's eye moved directly over Miami Beach and then downtown Miami during the morning of the 18th. Storm surge of nearly 15 feet was reported in Coconut Grove, just a few miles south of the City of Miami, and approximately 11.7 feet along Biscayne Boulevard in Downtown Miami (Barnes 1998). **Figure 1-8** shows storm surge impacts.

Figure 1-8. Submerged Palm Trees in Storm Surge (Source: State Archives of Florida)

The MacArthur Causeway connecting Miami and Miami Beach was submerged under six feet of water. Hundreds of people drowned near Lake Okeechobee because a large storm surge breached muck dikes. **Figure 1-9** shows a boat washed ashore because of the Great Miami Hurricane.

Figure 1-9. Boat Washed Ashore onto Bay Shore Drive (Source: NOAA)

The death toll is uncertain because many people were still missing, though a Red Cross report lists 373 deaths and 6,381 injuries because of the hurricane. Damage was approximately $105 million, which, if

normalized to today's conditions, would be approximately $236 billion, making it the costliest Atlantic hurricane to date (Weinkle et al. 2018).

Lake Okeechobee Hurricane of 1928

The Okeechobee hurricane of 1928, also known as the San Felipe Segundo hurricane, made landfall near Palm Beach, Florida, on September 16, 1928, as a Category four hurricane. Winds reached approximately 78 mph in Miami. According to the NHC, most of the 1,836 deaths, taken as the official count by the National Weather Service, were caused by six to nine feet of surge at Lake Okeechobee, inundating the surrounding area.

Hurricane King (1950)

Tropical Storm King intensified to a hurricane while passing to the west of Jamaica. It remained a major hurricane while emerging into the Straits of Florida, and on October 18, 1950, it struck Miami, Florida, as a Category three hurricane. Two recording stations in Miami reported winds of 122 mph, gusts of about 150 mph, and an eye radius of only five miles wide. King caused a 19.3-foot storm surge to the City of Miami, which caused property damage totaling $15,000,000 (1950 United States dollar [USD]) in the Miami metropolitan area. Overall, King caused four deaths and $28,000,000 (1950 USD) in damage (Norton 1951).

Hurricane Donna (1960)

Before its landfall on September 10, 1960, in the Florida Keys as a Category four, Hurricane Donna was generally a slow-moving system that roamed the Atlantic for a total of 17 days. It caused up to 11 feet of storm surge along the southwest coast of Florida. Reported rainfall totals in the Miami and South Dade County area were seven to ten inches. According to former Weather Forecast Office Miami Meteorologist-in-Charge Rusty Pfost (LMSWG 2018), Donna subjected the Everglades area to damaging winds for 36 hours, resulting in 50 to 90 percent of foliage torn off. It caused $6,600,000,000 (2010 USD) of overall damage, which resulted in the name "Donna" being retired from the list used by the NHC to name storms. It is the only hurricane on record to produce hurricane-force winds in Florida, the Mid-Atlantic States, and New England. It holds the record for retaining major hurricane status in the Atlantic Basin for the longest period (nine days).

Hurricane Cleo (1964)

Hurricane Cleo was the first hurricane to directly strike Miami since Hurricane King. Cleo intensified rapidly to a Category two just before landfall in Miami, Florida, on August 27, 1964. According to the South Florida Sun-Sentinel (LMSWG 2018), Cleo cut power to 620,000 homes and businesses in Southeast Florida, and electricity was out for five days in Miami Shores. At least two dozen fires blazed across Miami. The storm surge reached between four and six feet between Miami and Pompano Beach.

Hurricane Betsy (1965)

Hurricane Betsy was an intense tropical cyclone that brought widespread damage to South Florida. It was the first tropical cyclone of its time to accrue at least $1,000,000,000 in damage in the Atlantic Basin. Evacuation and traffic coordination plans were set in place for Miami and other surrounding cities. According to local newspapers, an estimated 25,000 telephones were knocked out of service, blackouts

cut electric service to 80 percent of customers in the Miami and Fort Lauderdale areas, two twin-engine cargo craft were blown off the airport's perimeter at MIA, and 25 to 50 percent of Florida's citrus crop was damaged because of the strong winds (Youngstown Vindicator 1965). Unusually strong storm surge caused a majority of the damage in Florida because of its low-lying areas (Sugg 1966). Storm tide measured approximately 6.1 feet along the Miami Beach waterfront causing extensive damage to shoreline property along Biscayne Bay (Connor 1965). Three barges were torn out of their moorings and drifted into the Rickenbacker Causeway, causing damage that resulted in isolating Key Biscayne residents from the mainland (Milwaukee Journal 1965). Water was forced into the Miami River causing it to overflow and spread inland for several blocks in Miami.

Hurricane Andrew (1992)

Hurricane Andrew was a powerful and destructive hurricane that made landfall in Miami-Dade County on August 24, 1992. According to the Miami-Dade County LMS, damage was estimated at $25,000,000,000, with 25,524 homes destroyed and 101,241 homes damaged. An estimated 90 percent of all mobile homes in the southern part of the County were totally destroyed. The Miami Herald reported $500,000,000 in losses for boats. According to the NHC's Preliminary Report on Hurricane Andrew (Rappaport 1993), the maximum sustained surface wind speed during landfall over Florida was estimated at 145 mph, with gusts at about 175 mph.

The peak storm surge arrived near the time of high astronomical tide, causing a storm tide of approximately four to six feet in northern Biscayne Bay and 16.9 feet at the Burger King Headquarters located on the western shoreline in the center of the bay. **Figure 1-10** and **Figure 1-11** from NOAA show, respectively, Sewell Park on a normal day and the day Hurricane Andrew made landfall. Rainfall totals more than seven inches were recorded in Southeast Florida.

Figure 1-10. Sewell Park on the Mouth of Miami River on a Normal Day (Source: NOAA)

Figure 1-11. Sewell Park just after Daybreak on August 24, 1992 (Source: NOAA)

Hurricane Andrew was reclassified as a Category five hurricane in 2002 after a reanalysis of the hurricane's intensity (Landsea et al. 2004). USACE used almost $400,000,000 in federal funds to help South Florida recover from the devastation either through debris removal, emergency generators and pumps, temporary housing, water supply and distribution, school repairs, and portable toilets and showers.

Hurricane Katrina (2005)

While Hurricane Katrina is widely remembered for the damage it caused to New Orleans, it also had a large impact on Florida. Katrina made landfall between Miami and Fort Lauderdale, Florida, as a Category one on August 25, 2005. According to the Miami-Dade County LMS, Katrina's heavy rains caused flooding to 50 single-family dwellings from a measured 12.25 inches of rainfall and caused significant tree damage at Bill Baggs Cape Florida State Park. Eleven Florida counties were declared federal disaster areas. While most of the 1,833 deaths were in Louisiana, three people drowned in Miami-Dade County. Katrina caused an estimated $41,100,000,000 (2005 USD) in insured damage on 1.7 million different claims to vehicles, homes, and businesses across six states. In addition, $16,100,000,000 in losses from flooding occurred, insured by the NFIP (Knabb 2011).

Hurricane Wilma (2005)

Hurricane Wilma made landfall in Southwestern Florida on October 24, 2005, as a Category three hurricane. According to the Miami-Dade County LMS, hurricane-force winds severely impacted downtown Miami's high-rise office buildings. Power outages occurred countywide for three weeks because of the damaged power lines and utility poles. The Port of Miami sustained damage to approximately 2,000 feet of bulkheads, and 300 vessels were damaged when the Sunny Isles Marina dry storage facility collapsed. Many docks and pilings throughout the County were severely damaged because of the moored vessels battering against them.

Tropical Storm Isaac (2012)

According to the Miami-Dade County LMS, Tropical Storm Isaac produced 1.3 feet of storm surge and sustained winds measuring 29 mph at MIA. Approximately 26,000 customers lost power in Miami-Dade County. Evacuation orders were only issued for mobile home residents in the County.

Hurricane Matthew (2016)

According to the LMS, Miami-Dade County was within the five-day and three-day forecast cones of Hurricane Matthew while it was a Category five; however, the storm turned and only the outside bounds of Matthew affected Miami-Dade County, resulting in a tropical storm warning.

Hurricane Irma (2017)

According to the LMS, Hurricane Irma was the first hurricane to make landfall in South Florida since Hurricane Wilma in 2005. It produced between five and ten inches of rainfall. Storm surge was between four and six feet on Biscayne Bay and two and four feet on the east coast. An estimated $225,000,000 in agriculture damage was reported.

Hurricane Dorian (2019)

On August 29, Florida Governor Ron DeSantis declared a state of emergency for Florida because of Hurricane Dorian. According to the NWS, Hurricane Dorian was the strongest and most destructive storm of the 2019 hurricane season. Dorian reached Category five intensity, with maximum sustained winds of 180 mph and with a storm surge greater than 18 feet when making landfall in Elbow Cay, Bahamas, on September 1, 2019. The track showed Dorian heading just north of Miami-Dade County; however, when Dorian was approximately 70 miles away from land, it took a turn northward, going parallel along the coast of Florida instead. What could have been a disastrous storm for Miami-Dade County ended up resulting in a few inches of rain and minor reports of street flooding.

Hurricane Ian (2022)

According to the NWS, Hurricane Ian made landfall in the Southwest Florida region at Category four intensity, producing winds up to 150 mph and up to 18 feet of storm surge. Ian was responsible for more than $112,000,000,000 in damage, making it the costliest hurricane in Florida's history and third costliest in the United States. Miami-Dade County was spared, yet again, from another nearby hurricane in recent years, causing less than one percent of its population to lose power and some trees being reported down. **Table 1-3** shows the historic FEMA flood claims in Miami-Dade County since 1978.

Table 1-3. Historic Federal Emergency Management Agency Flood Claims in Miami-Dade County

Total Claims Since 1978	Total Paid Since 1978	Average Amount Paid Per Claim
57,785	$955,743,735	$16,539

Source: FEMA as of October 29, 2019, with price levels adjusted to 2024

1.5.3 Prior Studies, Reports, and Programs

Numerous studies and reports have been conducted for Miami-Dade County. A comprehensive list of previous reports dating back to the early 1950s by USACE, as well as useful reports by others, including reports commissioned or authored by Miami-Dade County, are listed in **Table 1-4** and **Table 1-5**. These studies and additional information acquired are being used to characterize existing conditions.

Table 1-4. List of Prior USACE Studies, Reports, and Existing Water Projects

Title	Author	Date
Miami River Locks and Dam, Survey Review Reports	USACE	1950–1957
Evaluation Report on Hurricane-Protection Measures for Biscayne Bay, Florida	USACE	1958, 1963
A Planning Study on the Miami River	USACE	1962
Dade County, Florida Beach Erosion Control and Hurricane Protection Report	USACE	Various starting in 1965
Environmental Chemistry of Florida Estuaries: Deepwater Ports Maintenance Dredging	USACE	1984
Final Recommendations of the Miami River Management Committee	USACE	1984
Miami River Dredging Study	USACE	1986
Preliminary Evaluation of Proposed Waterway Design Improvements in Support of Deep Draft Vessel Operation in Miami, FL	USACE	1987, 1988
Navigation Study for Miami Harbor (Miami River), Florida	USACE	1989, 1990
Coast of Florida Erosion and Storm Effects Study Region III, Assessment of Wave Conditions During Hurricane Andrew at Miami Beach	USACE	1993
Miami River Sediments, Seybold Canal	USACE	1995
Coastal Engineering Report, Dade County Regional Sediment Budget	USACE	1997
Shoreline Stabilization Report and Final EA Virginia Key, Florida	USACE	2002
South Atlantic Coastal Study	USACE	2022

Table 1-5. List of Prior Miami-Dade County Studies, Reports, and Existing Water Projects

Title	Author	Date
Economics of Climate Adaptation: Shaping Climate Resilient Development, a Framework for Decision Making	Economics of Climate Working Group	2009
Institutionalizing Climate Preparedness in Miami-Dade County, Florida	International Council for Local Environmental Initiatives (ICLEI) – Local Governments for Sustainability	2010

Title	Author	Date
Miami-Dade Water and Wastewater WWTP Vulnerability Assessment Presentation	Hazen and Sawyer	2013
Adaptation Action Areas: Policy Options for Adaptive Planning for Rising Sea Levels	South Florida Regional Planning Council	2013
Sea Level Rise and Storm Surge Rapid Action Plan	Miami-Dade	2015
Design Guide for Hardening Wastewater Treatment Facilities against Flooding from Surge, Sea Level Rise, and Extreme Rainfall	CH2M Hill	2015
Unified Sea Level Rise Projection Southeast Florida	SE FL Regional Compact Work Group	2015
Flood Protection Level of Service Analysis for the C-4 Watershed	SFWMD	2015
Surge and Flood Modeling for Miami-Dade County (Task 2.10 as part of the 2015 OOL Validation Program)	CH2M Hill	2015
Sea Level Rise Task Force Final Report for Resolution R-48-15	Miami-Dade	2016
Assessment of Available Tools to Create a More Resilient Transportation System, 2016	Miami-Dade	2016
Design Guide for Hardening Wastewater Pump Station Facilities against Flooding from Surge, Sea Level Rise, and Extreme Rainfall	CH2M Hill	2016
Arch Creek Basin Adaptation Study Report	Urban Land Institute	2016
Pump Station Prioritization Based on Criticality and Risk of Flooding	CH2M Hill / Hazen and Sawyer	2017
South Miami Coastal Resilience: The Value of Mangrove Restoration	CH2M Hill / Nature Conservancy	2017
Assessment of Alternative Flood Mitigation Strategies for the C-7 Basin	Deltares	2017
Miami-Dade Whole Community Hazard Mitigation, Local Mitigation Strategy	Miami-Dade	2018
Septic Systems Vulnerable to Sea Level Rise Final Report for Resolution R-911-16	Miami-Dade	2018

Title	Author	Date
Rapid Action Plan: Vulnerability of County Assets to Sea Level Rise and Future Storm Surge	Miami-Dade	2018
Adapting Land Use and Water Management Plans to a Changing Climate in Miami-Dade and Broward Counties	Rand Corp.	2018
Matheson Hammock Sea Level Rise Flood Mitigation Study	Cummins Cederberg	2018
Resilient305	Miami-Dade and surrounding counties	2019
Miami-Dade County Sea Level Rise Strategy	Miami-Dade County	2021
Miami-Dade County Stormwater Master Plan	Miami-Dade County	2021
South Florida Water Management District Sea Level Rise and Flood Resiliency Plan	South Florida Water Management District	2023

Additionally, Miami-Dade County's Park, Recreation, and Open Space department has ongoing projects that include Parks Resilience Design Guidelines, Waterfront Recreation Access Plan (WRAP), and a series of sea level change studies for the following parks: Haulover Park, Crandon Park, Chapman Field Park, Biscayne Shores and Gardens Park, Pelican Harbor Marina, Black Point Park and Marina, Homestead Bayfront Park, Deering Estate, Greynolds Park, East Greynolds Park, and Fairchild Tropical Botanic Garden.

1.6 Purpose and Need

The purpose of this study is to develop, evaluate, and recommend CSRM solutions for future implementation in Miami-Dade County consistent with the federal objective of water and related land resources planning and in accordance with national environmental statutes, applicable executive orders, and other federal planning requirements. This study effort focuses on managing risk to critical infrastructure (CI), residential buildings, and nonresidential buildings with nonstructural measures in areas of high susceptibility to storm surge and underserved communities.

The study effort also establishes a new comprehensive framework paving the way for future investigations and potential future studies and recommends two new programs for authorization. The NBS Pilot Program's purpose is to develop, evaluate, and implement demonstration projects that will individually inform the calculation of CSRM benefits provided by different types of NBS to better inform how NBS reduce coastal storm damages. The purpose of the Miami-Dade Back Bay Nonstructural Program is to further innovate, formulate, and assess nonstructural measures for vulnerable infrastructure and buildings for which USACE nonstructural policy is still developing. This report, however, seeks $6 million to further study the Nonstructural Program and additional authorization will be sought to design and implement site-specific projects within the Program.

This study is needed because Miami-Dade County is extremely vulnerable to flooding from storm surge. Associated risk levels and vulnerability to coastal storms are expected to continue to increase because of sea level change and climate change in the future.

Miami-Dade County has 34 municipalities consisting of approximately 2.7 million people with more than 500,000 buildings, making it the most populous county in Florida and the seventh most populous in the United States. More than 26.5 million tourists visited Miami-Dade County in 2022, contributing $20,800,000,000 to the local economy. The MIA recorded passenger traffic at 50.7 million travelers in 2022. The region is well known for its risks of coastal flooding from hurricanes and tropical storms. Sea level change has increased these risks and will continue to do so in the future. Without plans to manage coastal flood risk and increase resilience, threats to life, property, and the economy will continue to increase. This study developed and evaluated CSRM measures for CI and Miami-Dade County's residents, industries, and businesses.

SACS is a comprehensive study that applies watershed planning concepts to identify actions for advancing coastal resilience along the 65,000 miles of tidally influenced shoreline across North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Puerto Rico, and the U.S. Virgin Islands. The study was completed in July 2022, and one of its many goals was to identify and focus current and future resources to high-risk locations.

According to SACS, Florida accounts for most of the coastal storm risk in the study area because of its large coastline, flat low-lying topography, and significant population and development located near the coast. Approximately 84 to 87 percent of the economic risk for the entire study area was within Miami-Dade, Broward, Lee, and Pinellas Counties, which accounted for nearly two-thirds of the economic risk in the State of Florida.

SACS ranked areas based on the three data set rankings: magnitude of future economic damages, potential high environmental risk acreage, and the average relative social vulnerability. The regional ranking was developed by aggregating all three input data set rankings, while applying a weighting of 60 percent toward economic damages, 30 percent toward environmental risk acreage, and 10 percent toward social vulnerability. Out of the 45 feasibility study recommendations for the entire South Atlantic Coast, the need for a study in the Miami-Dade Back Bay area had an overall rank of one.

1.7 Problems and Opportunities

The first step in USACE's planning process is identifying problems and opportunities, followed by defining the objectives and constraints that will guide efforts to solve those problems and achieve those opportunities. The PDT and the NFS held charrettes in Miami, Florida, with various stakeholders providing feedback and discussing possible problems, opportunities, objectives, and constraints in the Miami-Dade County area. The following sections cover the results of those charrettes, as well as other planning considerations.

Problems are existing, negative conditions. Following are the primary problems occurring in Miami-Dade County with relation to coastal storm risk:

1. Geographic location, low elevation, and high population of Miami-Dade County make it vulnerable to storm surge from hurricanes and tropical storms.
2. Increasing high tides and king tides, resulting from sea level change, contribute to recurrent flooding of transportation systems and properties and exacerbate coastal storm risk.
3. Increasing flooding from rain events, caused by the higher ground water elevations and higher tailwater elevations from sea level change, threatens properties and infrastructure and exacerbates coastal storm risk.

Coastal storm risk, especially risk associated with storm surge flooding, contributes to the following specific concerns:

1. Risks to human life and health
2. Damage to development (buildings) causing negative economic impacts to residents, the County, and the nation
3. Damage to CI and disruption of their service
4. Decreasing level of service provided by the regional water management infrastructure
5. Saltwater intrusion into freshwater supplies for drinking and agriculture
6. Transportation disruptions including inundation of evacuation routes and increased risks to coastal causeways that reduce connectivity within the County

Opportunities are the desirable future outcomes that address the water resource problems and improve conditions in the study area. Opportunities include:

1. Reduce the risk to human life and health caused by coastal flooding, high flooding events, or infrastructure failure.
2. Reduce coastal storm–related economic damage and improve economic resilience of the local economy and communities, particularly low-income communities and vulnerable populations.
3. Increase resilience, structural integrity, and reliability of CI.
4. Reduce transportation disruptions from high-water events that make evacuation routes and other roadways impassable and threaten coastal causeways.
5. Use available natural areas and open spaces for improving wave attenuation, water retention, and water storage. Create co-benefits supporting recreation, human health, public access to water, and tourism.
6. Manage flood risk and damage to residential, commercial, historic, cultural, and critical assets and infrastructure.
7. Improve neighborhood cohesion and social fabric by managing flooding risks and improving neighborhood connectivity (e.g., greenways, new open space, and transportation improvements).
8. Improve community awareness about coastal storm risks.
9. Improve existing recreational opportunities to the full extent possible when planning for CSRM.

1.8 Objectives and Constraints

Objectives are statements that describe the results one wishes to achieve by solving the problems and taking advantage of the opportunities identified earlier. The goal of this study is to develop and evaluate CSRM planning solutions consistent with the federal objective of water and related land resources

planning, which is to contribute to the National Economic Development (NED), consistent with protecting the nation's environment, in accordance with national environmental statutes, applicable executive orders, and other federal planning requirements, with the purpose of recommending an implementable suite of CSRM measures for Miami-Dade County to address damage cause by flooding from coastal storm events. The following objectives will help to achieve the study goal:

1. Increase the resilience of Miami-Dade County to function effectively before, during, and after coastal storm events by decreasing the vulnerability of CI to flooding damage from storm surge with consideration for sea level change over the period of analysis.
2. Manage coastal storm risk by reducing economic damage to buildings in Miami-Dade County communities that have been identified as vulnerable to severe damage from storm surge with consideration for sea level change over the period of analysis.
3. Manage risk to human health and life safety throughout Miami-Dade County over the period of analysis.

Constraints are conditions to be avoided, or things that cannot be changed, which limit the development and selection of alternative plans. Specific constraints for this analysis include:

1. Avoid creating or exacerbating storm surge flooding within the study area to other local municipalities and to local military installations, without appropriate mitigation.
2. Avoid and/or minimize impacts to existing environmental and cultural/historic resources in the Region of Influence (ROI) (e.g., threatened and endangered species, water quality, Biscayne Bay Aquatic Preserve, Biscayne Bay National Park, and Miami Circle National Historic Landmark).
3. Avoid exacerbating saltwater intrusion or any other water quality and/or quantity impact that would negatively affect wellfield protection areas and freshwater supply for stakeholders in South Florida.

Other planning considerations include:

1. Do not negatively impact navigation and port interests.
2. Do not impact or impair CERP restoration goals, including BBSEER.
3. Avoid reducing evacuation capacities once the project is completed.

1.9 General Approaches to Coastal Storm Risk Management

Coastal communities like Miami-Dade County can shape how storm surge affects the natural and built environments and manage risk by 1) creating or enhancing features that provide resistance or reduce the energy of moving water, 2) adapting vulnerable buildings in place and other critical assets to minimize damage, or 3) attempting to keep storm surge completely out of vulnerable areas using large-scale barriers. **Table 1-6** provides descriptions of these CSRM approaches and **Figure 1-12** provides illustrations.

Table 1-6. Coastal Storm Risk Management Approaches

CSRM Measure	CSRM Approach	Description
NBS and Nonstructural Measures	Resist or reduce energy.	Similar to speed bumps on the road, different features both in the water, such as coral or hybrid reefs, mangroves, and seagrass, as well as elements on land, including barrier islands with their beach and dune system, act to slow down or reduce wave energy of the approaching surge. The more speed bumps or "lines of defense" that are in place, the greater their cumulative effect and less damaging or impactful a storm surge of any intensity will be for the communities and infrastructure behind them. In addition, these series of lines can be designed or naturally connected and serve to reinforce one another.
	Adapt in place or live with water.	In most cases, the lowest elevation areas will still experience some degree of storm surge flooding, especially when the storm also brings intense rainfall flooding, creating what is known as compound flooding. In these vulnerable locations, on barrier islands, near Biscayne Bay's shorelines, and along major canals, residential buildings may be lifted or elevated above predicted flood levels to further minimize damage as water is allowed to pass underneath. In the same areas, CI such as fire stations and sewer pump stations, as well as commercial buildings, can be floodproofed. This common practice addresses the individual structures' key vulnerabilities for flooding by deploying temporary barriers at door or window openings ahead of the storm or permanently elevating critical electrical or mechanical equipment located near the ground.
Structural	Keep water out with barriers (permanently or temporarily).	In some cases, communities can leverage the region's existing topography, landscapes, and their relatively high ground elevations to construct features that either serve as permanent barriers, such as levees (which can serve a dual purpose for transportation or recreation), or as part of a gate system that only closes temporarily ahead of and during large storms. These types of barriers block the storm surge waters from entering low-lying or vulnerable areas and can significantly reduce damage when in place or activated for more intense storm surge events.

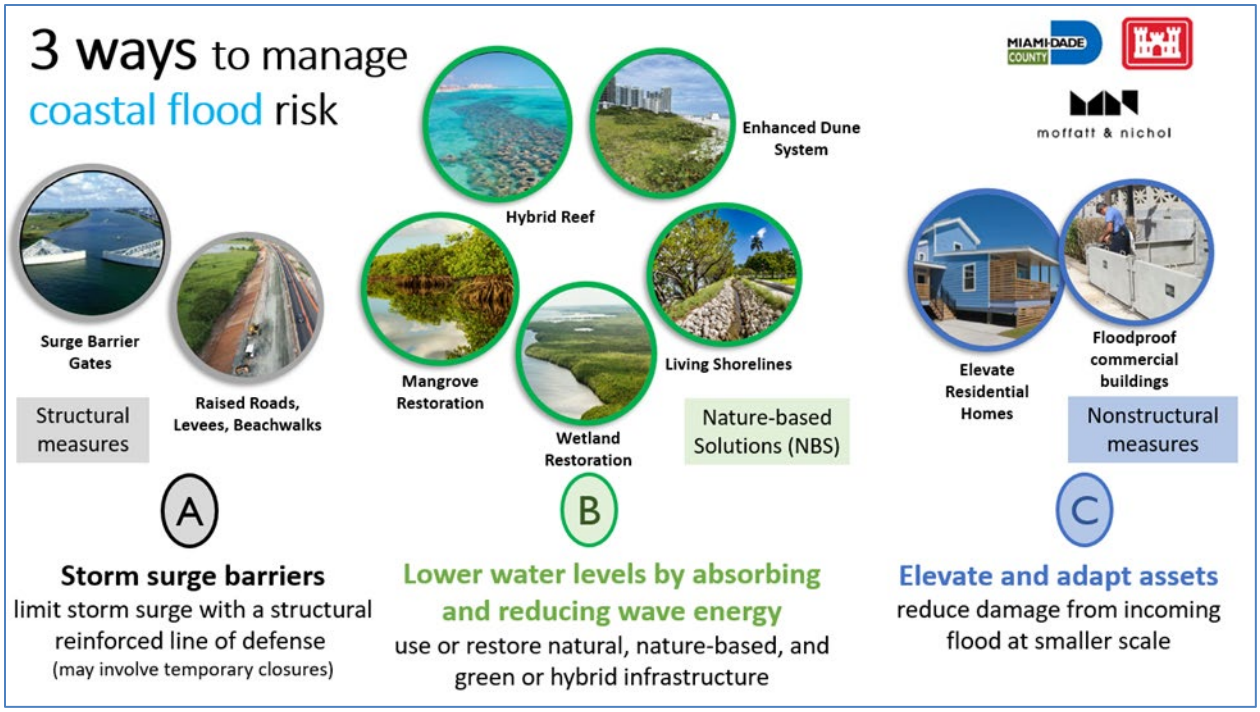


Figure 1-12. Three Approaches to Managing Storm Surge Risk

Miami-Dade County and its regional and local partners have a range of experience using these types of approaches through other resilience initiatives implemented with support from other federal agencies (e.g., FEMA), as well as nongovernmental organizations (NGOs) focused on urban and climate resilience. When combined as part of a series of CSRM measures, it creates multiple lines of defense that have the cumulative effect of managing risk across the landscape. This is the vision articulated further in Section 2, Comprehensive Framework.

1.10 Study Scope

This study began in October 2018 and went through the USACE planning study process described in Section 1.2, which determined a recommended plan that included structural measures, nonstructural measures, and NBS.

In 2021, the study was paused when Miami-Dade County requested an exception for additional time and funding for the study. The Office of the Assistant Secretary of the Army for Civil Works (OASA[CW]) approved the exception, which included up to an additional five years and $8,200,000 in August 2022. One of the requirements for the exception was to develop and brief the ASA(CW) on an alternative in the first year of the exception that supports the NFS's request to develop and analyze flood risk features, including investigating NBS. **Table 1-7** shows the various charrettes and meetings held in the first year since the restart of the study in August 2022. Section 10.2 provides more information about public and stakeholder involvement.

Table 1-7. Public, Stakeholder, and Miami-Dade County Engagement Since Reinitiation

Session	Date	Description
Charrette #1	November 2022	Charrette in Miami, Florida, included reinitiating the study, goals of the first year, and an in-person public meeting.
Charrette #2	March 2023	Charrette in Miami, Florida, refined the measures and their locations.
Virtual Public Meetings	October 2022, February 2023, June 2023, August 2023, March 2024	Virtual meetings were held with resource agencies, the public, stakeholders, and the Jacksonville District for integration throughout the year.
Workshop	December 2023	Workshop meeting in Miami, Florida to identify Focus Areas for the 2024 study.

Miami-Dade County and USACE actively engaged with the public and stakeholders to gather input. The result from the first charrette was the concept of "multiple lines of defense," which emerged as the vision to guide the formulation of risk management measures. This concept represents a spectrum of possible measures and led to NFS developing two "book-end" alternatives: the Atlantic Coastline Alternative (ACA) and the Nonstructural Alternative. On one end, the Nonstructural Alternative concept focused on adapting to living with more water and included nonstructural measures such as elevating and floodproofing buildings and CI, as well as NBS such as mangrove restoration, hybrid reef structures, and wetland restoration, among others. On the other end, the ACA concept was emphasized and relied primarily on structural measures along the barrier island such as berms, elevating the boardwalk along the beach, and multiple storm surge barriers at inlets, along with limited nonstructural and NBS measures. Further descriptions and graphics of both concept alternatives are in Appendix A-6, the Public Coordination Appendix.

The team developed courses of actions (COAs) that would have allowed further investigation of the multiple lines of defense, including the ACA throughout the next few years of the study phase. The team presented the COAs at an August 2023 meeting with the ASA(CW) and Miami-Dade County mayor. While Miami-Dade County's leadership and the ASA supported the COA presented, there was a joint recognition for the need to advance actionable measures in the short-term for Miami-Dade County's environmental justice communities, while allowing for continued feasibility study in the medium to long term.

Following the meeting with the ASA(CW), the team received study guidance from USACE headquarters to focus on seeking authorization for the CSRM of CI and vulnerable communities as soon as possible, meaning WRDA 2024, while identifying further study efforts for Miami-Dade County that would take additional time to investigate. Each of these independent study efforts would provide solutions with independent utility, but the culminating feasibility reports' recommendations would work collectively toward managing coastal storm risk more broadly for the study area (consistent with the initial, larger multiple-lines-of-defense approach). This study effort focuses recommended measures on managing risk

to CI, residential buildings, and nonresidential buildings using primarily nonstructural measures, such as elevating and floodproofing. The USACE headquarters guidance also called for the creation of a new comprehensive programmatic study framework describing future investigations and potential future projects. Appendix A-8 presents this guidance.

1.10.1 Method for Identifying Focus Areas

To complete this study within an expedited schedule to accomplish a Chief's Report in 2024, the team had to strategize and determine Focus Areas where risk management measures would be considered for this effort and which ones would be part of future interim responses. The team held a workshop with Miami-Dade County and municipalities in Miami, Florida, during the first week of December 2023, where the goal was to determine Focus Areas for the study. Following is the process for identifying the Focus Areas:

1. The primary focus was identifying areas of highest risk to storm surge. These areas were identified by looking at high-frequency inundation areas—in this case, the 10 percent AEP or 10-year return period floodplain based on FEMA's Region IV South Florida Storm Surge Study (SFLSSS) water surface elevation estimates with the addition of USACE High Sea Level Change Curve to the year 2089. Ten percent AEP represents the flood extents that have a 10 percent chance of being equaled or exceeded in any given year.
2. The areas were further refined by determining environmental justice within the 10 percent AEP.
    a. The Council on Environmental Quality's Climate and Economic Justice Screening Tool (CEJST) was used to identify environmental justice communities within Miami-Dade County. A census tract is considered disadvantaged if it meets more than one burden threshold and the associated socioeconomic threshold. The following site provides further information on the CEJST tool's burden categories and thresholds: https://screeningtool.geoplatform.gov/en/methodology
    b. Environmental justice communities specifically identified by municipalities were prioritized over data from CEJST. This included areas within the City of Miami and the City of Miami Beach.
3. The first two processes resulted in six Focus Areas at Biscayne Canal, Little River, Miami River, North Beach, South Beach, and Cutler Bay. They were slightly expanded in certain areas to include additional data, if applicable. For instance, as described in Section 1.4.2 Resilience Actions by Miami-Dade County, AAAs were developed by Miami-Dade County within the Biscayne Canal and Little River basins. The Focus Areas, in coordination with Miami-Dade County, were adjusted to include parts of those AAAs since they are areas that experience coastal flooding caused by extreme high tides, intense rainfall, storm surge, and those that are vulnerable to the related impacts of sea level change.
4. FEMA repetitive loss data from the NFIP was used to ensure that any cluster of repetitive loss or severe repetitive loss buildings in proximity was incorporated into the Focus Areas.
    a. Repetitive Loss – An NFIP-insured building that has had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978.
    b. Severe Repetitive Loss – Four or more separate claim payments of more than $5,000 each (including building and contents payments) or two or more separate claim payments

(building payments only) where the total of the payments exceeds the current value of the property.

Providing CSRM to CI was also a priority for this study. CI categories were narrowed down from a previous workshop with stakeholders and Miami-Dade County, which included fire stations, police stations, emergency operations centers, evacuation shelters, wastewater treatment plants, and communication buildings. CI within or providing service to the six Focus Areas were selected for evaluation. **Figure 1-13** shows the Focus Areas and the CI being considered for evaluation in this study. Note that shelters are not shown on maps because those data are private.

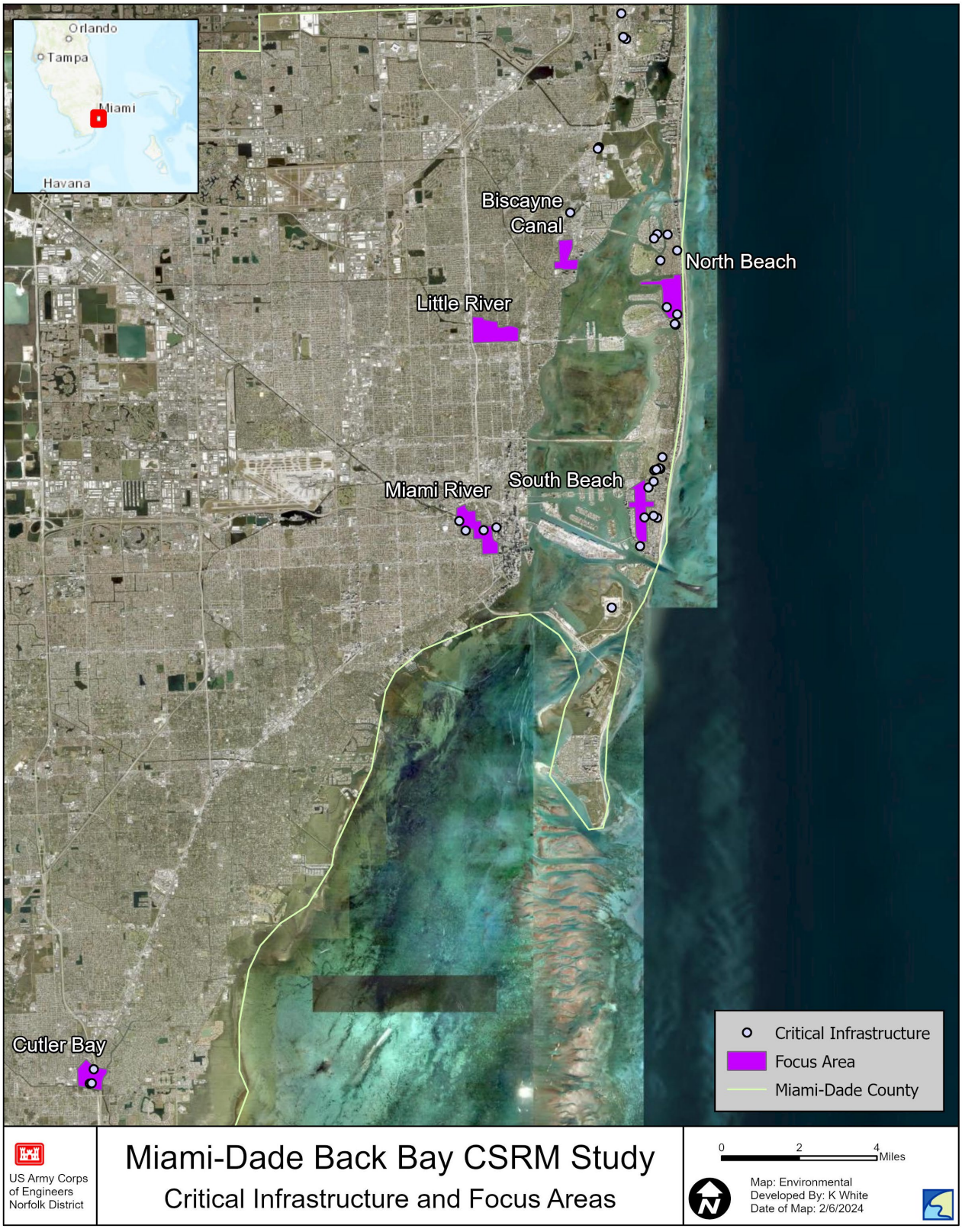


Figure 1-13. Critical Infrastructure and Focus Areas

2 COMPREHENSIVE FRAMEWORK

Miami-Dade County is one of the most complex, culturally diverse, and vulnerable coastal communities in the world, and it demands significant investment in an integrated, adaptive, resilience strategy to address coastal storm risk while navigating the challenges of a changing climate. This Integrated Feasibility Report and Environmental Assessment (IFR/EA) proposes for authorization actionable nonstructural measures, the Nature-Based Solutions (NBS) Pilot Program, and the Nonstructural Program study, all of which are anticipated to provide significant Coastal Storm Risk Management (CSRM) benefits for Miami-Dade County in the near future. To fully address coastal storm risk in the region, the United States Army Corps of Engineers (USACE) intends to continue its study efforts in Miami-Dade County following completion of this study. This section provides a high-level overview of USACE and Miami-Dade County's plan to develop a comprehensive strategy for CSRM in the County for which authorization will be sought in the future.

Miami-Dade County seeks to advance an innovative and comprehensive framework needed to guide collective action based on decades of observations made around the United States, lessons learned from historical approaches to CSRM, and insights gained during the Miami-Dade Back Bay Feasibility Study's extensive stakeholder engagement. The Comprehensive Framework (Framework) will be developed in response to official study guidance issued by the USACE Headquarters Office on December 5, 2023, and referenced in Appendix A-8. That guidance articulated the need to use a comprehensive framework describing future independent investigations leading to future implementable projects. The guidance also noted that this Framework will entail preparing Chief's Reports for potential future biennial Water Resources Development Act (WRDA)-authorized studies in 2026 and/or 2028.

The Framework represents a regional strategy to address coastal storm risk more broadly, encompassing a blend of various federal and local guiding principles, goals, objectives, studies, and initiatives that strive to address coastal storm risk proactively and equitably while building holistic community resilience to climate change impacts. These principles include, but are not limited to, the 2021 Miami-Dade County Sea Level Rise Strategy[1] and the 2014 Council of Environmental Quality (CEQ) Principles, Requirements, and Interagency Guidelines.[2] The Framework will also illustrate a joint path forward for a flexible and sustainable partnership between Miami-Dade County and USACE.

2.1 Three Pillars of the Framework

The Framework will contain **three pillars** that serve as a foundation for ensuring successful and continuing joint efforts of the Back Bay study, including:

1. **Multiple Lines of Defense:** the vision for managing coastal storm risk across the range of natural, built, and hybrid environments in the water, along the shoreline, and on land through the implementation of a series of independently justified projects
2. **Adaptive Management:** the flexible decision-making process for addressing evolving circumstances as well as short- and long-term needs

[1] The Miami-Dade County Sea Level Rise Strategy guiding principles include making us safer, being equitable, reducing environmental pollution, being flexible, building with nature, and aligning with other initiatives.

[2] The Guiding Principles (CEQ 2014 Principles, Requirements, and Interagency Guidelines) include environmental justice and equity, floodplains, healthy and resilient ecosystems, public safety, sustainable economic development, and a watershed approach.

3. **Integration:** the collaborative effort for ensuring the development of plans, policies, programs, and projects that are streamlined, complementary, and equitable across scales

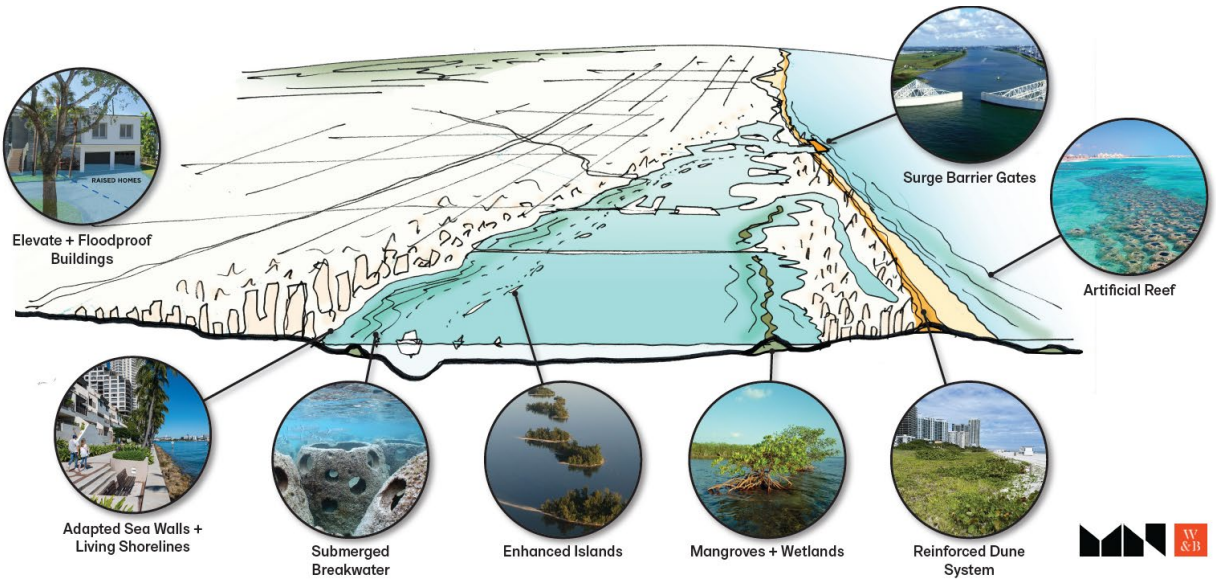
Given the complexity of the challenge, the Framework's success will depend on continued and expanded coordination efforts at all levels of government, including municipalities, Miami-Dade County, and regional entities such as the South Florida Water Management District (SFWMD, the State of Florida, and federal agencies.

2.1.1 Pillar #1: Multiple Lines of Defense

Storm surge flooding from hurricanes, tropical storms, or nontropical systems, science and lived experience demonstrate how the incredible force of rising water levels will flow along paths of least resistance. As described in the Introduction (Section 1.9), following are the ways coastal communities like Miami-Dade County can shape how storm surge affects the natural and built environments and manages risk:

1. Resisting or reducing the energy of destructive storm surge with features in water and/or on land
2. Adapting vulnerable buildings and other critical assets in-place to minimize flood consequences
3. Creating large-scale barriers that attempt to keep storm surge completely out of vulnerable areas

The foundational vision for the Framework is a multiple-lines-of-defense approach that emerged out of the iterative and intensive stakeholder engagement process (**Figure 2-1**). Appendix A-6, Public Coordination, details additional concepts developed from stakeholder engagement and feedback.



The **Multiple-Lines-of-Defense** approach seeks to explore and implement a series of diverse nature-based, nonstructural, and potential structural measures across the landscape and in the water that manage coastal storm risk across the region.

Figure 2-1. Multiple-Lines-of-Defense Concept

The nonstructural measures and programs recommended in this IFR/EA integrate with the broader Framework and multiple-lines-of-defense concept.

The proposed NBS Pilot Program will evaluate the advancement of NBS measures that are independently justified and anticipated to provide coastal storm risk management benefits and additional co-benefits (Section 5). As emphasized during public engagement, NBS can and already serve as a line of defense by attenuating wave energy and reducing shoreline erosion that results from high-frequency and low-intensity storms. The Miami-Dade Back Bay NBS Pilot Program will evaluate different NBS types and document their contribution to storm surge reduction and the extent to which a series of independently justified pilot demonstration projects contribute to improving resilience across the region (Section 5).

Similarly, the proposed Nonstructural Program will evaluate measures such as building elevation and floodproofing for building types (e.g., hospitals and larger, four-plus-unit residential buildings) for which current USACE implementation practices and policies are still developing (Section 6).

This IFR/EA also recommends specific residential and nonresidential structures, as well as critical infrastructure, for elevation or floodproofing. This elevation or floodproofing will provide immediate and independent benefits in the form of reducing the impacts of coastal storms on the treated structures. Large-scale structural measures, such as a system of storm surge gate structures near the barrier islands identified in the Atlantic Coastline Alternative (Section 1.10), would not be evaluated in the current study and would potentially be considered in a future feasibility study.

In summary, local governments in the region have a range of familiarity and experience in designing and implementing these measures, and many have become adept at working with partners to build resilience to flooding and sea level change impacts. Local communities also strive to address other resilience challenges related to water quality, transportation systems, and overall health of neighborhoods. Through continued collaborative partnerships and creative implementation strategies, USACE can help Miami-Dade County and its partners realize a vision for addressing a variety of water resources management challenges through multiple lines of defense that provide numerous benefits. To ensure success, the Framework offers two additional pillars that articulate how the first can be achieved.

2.1.2 Pillar #2: Adaptive Management

Miami-Dade County, like many large coastal urban areas, is dynamic and will continue to be shaped by changing development patterns, regional and global economic trends, and climate change.

Adaptive management addresses these challenges by providing opportunities to prioritize potential projects that will deliver immediate benefits to the County. Using an adaptive management structure

involves a conscious evaluation of the landscape to choose the best sequence of projects. As this process proceeds over time, certain factors will change—either by progress from other resilience efforts, changing environmental insights or nature-based opportunities, or shifting climate change predictions.

An adaptive management structure can address risk and uncertainty inherent within flood risk management by encouraging flexible plans and designs. This is a structured management approach for addressing uncertainties by testing hypotheses, linking science to decision-making, and adjusting implementation, as necessary, to improve the probability of success.

The Comprehensive Everglades Restoration Plan (CERP), authorized by Congress through the 2000 WRDA, is a testament to the potential for large-scale interventions to build resilience into a complex system. The CERP Restoration Initiative is driven by ecological and risk-informed science and has undergone dozens of cycles of planning, design, and construction as part of an adaptive management approach with congressionally authorized changes to projects, where necessary.

Adaptive management also encourages stakeholder engagement and interagency collaboration, leading to a common understanding of the issues. Adaptive management generates new information to improve the implementation through iterative refinement of project plans, designs, construction, monitoring, and operations.

The long-term strategy of this adaptive management framework approach would be to address, adapt, and adjust to coastal flood risks over time in the event of changing circumstances, outcomes, unknowns, and uncertainties. Additionally, Miami-Dade County is interested in potentially expanding the existing study authority or identifying another authority that, in addition to CSRM, would allow the purposes of ecosystem restoration to be addressed in future study efforts.

2.1.3 Pillar #3: Integration of Programs, Projects, and Studies

Critical to making decisions in a complex environment is the recognition that no single activity occurs in a vacuum or operates independently of other decisions and circumstances. While standard USACE procedures are required to consider possible futures with and without a proposed federal project, it is increasingly important that decisions for CSRM are evaluated and integrated with other ongoing planning and implementation processes. USACE, Miami-Dade County, and its partners have learned over decades of collaborative practice that siloed efforts can lead to unforeseen or even negative consequences.

The third pillar of the Framework is the integration of other relevant programs, projects, and studies that are currently being implemented or planned. Investments at the federal, state, county, and municipal levels should be considered and coordinated to minimize potential conflicts, and to complement other community resilience initiatives (**Figure 2-2**).

The County is highly supportive of ongoing efforts of the USACE Jacksonville District to integrate various studies/projects in the area including, but not limited to:

- CERP
- Biscayne Bay Southeastern Everglades Ecosystem Restoration (BBSEER)
- Central and Southern Florida (C&SF) System Section 216 Flood Resiliency Study

- Dade County Beach Coastal Storm Risk Management (CSRM) Project
- Key Biscayne Coastal Storm Risk Management (CSRM) Study
- Miami Harbor Improvement Navigation Project
- Local municipal projects and initiatives

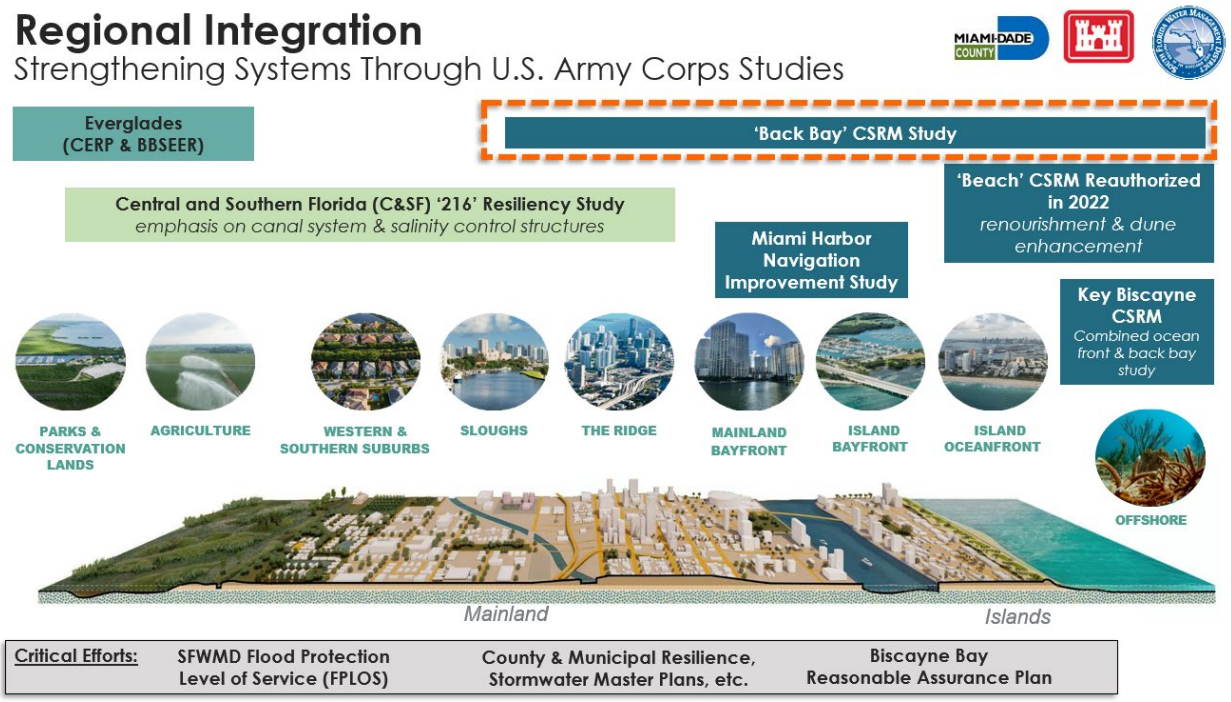


Figure 2-2. Multiple-Lines-of-Defense Concept Focused on Regional Integration.

Miami-Dade County desires to see further development of the integration efforts (e.g., definition of joint priorities, roles, structure, etc.) to include flood risk management and related resilience work of the SFWMD, Miami-Dade County, and 34 municipalities. As projects are advanced within initial focus areas of highest priority, the County and its partners may seek to integrate CSRM measures with other investments addressing broader community resilience issues through multi-jurisdictional programs such as Adaptation Action Areas (AAAs). Continued on-the-ground coordination and expanded community education and engagement led by Miami-Dade County can help facilitate effective integration across USACE, regional, and local efforts.

Finally, through evaluation and integration of comprehensive benefits defined by the four national accounts (National Economic Development, Regional Economic Development, Environmental Quality, and Other Social Effects), USACE and Miami-Dade County can further realize maximum net public benefits for communities, the economy, and sensitive biodiversity. Centering environmental justice communities as part of a more equitable plan formulation and stakeholder engagement process will lead to greater overall risk management and increase community resilience.

Engineer Research and Development Center Modeling

Coastal structures (such as those described in the Atlantic Coastline Alternative in Section 1.10) near Miami-Dade County, Florida, where coastal storm flooding and sea level change are potential risks to the

community, need to be modeled to assess their effectiveness. U.S. Army Engineer Research and Development Center (ERDC) Coastal and Hydraulics Laboratory (CHL), in partnership with the Norfolk District, USACE, will be analyzing impacts of these structures on coastal and inland inundation as well as on some environmental and navigation parameters. Potential areas for NBS are requested to be included as part of this modeling task, which may require refining the grid near the proposed locations, once available.

The Coastal Storm Modeling System (CSTORM-MS) will be used to evaluate storm surge and wave impacts for both without- and with-project conditions. A finite element numerical model will be developed for the study area to estimate the impact of the with-project design on non-storm hydrodynamics and environmental properties such as water surface elevation, depth, velocity patterns, salinity, and water exchange. The models will also be used to assess any storm surge barrier gate closure sequences from a system perspective. A back bay regional numerical model will be developed for the study area to determine the impact of the design on non-storm hydrodynamics and salinity transport. Analysis of the water surface elevation, depth, velocity patterns, salinity and water exchange results associated with the in-place with-project structures will be conducted. In addition, several water quality parameters will also be analyzed.

For CSRM features, this modeling will help determine:

- Feasibility design heights of structures and levels of flood risk management
- Any potential areas of induced coastal flooding from the inclusion of the CSRM features
- How different CSRM features work together as a system and their regional impacts to hydrodynamic conditions during storm events
- If they will adversely impact the circulation and water quality within the system under non-storm conditions

Analysis for storm conditions will provide details on changes, if any, to storm surge flood pathways and heights as well as wave heights in the surrounding area of the project. Impacts to storm surge and wave conditions from both the hardened structures, such as flood gates and tie-ins and sea walls, as well as potential NBS, will be possible from this modeling. Major flow canals/rivers, those at least 40 meters wide, can be included in the storm modeling and coordination with the C&SF Section 216 Study will help to inform the canal flows into the Biscayne Bay. Storm simulations will be performed using two sea level states to account for future sea level change. In general, the results will aid in determining the level of storm risk management and subsequent system recovery in a reasonable time frame.

3 EXISTING CONDITIONS

Under the Council for Environmental Quality (CEQ)'s National Environmental Policy Act (NEPA) regulations, federal agencies must analyze the potentially affected environment and evaluate the impacts of the proposed activity on the "affected environment" (40 Code of Federal Regulations [CFR] § 1501.3(b)). This section describes the affected environment for the Proposed Action to include the Recommended Plan (RP), Nature-Based Solutions Pilot Program (NBS Pilot Program), and the Nonstructural Program.

The Future Without Project (FWOP) condition represents the No Action Alternative as required by NEPA; Section 4 provides further detail.

3.1 Period of Analysis

The economic period of analysis for all the alternatives is a 50-year period from 2040 to 2089, and implementation is expected to begin potentially as early as 2027. The implementation period is the time frame that construction is expected, which would run from 2027 to 2040. The base year is the year the alternatives will have been implemented and benefits begin accruing, which is assumed to be 2040. Future damage was calculated out to the year 2089 to evaluate plan performance over 50 years.

The RP was assessed for engineering and environmental performance out to 100 years from project implementation, which is estimated to be the year 2139. This 100-year period for consideration of coastal sustainability follows U.S. Army Corps of Engineers (USACE) planning guidance as described in Engineer Pamphlet 1100-2-1: Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation (2019).

3.2 General Setting

Miami-Dade County is in the south Miami-Dade watershed, approximately 230 miles southeast of Orlando, Florida, and approximately 120 miles east of Naples, Florida. Miami-Dade County is bordered mostly by water, with Biscayne Bay in the center and the Atlantic Ocean to the east. The most populous county in Florida, Miami-Dade County, is home to 34 incorporated municipalities, cities, towns, and villages, as well as unincorporated communities and neighborhoods. Additional major water bodies that traverse Miami-Dade County include the Miami River and Little River, and the County also includes many canals and waterways.

As described in Section 1.10, Study Scope, the six Focus Areas for the RP are Biscayne Canal, Little River, Miami River, North Beach, South Beach, and Cutler Bay. The naming conventions for these Focus Areas are based on areas or municipalities nearby, but do not necessarily only or fully contain the area or municipality. For instance, the North Beach Focus Area covers the area of North Beach, which is a neighborhood in the City of Miami Beach, Florida, but it also contains areas of Miami Beach, Florida.

Miami-Dade County's built landscape spans more than 150 years. The Focus Areas include primarily residential buildings, but there are also many commercial buildings, industrial buildings, historic districts, Miami-Dade County–designated historic sites, and the roads and bridges that connect them all.

3.3 Natural Environment

This subsection describes aspects of the natural environment that the Proposed Action may affect. In accordance with CEQ regulations 40 CFR §§ 1501.3(b) and 1501.5, this subsection identifies resource areas in Miami-Dade County that are most relevant to the Proposed Action and have the potential for direct or indirect impacts. Land use and navigation are excluded from further consideration in this analysis because there would be no anticipated impacts to these resource areas.

3.3.1 Wildlife Resources and Terrestrial Habitats

3.3.1.1 Existing Conditions

For the following discussion, wildlife is limited to terrestrial species of invertebrates, amphibians, reptiles, birds, and mammals, and their associated upland habitats. Section 3.3.2 discusses terrestrial federally listed threatened and endangered species.

Terrestrial habitats in urban areas of Miami-Dade County are home to species tolerant to human activity and well adapted to such urbanized conditions. Mammals known to occur include small rodents, raccoons (*Procyon lotor*), opossum (*Didelphis virginiana*), and white-tailed deer (*Odocoileus virginianus*). Bird species that may be present include raptors, songbirds, and seabirds. Common amphibians that may be present include various species of toads, frogs, and salamanders. Various species of snakes, lizards, and terrapins are common reptiles that also may occupy these areas.

Because of the continued urbanization and development, ecosystems and habitats have been disrupted and/or lost. Miami-Dade County's Department of Regulatory and Economic Resources began administering the Environmentally Endangered Lands (EEL) Program in 1990 to protect these habitats unique to Southern Florida (Miami-Dade County 2022). The EEL Program aims to acquire, protect, and maintain lands that have been identified as environmentally endangered; these habitats include rockridge pineland, tropical hammock, and scrub habitats. Currently, the EEL Program, in conjunction with Miami-Dade County Parks, protects more than 23,500 acres of land, with approximately 5,500 acres of EEL that occur within the urban development boundary (Miami-Dade County 2022).

Coastal Barrier Resources

Congress passed the Coastal Barrier Resources Act (CBRA) in 1982 to encourage conservation of hurricane-prone, biologically rich coastal barriers. The CBRA prohibits most new federal expenditures that encourage development or modification of coastal barriers. Therefore, most new, or substantially improved, residences, businesses, or other development in the Coastal Barrier Resource System (CBRS) are not eligible for certain federal funding and financial assistance, including coverage under the National Flood Insurance Program (NFIP). Development can still occur within CBRS, as long as private developers or other nonfederal parties bear the full cost. More specifically, NFIP cannot provide flood insurance coverage for structures built or substantially improved after the area is designated as a CBRS unit (initial designations went into effect on October 1, 1983). The United States Fish and Wildlife Service (USFWS) maintains the boundary information for CBRS units. **Figure 3-1** presents CBRS mapped units in Miami-Dade County. The CBRS units denoted with a "P" identify Otherwise Protected Areas (OPA). Unlike mapped system units, the only prohibited federal expenditure in an OPA is on federal flood insurance.

Figure 3-1. Coastal Barrier Resources System Mapped Units in Miami-Dade County

Wetlands

The Clean Water Act (CWA) regulations define wetlands as, "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR § 328.3). The two major categories of wetlands are tidal (subject to the ebb and flow of tide) and nontidal (fresh water). Wetlands may be forested, scrub/shrub, or emergent. Wetlands play a critical role in a vast number of functions for any ecosystem where they naturally occur, which include water purification, ground water/aquifer recharge, retention of flood waters, fish and wildlife habitat, shoreline stabilization, protection from coastal erosion, and many more.

The CWA, 33 United States Code (U.S.C.) Section 1251 et seq., is the primary federal law that protects the nation's waters, including lakes, rivers, and coastal areas. The CWA prohibits all unpermitted discharge of any pollutant into any jurisdictional Waters of the United States, including wetlands. Section 404 of the CWA requires a permit for the dredging and/or filling of jurisdictional Waters of the United States, including wetlands. Section 401 of the CWA requires a state water quality certification for impacts to Waters of the United States, including wetlands and other special aquatic sites.

Wetlands are further protected by Executive Order (EO) 11990, Protection of Wetlands, which tasks federal agencies to take action to "minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands." USACE is required to avoid, minimize, and mitigate impacts to wetlands, pursuant to Sections 401 and 404 of CWA and EO 11990.

The Florida Administrative Code (FAC) also has a regulation, Chapter 18-18, The Biscayne Bay Aquatic Preserve, that manages and enforces any potential impact to Biscayne Bay Aquatic Preserve through a permitting process and restricts (aside from a few exceptions) any potential impacts past 18 inches of the existing sea wall along the shoreline of Biscayne Bay. Biscayne Bay is afforded special protections in accordance with its designation as an Outstanding Florida Water (OFW) according to FAC 62-302.700.

Biscayne Bay is a shallow, subtropical estuary on the southeastern coast of Florida primarily within Miami-Dade County. The Bay can be divided into four major areas: North Bay, Central Bay, South Bay, and Card and Barnes Sounds. Each of the four areas has distinct physical and ecological characteristics. The Bay is hydrologically connected to the Greater Everglades ecosystem, historically, through tributaries, sloughs, and ground water flow and, beginning in the 20th century, through conveyance canals. The adjacent urban development heavily impacts the area along Biscayne Bay from the Broward County line through the City of Miami. Development along Biscayne Bay south of the City of Miami grades from suburban to agricultural to park land, where much of the natural mangrove wetlands near the Cutler Bay area are still intact along the western shore and eastern barrier islands as a part of Biscayne National Park.

Freshwater wetlands occur throughout Miami-Dade County, particularly in the western and southern parts of the County. Freshwater wetlands are a major element of the South Florida landscape, though they have been reduced to half of their original extent (Miami-Dade County 2013). The largest freshwater wetlands in Florida is the Everglades.

The western extent of the Cutler Bay area of Miami-Dade County is characterized by palustrine wetlands, which include nontidal wetlands and wetlands that occur in tidal areas where salinity is less than 0.5 parts per thousand (ppt). Palustrine forested wetlands, characterized by 6-meter or taller woody vegetation, are also present. The Cutler Bay area also includes partly drained wetlands that have experienced hydrologic alteration or are connected/associated with ditches; however, the soil moisture remains sufficient to support wetland plants. Estuarine scrub-shrub wetlands are also present and may include species such as Gulf cordgrass (*Spartina spartinae), s*aw grass, *(Cladium jamaicense),* and sea oxeye daisy *(Borrichia frutescens)*. Mangrove wetlands primarily characterize the easternmost extent of the Cutler Bay wetlands.

Mangroves

The mangroves in the Cutler Bay area, and throughout South Florida in general, consist of the red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*). The roots of most red mangrove–dominated wetlands are either fully submerged in water or inundated daily with the tidal cycle. They are an important habitat for wildlife, both above and below the water. The prop roots of the red mangrove serve as nursery areas to many commercially and recreationally important fin and shellfish aquatic species. Above the water, they are critical nesting, resting, and feeding sites for birds of prey, wading birds, and migratory birds. Black and white mangroves are typically found further inland in coastal wetlands with the white mangroves occurring the furthest inland. Green buttonwood trees (*Conocarpus erectus*) are sometimes intermingled with black and/or white mangrove species; however, usually, buttonwood is found near the transitional wetland/upland border (Miami-Dade 2014).

Mangrove wetlands are highly valuable and high-functioning wetlands. They range from tall, coastal forest to low, dense scrub communities, with each variety providing different physical habitats, niches, microclimates, and food sources for a diverse assemblage of animals (National Oceanic and Atmospheric Administration [NOAA] Office of National Marine Sanctuaries 2019). Mangrove forests help to stabilize coastlines and reduce erosion from storm surge, currents, waves, tides, and hurricane damage (NOAA Office of National Marine Sanctuaries 2019). Mangrove communities along the coastal areas of Biscayne Bay stabilize bottom sediments and protect shorelines from erosion and storm surge (Miami-Dade 2014). These communities can also help to potentially reduce the damage to upland areas from hurricanes. They also slow down and filter runoff, which aids in improved water quality. Mangrove wetlands have drastically reduced in size because of the increased development in and around Miami-Dade County over the years. However, in 1996, the State of Florida passed the Florida State Mangrove Trimming and Preservation Act, which limits the removal and trimming of mangroves on both public and private property.

Mangroves, salt marshes, and seagrass beds reduce the effects of climate change by capturing carbon dioxide from the atmosphere (carbon sequestration) and by storing carbon in plant material or sediments (NOAA 2024a). The carbon stored in the vegetation and soils of saltwater ecosystems is referred to as coastal blue carbon (Scott and Lindsey 2022). Most coastal blue carbon is stored primarily in the soil (NOAA 2024a).

Biscayne National Park

Biscayne National Park encompasses approximately 270 square miles and is the largest marine park in the National Park system. It encompasses a diversity of marine and estuarine habitats extending from the

mangrove forests along the coast and out into Biscayne Bay where hard bottom and coral communities and seagrass meadows can be found. Biscayne National Park boasts exceptional recreational opportunities from boating and kayaking to snorkeling/diving along the Maritime Heritage Trail to explore the remains of shipwrecks found in the park.

Seagrasses/Submerged Aquatic Vegetation

Seagrasses are a type of submerged aquatic vegetation occurring throughout the soft bottom, shallow-water areas within Biscayne Bay and its surrounding tributaries wherever water quality allows adequate light penetration to enable photosynthesis. Seagrass communities provide a range of ecosystem services, including stabilizing the bottom through their dense roots and rhizomes and helping to maintain water clarity by trapping fine sediments and other particles in their leaves and root systems. Seagrasses also play a major role in benthic community health and serve as a shelter, feeding grounds, and a nursery habitat for marine life.

3.3.1.2 Existing Conditions

In accordance with the Endangered Species Act (ESA) of 1973, 16 U.S.C. § 1531 et seq., an "endangered species" is any plant or animal species in danger of extinction throughout all or a significant portion of its range (16 U.S.C. § 1532(6)). A "threatened species" is any species likely to become an endangered species in the foreseeable future throughout all or a significant part of its range (Id. at § 1532(20)). Section 3 of the ESA defines critical habitat as specific areas essential for the conservation of a federally threatened or endangered species and that may require special management and protection (Id. at § 1532(5)). The ESA establishes the conservation of species that are listed as endangered or threatened throughout all or a significant portion of their range and the conservation of habitats upon which they depend. The law also prohibits any action that causes a "taking" of any listed species of endangered fish or wildlife unless otherwise authorized by the USFWS or National Marine Fisheries Service (NMFS). As defined in 50 CFR § 402.02, the Action Area includes all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action. The Action Area for the RP includes the footprint of individual structures (to which direct modifications would occur), and lawns, driveways, and parking areas immediately surrounding the buildings (including critical infrastructure [CI] facilities) where temporary laydown areas for materials would occur. Future NEPA documentation will define the Action Area for the NBS Pilot Program and the Nonstructural Program when specific locations have been determined.

The Fish and Wildlife Coordination Act (FWCA) requires USACE to coordinate with USFWS and Florida Fish and Wildlife Conservation Commission (FWC) on water resources–related projects with respect to the potential impacts resulting from projects on fish and wildlife resources.

Protected species under the jurisdiction of USFWS that may be present in the study area for the RP, but would not be affected by the RP, are listed in the Biological Assessment included in Appendix A-3. There are no measures included in the RP that are proposed in water or that would have in-water impacts; therefore, there are no effects to trust resources under the jurisdiction of the NMFS, and they are not discussed further in Section 7.3.

Following is detailed biological information on the Florida bonneted bat (*Eumops floridanus*) as it relates to the Action Area for the RP. The Florida bonneted bat is listed as federally endangered. With a very small

geographic range, the Florida bonneted bat is threatened primarily by loss of habitat; however, natural disasters also pose a threat to this species (FWC 2024).

Natural roosting habitats used by the Florida bonneted bat include tall, mature trees (live or dead) that may have cavities, crevices, or loose bark. Natural roosting habitat includes natural forest types, such as flatwoods, pine rocklands, and mixed or hardwood hammocks. The Florida bonneted bat is also known to roost in artificial structures such as buildings, bat houses, and bridges (USFWS 2019). Data collected from two telemetry efforts conducted in the 1990s in Coral Gables suggest that Florida bonneted bats also roost in chimneys (Gore et al. 2015).

The Action Area for the RP does not contain natural roosting habitat because there are no forested areas where project activities would be occurring. However, the RP involves modifications to existing residential buildings and nonresidential structures; therefore, there is artificial roosting habitat in the Action Area. Webb et al. (2021) document the history of building use by Florida bonneted bats in Miami, noting that of the buildings used, many have Mediterranean Revival architecture, which may attract Florida bonneted bats. Webb et al. (2021) further state that the Miami region is currently the only area within their range where Florida bonneted bats have reportedly roosted in buildings.

Foraging requirements of the Florida bonneted bat include natural water sources such as open fresh water and wetlands. In urban and residential areas, drinking water and foraging habitat may be present in distinct seminatural habitats. The habitat in the Action Area for the RP comprises a dense, highly populated urban landscape. Nonstructural Focus Areas consist of residential neighborhoods and nonresidential buildings. In urban and residential areas, suitable foraging habitat for the Florida bonneted bat can be found in parking lots and other small patches of natural habitat. Seminatural habitat present in the Action Area may also include residential lawns and existing trees. Foraging habitat in the Action Area for the Florida bonneted bat includes artificial structures such as bat houses, buildings, and utility poles.

State Listed Species

The State of Florida's Endangered and Threatened Species List includes federally listed species. The Florida Endangered and Threatened Species List includes additional species specifically designated by FWC as state-designated threatened species and are listed in the Florida Administrative Rule 68A-27.003.

Migratory Birds

Migratory birds nest throughout North America, some as far north as the Arctic. In late summer and fall, they migrate south for the winter. Some winter in the southern United States, Mexico, the Caribbean, or Central America while others go as far as South America. Then, each spring they return north to their breeding grounds. The Migratory Bird Treaty Act (MBTA), 16 U.S.C. § 703 et seq., and EO 13186 require federal agencies to protect and conserve migratory birds and their habitats. Any activity that results in the take of migratory birds or eagles is prohibited unless otherwise authorized by USFWS in accordance with the MBTA. Most birds native (naturally occurring) to the United States are protected by MBTA, provided the species meets the criteria designated in MBTA.

The Bald and Golden Eagle Protection Act, 16 U.S.C. § 668 et seq., is a federal law that protects bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*). Coordination with USFWS is required

under the Bald and Golden Eagle Protection Act if a proposed federal action might impact bald or golden eagles. The USFWS National Bald Eagle Management Guidelines (2007) provide general recommendations for land management practices that will benefit bald eagles, describe the potential for various human activities that disturb bald eagles, and encourage land management practices that benefit bald eagles.

The FWC maintains records on historical bald eagle nesting areas from 1998 to 2017. The FWC maintains a partnership with Audubon Florida through its EagleWatch Program. The Audubon's EagleWatch is a community program sponsored by the Audubon Center for Birds of Prey, which tracks active bald eagle nests, provides population trends, and improves nesting activity awareness toward the protection of this species. According to the EagleWatch's current nesting data, there are several bald eagle nests documented as occupied for the 2023 season throughout Miami-Dade County.

3.4 Physical Environment

3.4.1 Geology, Topography, and Soils

3.4.1.1 Existing Conditions

Miami-Dade County is approximately 6 feet (1.8 meters) above sea level. It is rather new geologically and is at the eastern edge of the Florida Platform, a carbonate plateau created millions of years ago. Miami-Dade County is mostly characterized by Qm (Miami limestone), which is white to gray limestone, variably fossiliferous, oolitic, and pellatal (Florida Geologic Survey 1993). The surface bedrock under the Miami area is called Miami oolite or Miami limestone. This bedrock is up to 50 feet thick and covered by a thin layer of soil. Miami limestone formed as the result of the drastic changes in sea level associated with recent glaciations or ice ages. Florida has hundreds to thousands of feet of limestone under it because the geology of Florida formed under the ocean, and Florida's geologic strata are divided into formations (Florida Department of Environmental Protection [FDEP] 2024a).

There are two kinds of calcareous soils in Miami-Dade County: rocky or gravelly soils and marl soils (University of Florida [UF] 2001). The rocky soils have rapid drainage and exist in areas with rocky pinelands that are typically at a higher elevation (UF 2001). The texture of calcareous soils is characterized by being sandy, loamy, or gravelly, and soil depths range from inches to feet (UF 2001). Calcareous soils are important for agriculture, so management of nutrients is important to crop production on calcareous soils (UF 2001). The marl soils are typically at a lower elevation in South Florida than calcareous soils. The drainage of marl soils is poor or very poor and is affected by the modern drainage system in Miami-Dade County (UF 2001).

The Biscayne aquifer is the main aquifer source, including potable water, for all of Miami-Dade and Broward Counties. Because of the geology of Miami-Dade County (mostly Miami limestone), the Biscayne aquifer is highly permeable and lies at shallow depths throughout the County within the underlying bedrock and overlying surficial soils (United States Geological Survey [USGS] 1990). The Biscayne aquifer is prone to saltwater intrusion because of its proximity to saltwater sources, its low land–surface altitude, and topography (Prinos et al. 2014). The Biscayne aquifer and the gray limestone aquifer make up the surficial aquifer system, and both aquifers are characterized by highly porous, karstic limestone (Prinos et al. 2014). The hydrogeology of the Biscayne aquifer is complex. Numerous factors, including the porosity of the limestone, influence saltwater intrusion in the Biscayne aquifer. Because of the shallow, karstic

limestone of the aquifer, the water table can occur near the land surface and may exceed the land surface during periods of wet weather (Prinos and Dixon 2016).

The Floridan aquifer system underlies the shallow, surficial aquifer system. The surficial aquifer system separates the system by alternating layers of sand, silt, and clay, which prevents groundwater movement between the two aquifer systems (Hughes and White 2016).

3.4.2 Bathymetry, Hydrology, and Tidal Processes

3.4.2.1 Existing Conditions

Bathymetry is the configuration of the bottom of a waterway or water body and can influence the hydrology and hydraulics of a system. Hydrology is the science that deals with the properties, circulation, and distribution of water on and under the surface of the earth and in the atmosphere from the moment of precipitation until it returns to the atmosphere through evapotranspiration or is discharged into the ocean.

Tides occurring in the region experience semidiurnal tides, with two high and two low tides each day. The timing and height of the tides vary over the month with the position of the moon relative to the earth. The typical tidal range between low and high tides in local waters is approximately 1.65 feet, though this can range much higher during storm events and king tides. In southeast Florida, tidal flooding commonly occurs during extreme high tides, which is often referred to as “sunny-day flooding.” These tides are often associated with a full or new moon, when the combined gravitational pull of the sun and moon drives tides slightly higher and lower than normal. Several times a year, when the moon is closest to the earth, this phenomenon is amplified, and a king tide occurs. The more than 15 inches of sea level change projected for Miami-Dade County by mid-century, based on the intermediate-high curve from the global mean sea level from the 2014 National Climate Assessment, on top of these normal tidal variations, will mean that tides may reach further inland and cause flooding with greater frequency (Spanger-Siegfried et al. 2014).

Seasonal rainfall patterns occurring in Miami-Dade County generally include higher average rainfall during the warmer months of the year, which also coincides with the hurricane season that begins on June 1 and ends on November 30. After a rainfall event, a series of interconnected canals and water management structures, which make up the Central and Southern Florida (C&SF) Project that the South Florida Water Management District (SFWMD) operates and maintains, are used to convey floodwaters that discharge water into Biscayne Bay. During some high tides the sea level can rise higher than water levels in the canals; the canals are increasingly unable to alleviate flooding. The SFWMD implements the Flood Protection Level of Service Program to prioritize infrastructure improvements and ensure the level of service within basins can be maintained long term, to ensure resilience of the system to extreme weather events, such as hurricanes, floods, and droughts.

The network of drainage canals completed during the second half of the 20th century has greatly altered the distribution of freshwater within the watershed, as well as the quantity, quality, and timing of freshwater discharges to Biscayne Bay (Larsen 1995). Much of the urban and agricultural development that has occurred since the 1900s in southeast Florida can be attributed to the surface water system of

canals. The canal system was originally put in place to provide drainage but was subsequently enhanced to serve the additional functions of flood and salinity-intrusion control.

3.4.3 Water Quality

3.4.3.1 Existing Conditions

Water quality describes the chemical and physical composition of water as affected by natural conditions and human activities. Impacts on water resources can also influence other issues such as land use, biological resources, socioeconomics, public safety, and environmental justice. The United States Environmental Protection Agency (USEPA) is responsible for administering the water quality requirements of CWA. Section 303(d) of CWA requires all states to identify waters that do not meet, or are not expected to meet, applicable water quality standards. States must develop a total maximum daily load (TMDL) for each pollutant that contributes to the impairment of a listed water body. The FDEP is responsible for ensuring that TMDLs are developed for impaired surface waters in Florida.

Florida's surface water quality standards system is published in FAC Chapter 62-302. The components of this system include classifications, criteria (including site-specific criteria), an anti-degradation policy, and special protection of certain waters (e.g., OFW). The State of Florida recognized the importance of surface water quality and its present overall condition when it designated the surface waters of Biscayne Bay an OFW. This designation provides for the highest levels of protection to assist in maintaining the quality of its waters.

Most of Biscayne Bay is less than 6 feet in depth, with a maximum depth of only about 16 feet. Within the Bay, local tidal forcing is an important force driving flows throughout Biscayne Bay. Wind is a secondary factor, moving deeper waters in the Bay and having an impact on water residence time, depending on speed and direction of the wind. The water quality and supported habitats in some portions of Biscayne Bay and adjunct tidal tributaries exhibit signs of human impact. Excess nutrients may lead to algal blooms that reduce water clarity, damage seagrass, and reduce the ecological health of the Bay. A recent study (Millette et al. 2019) examined eutrophication trends over time (1995 to 2014) in Biscayne Bay and concluded that chlorophyll *a* concentrations throughout the northern area, where circulation is restricted, and in nearshore areas of central Biscayne Bay are increasing at a higher rate compared to the rest of the Bay. "This suggests increases in chlorophyll *a* are due to local nutrient sources from the watershed. These areas are also where recent seagrass die-offs have occurred, suggesting an urgent need for management intervention." Untreated stormwater runoff often contaminated with bacteria and nutrients from agricultural operations and other sources, such as lawn fertilizer, also cause such conditions. Conditions such as these have played a role in the occurrence of three unprecedented algal blooms in the last decade in Biscayne Bay, and two of these blooms have caused significant harm to the seagrass community.

Approximately 120,000 properties in Miami-Dade County remain on septic systems instead of connected to sewage treatment facilities. Septic systems are vulnerable to failure. Rising groundwater presents risks to public health and the health of the Biscayne Bay ecosystem because of the potential water quality impacts associated with nutrient loading and excess bacteria, which serves as an indicator of sewage contamination. Miami-Dade County implemented a program, Connect 2 Protect, to provide residents the opportunity to connect to sanitary sewer services. The County continues to undertake efforts to better

understand the scale and extent of vulnerable systems and prioritize the connection of septic systems to the sewer system.

Portions of several canals in urbanized areas of Miami-Dade County do not meet one or more water quality criteria, and the State of Florida has designated these as "impaired." Discharge points from canals are areas particularly prone to alterations in water quality, such as salinity, pathogens, and nutrients that can cause eutrophication and lower salinity, especially near canal outfalls. Water quality declines have been the most severe and submerged aquatic vegetation (SAV) die-off has been the most extensive in the restricted northern Bay region and the south-central region, where there are a number of canal outfalls along a relatively short segment of Bay shoreline (Millette et al. 2019).

3.4.4 Floodplains

3.4.4.1 Existing Conditions

Through EO 11988, Floodplain Management, as amended by EO 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input, federal agencies are required to evaluate all proposed actions within the one percent annual chance floodplain or base floodplain as defined by Federal Emergency Management Agency (FEMA). The 0.2-percent annual chance floodplain is applied to critical actions. Actions include any federal activity involving 1) acquiring, managing, and disposing of federal land and facilities; 2) providing federally undertaken, financed, or assisted construction and improvements; 3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning and licensing activities. A critical action includes any activity for which even a slight chance of flooding would be too great. USACE implements EO 11988 through an eight-step planning process when evaluating proposed actions within or affecting the one percent annual chance floodplain or the 0.2-percent annual chance floodplain for critical actions. The eight steps and project-specific responses to them are summarized below.

1. Determine if the Proposed Action is in the base floodplain (the area that has a one percent or greater chance of flooding in any given year).
    - The Proposed Action is within the base floodplain.
2. If the action is in the base floodplain, identify and evaluate practicable alternatives to the action or to location of the action in the base floodplain.
    - Practicable measures and alternatives were formulated and evaluated using USACE guidance, including nonstructural measures such as floodproofing and elevations.
3. If the action must be in the floodplain, advise the general public in the affected area and obtain their views and comments.
    - Plan formulation was completed via charrettes and workshops with stakeholders and the public. The team hosted multiple public meetings and engagement opportunities, and the draft Integrated Feasibility Report and Environmental Assessment (IFR/EA) was released for public review and coordinated with agency officials.
4. Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial floodplain values. Where actions proposed to be located outside the base

floodplain will affect the base floodplain, impacts resulting from these actions should also be identified.

- The project would not alter or impact the natural or beneficial floodplain values. Nonstructural measures would impact existing structures and prevent or minimize future damages to those structures. No additional land located in the floodplain would be disturbed. The Proposed Action would not affect the timing or magnitude of flooding in downstream reaches.

5. If the action is likely to induce development in the base floodplain, determine whether a practicable non-floodplain alternative for the development exists.

    - The Proposed Action would not encourage additional development in the floodplain, because all properties available for development have been developed. The project provides benefits solely for existing development.

6. As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial floodplain values. This should include reevaluation of the No Action Alternative.

    - The Proposed Action would not induce development in the floodplain. Sections 4 and 8 of this report summarizes the alternative identification, screening, and selection process. The plan formulation phase included the No Action Alternative.

7. If the final determination is made that no practicable alternative exists to locating the action in the floodplain, advise the general public in the affected area of the findings.

    - The team hosted multiple public meetings and engagement opportunities throughout the plan formulation and report development process, and the draft IFR/EA was released for public review. No practicable alternatives were found to locating the action in the floodplain.

8. The plan most responsive to the planning objectives established by the study and consistent with the requirements of the EO 11988 must be recommended.

    - Alternative 4 as described in Sections 8 and 9 is the RP and the plan that is most responsive to the study planning objectives to manage coastal storm risk to vulnerable communities and existing infrastructure in Miami-Dade County.

EO 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input, was issued to improve the nation's resilience to current and future flood risks, which are anticipated to increase over time because of the effects of climate change. Federal agencies are required to expand management from the one percent annual chance elevation to a higher vertical flood elevation and corresponding horizontal floodplain for federally funded projects. Federally funded projects include new construction, substantial improvement, or to address substantial damage to structures (a walled and roofed building, including a gas or liquid storage tank) and facilities (any human-made or human-placed item other than a structure, e.g., bridge, road). FEMA's threshold for substantial improvement or substantial damage to a building is 50 percent or greater than the market value of the

building, but agencies can set their own requirements. Agencies can also use higher standards for actions that they determine to be critical actions. The EO identifies three approaches for addressing a higher vertical elevation and corresponding horizontal floodplain: climate-informed science, additional freeboard height above the one percent annual chance flood elevation (two feet for noncritical actions and 3 feet for critical actions), or the 0.2 percent annual chance flood elevation.

The effective FEMA Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRM) for Miami-Dade County and incorporated areas are dated September 11, 2009. All or most of the land area shown within each Focus Area is located within the one percent annual chance floodplain (AEP) (**Figure 3-2**). For the Focus Area communities, the initial FEMA FIRMs were produced in September 1972. Almost half of the existing buildings within the County were built before 1973, when comprehensive floodplain management programs and regulations were not in place (Miami-Dade County 2020). Many buildings within the County were built with slab-on-grade construction or with a raised slab using stem walls. For the Focus Areas, one percent annual chance flood elevations generally range from four to ten feet, North American Vertical Datum of 1988 (NAVD88), and estimated flood depths from one to six feet.

The effective 2009 FIS and FIRMs have been revised. The preliminary FIS and FIRMs, dated February 25, 2021, are currently going through public review and are available from FEMA's Map Service Center. Preliminary FEMA flood hazard data provide the public an early look at the projected risk identified by an in-progress flood hazard study. Preliminary products are not final and are subject to change.

Engineering Appendix A-1 provides design stillwater levels at different AEPs and discusses how sea level change is applied over the design period. This effort is in alignment with EO 13690 by using a climate-informed science approach for project resilience.

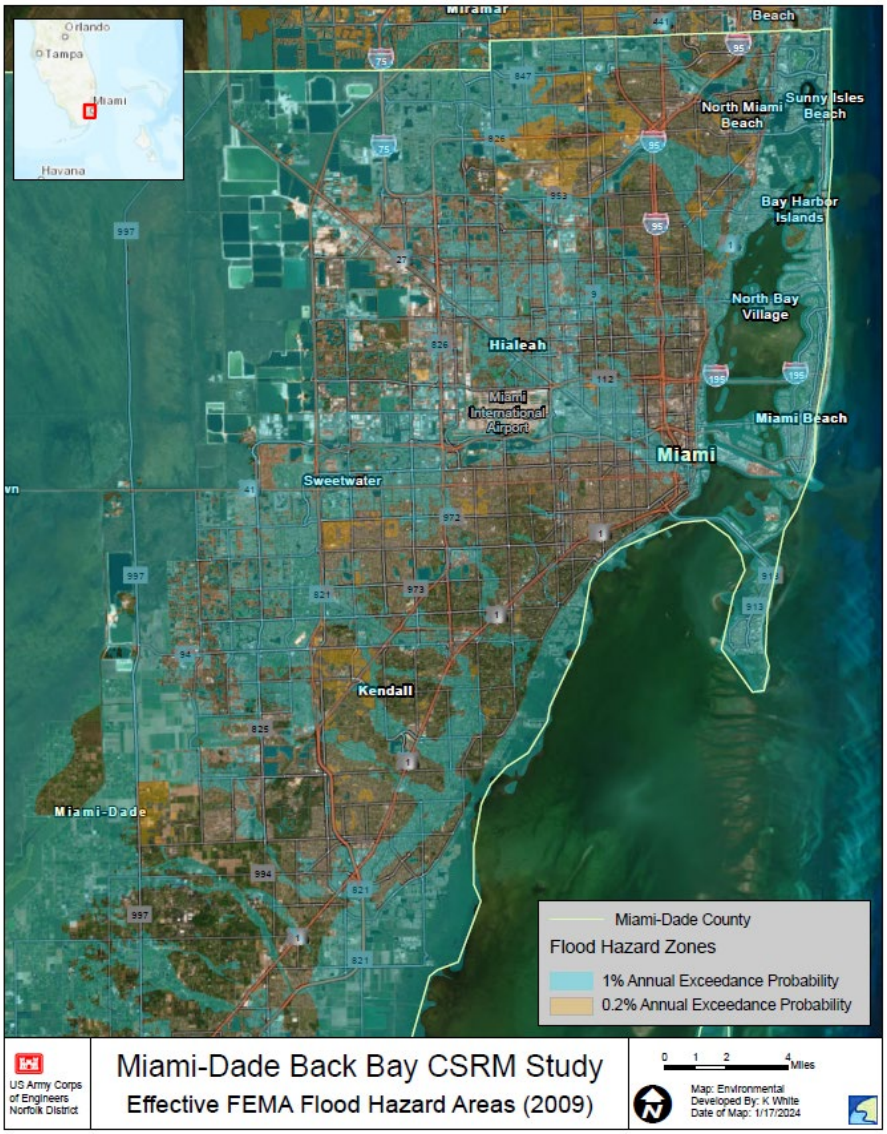


Figure 3-2. Flood Hazard Zones in Miami-Dade County

As part of its long-term strategy for building resilience, Miami-Dade County has identified AAAs, which are defined by the Florida legislature as a "designation in the coastal management element of a local government's comprehensive plan which identifies one or more areas that experience coastal flooding due to extreme high tides and storm surge, and that are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure needs and adaptation planning" (Florida Statutes § 163.3164(1)). AAA plans foster planning efforts in communities with immediate climate-related needs and build community partnerships that promote infrastructure investments to meet the specific needs of those communities.

In January 2022, Miami-Dade County completed its Adaptation Plan for the Little River AAA. The study area encompasses multiple jurisdictions near the Little River closest to Biscayne Bay and includes the Village of El Portal, the northern edge of the City of Miami, and two areas of unincorporated Miami-Dade

County. Collectively, these low-lying areas are prone to flooding from multiple flood drivers exacerbated by sea level change. The Adaptation Plan aligns research, data, and planned projects, and promotes community-level engagement to identify values, challenges, projects, and policies. The Adaptation Plan provides a path forward for existing and planned projects and policy changes needed to achieve its objectives toward an equitable adaptation planning effort. These efforts are also part of the broader Resilient305 Strategy, developed jointly by Miami-Dade County, the City of Miami, and the City of Miami Beach (Greater Miami & the Beaches 2019). The Resilient305 Strategy aims to improve climate resilience by addressing vulnerabilities and current challenges through actionable projects implemented through intergovernmental and community collaborative efforts.

3.4.5 Cultural Resources

3.4.5.1 Existing Conditions

Several federal laws and regulations have been established to manage cultural resources, including the National Historic Preservation Act (NHPA) and its implementing regulations at 36 CFR Part 800, the Archeological and Historic Preservation Act, the American Indian Religious Freedom Act, the Archaeological Resource Protection Act, and the Native American Graves Protection and Repatriation Act. In addition, Department of Defense Instruction (DoDI) 4710.02, Department of Defense Interactions with Federally Recognized Tribes (2006), governs DoD interactions with federally recognized tribes. EO 13175, Consultation and Coordination with Indian Governments (updated 2018), charges federal departments and agencies with regular and meaningful consultation with Native American tribal officials in the development of policies that have tribal implications. More recent guidance for consulting with tribal officials is contained in the Presidential Memorandum on Tribal Consultation and Strengthening Nation to Nation Relationships, dated January 26, 2021, Presidential Memorandum on Uniform Standards for Tribal Consultation, dated November 30, 2022, and the December 2023 USACE Civil Works Tribal Consultation Policy.

Other laws, regulations, EOs, and policies that protect and preserve historic resources under the jurisdiction of USACE include:

- Public Law 74-292 Historic Sites Act of 1935, and Implementing Regulations
- 36 CFR Part 65 National Historic Landmarks Program
- 36 CFR Part 60 National Register of Historic Places
- 36 CFR Part 67 The Secretary of the Interior's Standards for Rehabilitation
- 36 CFR Part 68 The Secretary of the Interior's Standards for Preservation Projects
- 36 CFR Part 79 Curation of Federally Owned Archaeological Resources
- 36 CFR Part 800 Protection of Historic and Cultural Properties

- Public Law 91-190 National Environmental Policy Act of 1969
- 32 CFR Part 229 Protection of Archaeological Resources
- 43 CFR Part 7 Protection of Archaeological Resources, Uniform Regulations and Department of the Interior Supplemental Regulations
- EO 11593 (1971) Protection and Enhancement of the Cultural Environment
- EO 13007 (1996) Indian Sacred Sites

Cultural resources include buildings, structures, objects sites and districts of varying types such as landscapes, locations of important historical events, or traditional cultural places. To be considered significant, a cultural resource must meet one or more of the following National Register of Historic Places (NRHP) criteria:

"The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and (a) that are associated with events that have made a significant contribution to the broad patterns of our history; or (b) that are associated with the lives of persons significant in our past; or (c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or (d) that have yielded, or may be likely to yield, information important in prehistory or history" (36 CFR § 60.4).

Cultural resources determined eligible for listing in the NRHP are referred to as "historic properties." Regulations at 36 CFR § 800.14(b)(ii) authorize federal agencies to develop programmatic agreements when effects on historic properties cannot be fully determined prior to approval of an undertaking. The signed 2021 Programmatic Agreement (PA) among USACE, Florida State Historic Preservation Officer, the Bureau of Ocean Energy Management, and the Advisory Council on Historic Preservation Regarding Compliance with Section 106 of the National Historic Preservation Act During Implementation of the United States Army Corps of Engineers, Jacksonville District Operations, Navigation, and Shore Protection Programs establishes a phased review process that governs how this project will take into account effects on historic properties. Pursuant to Stipulation V of that PA, USACE will consider effects on historic properties later in the more detailed design phases (Preconstruction Engineering and Design [PED] Phase) requiring establishment of the area of potential effects, identification of potential historic properties through intensive survey, making findings of effect, and developing treatment. It is likely the various phases of the project could have direct and indirect effects (including visual impacts) to historic properties, if present.

The PA does not apply to undertakings on tribal lands or project impacts to cultural resources on tribal land; in that case, consultation would be conducted according to 36 CFR Part 800. West of Hialeah is Miccosukee Indian Tribe land (Miami-Dade County 2024).

Recorded Historic Resources in Miami-Dade County

In lieu of having a refined area of potential effects (APE) for project undertakings, a brief overview of known historic resources, provided by the Florida Division of Historical Resources as of December 2023, is summarized for Miami-Dade County to provide context. The entire county has not been surveyed for cultural resources; therefore, this summary is not representative of the total frequency or distribution of cultural resources that may be present. There are 192 NRHP-listed properties in Miami-Dade County (**Figure 3-3**). This number includes seven National Historic Landmarks, archaeological sites, buildings, structures, objects, and historic districts. It does not include properties contributing to historic districts. There are 648 archaeological sites in the County. Most of these are prehistoric Native American sites, with many shell middens, but also 274 burial mounds, along with other burials, platform mounds, earthworks, and habitation sites. Of the archaeological sites recorded, but not already NRHP listed, 155 are considered eligible, 37 are considered potentially eligible or having insufficient information to evaluate, and 118 have been evaluated as ineligible. Seventy-three of the sites include human remains.

Extensive historic architectural survey in Miami-Dade County has been completed with 15,455 buildings surveyed (**Figure 3-4**). Of these, 605 are considered eligible for the NRHP (including as contributing to districts), 145 are considered likely eligible, 10,093 have either insufficient information or no evaluation, and 4,612 are evaluated as ineligible. A total of 198 bridges have been surveyed, with 47 considered NRHP eligible, 40 not evaluated, and 111 not eligible. Two cemeteries, the City of Miami Cemetery and the Lincoln Memorial Park Cemetery, are considered NRHP eligible.

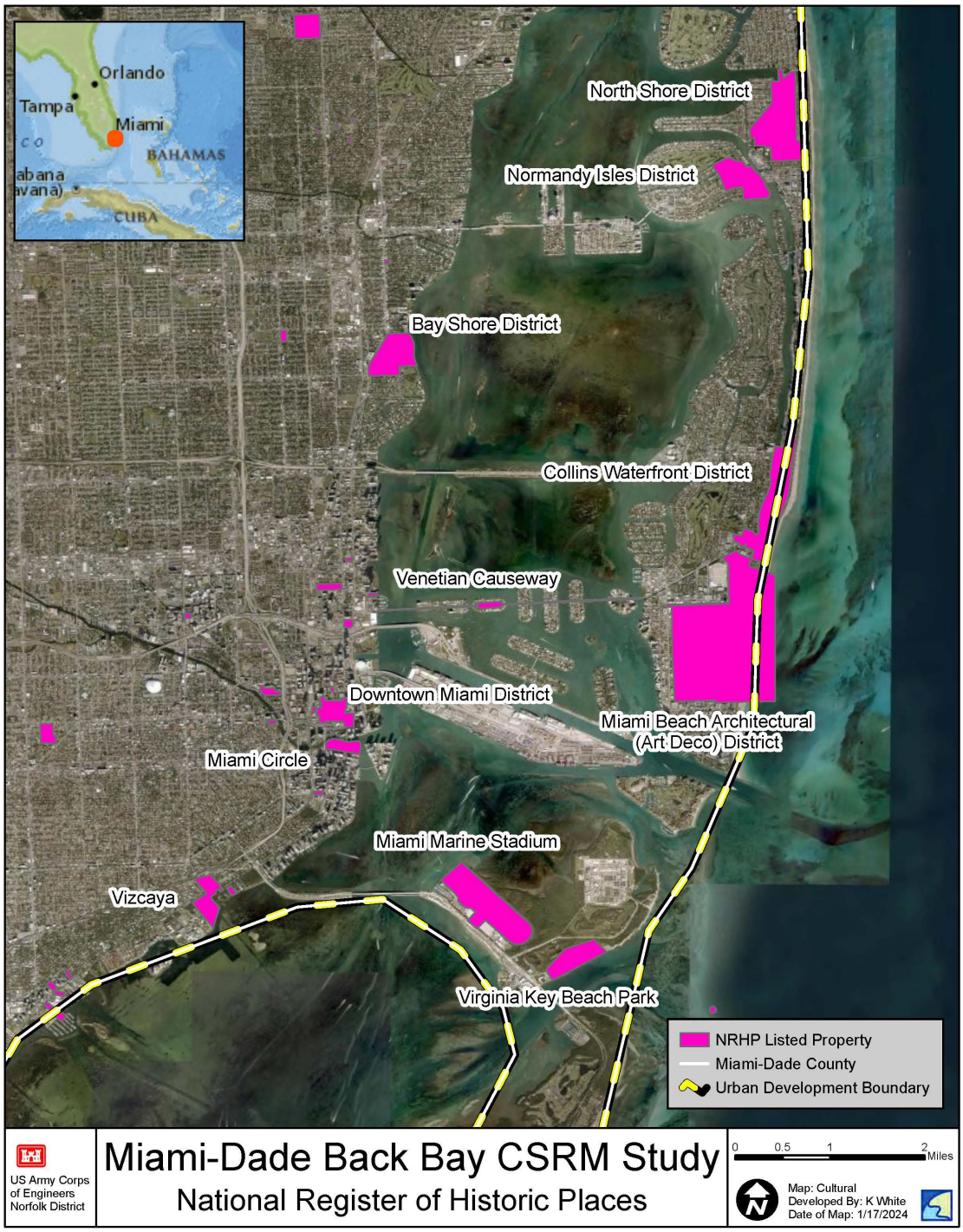


Figure 3-3. National Register of Historic Places–Listed Properties in the Miami Area

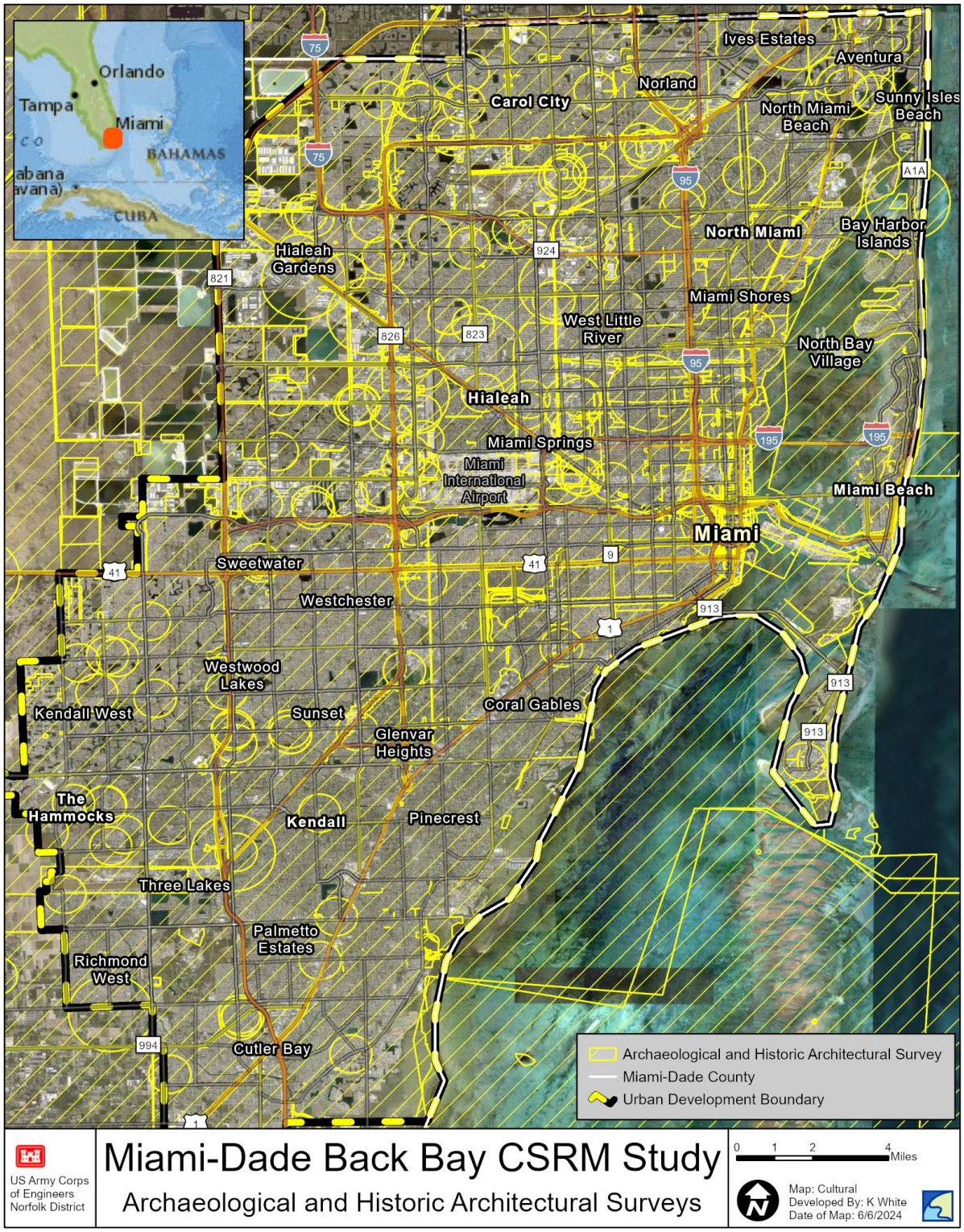


Figure 3-4. Archaeological and Historic Architectural Surveys in Miami-Dade County

3.4.6 Aesthetics and Visual Resources

3.4.6.1 Existing Conditions

Visual resources are the natural and human-made features that make up the visual qualities of a given area, or "viewshed." These features form the overall impression that an observer receives of an area or its landscape character. Topography, water, vegetation, human-made features, and the degree of panoramic view available are examples of visual characteristics of an area. Section 3.4.5, Cultural Resources, evaluate visual impacts to historic properties.

Visual resources are subjective by nature; therefore, the level of the proposed project's visual impacts can be challenging to quantify. Generally, projects that create a high level of contrast to the existing visual character of a project setting are more likely to generate adverse visual impacts because of visual incompatibility. Thus, it is important to assess project effects relative to the existing conditions of the area. Within a discrete viewshed, an individual's visual perception is a function of the area's spatial properties, visual content, and an individual's previous experiences. Actions that would modify the landscape can alter the visual character of an area.

The general visual landscape of the study area can be described as mostly urban, with a network of parks and associated waterways, including various rivers and canals. Among the dominant features in the visual landscape is the extensive transportation network within Miami-Dade County. This network includes, but is not limited to, railroads, highways, bridges, causeways, seaports, freight facilities and their connecting waterways, transit facilities, and airports (both civilian and military). Within the city there are parks and green spaces, even though a large amount of the city has been hard structured through development.

3.4.7 Air Quality

3.4.7.1 Existing Conditions

To protect the overall health and well-being of the public and to prevent further damage to the environment, Congress established the Clean Air Act (CAA), which requires USEPA to set and implement the National Ambient Air Quality Standards (NAAQS) for six criteria pollutants: ozone, particulate matter, nitrogen dioxide, sulfur dioxide, carbon monoxide, and lead (42 U.S.C. § 7409) (**Table 3-1**). Under the CAA, USEPA sets specific limits on certain outdoor air pollutants that have been scientifically proven to have deleterious health effects in all regions of the United States. The CAA also gives USEPA the authority to limit emissions of air pollutants coming from sources like chemical plants, utilities, and steel mills (42 U.S.C. § 7411). Individual states, counties, cities, or tribes may have stronger air pollution laws, but they may not have weaker pollution limits than those set by USEPA.

Table 3-1. National Ambient Air Quality Standards

Pollutant	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)	Primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	

Pollutant		Primary/ Secondary	Averaging Time	Level	Form
Lead (Pb)		Primary and Secondary	3-month period	0.15 µg/m^3	Not to be exceeded
Nitrogen Dioxide (NO_2)		Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and Secondary	Annual	53 ppb	Annual mean
Ozone (O_3)		Primary and Secondary	8 hours	0.070 ppm	Annual fourth highest daily maximum 8-hour concentration, averaged over 3 years
Particulate Matter	(PM2.5)	Primary	Annual	9 µg/m^3	Annual mean, averaged over 3 years
		Secondary	Annual	15 µg/m^3	Annual mean, averaged over 3 years
		Primary and Secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	(PM10)	Primary and Secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		Primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Sources: 40 CFR § 50.1-50.19; USEPA 2024a
Notes: µg/m^3 = micrograms per cubic meter; ppb = parts per billion; ppm = parts per million

To ensure NAAQS are achieved and/or maintained, the CAA requires each state to develop an enforceable State Implementation Plan (SIP) (42 U.S.C. § 7410). According to the plans outlined in the SIP, states and local agencies are delegated authorities to implement the regulations to control emissions sources of criteria pollutants.

The USEPA is required to designate geographical areas as either attainment or nonattainment for the criteria pollutants (42 U.S.C. § 7407). Areas in attainment meet or exceed NAAQS, whereas areas in non-attainment do not meet the NAAQS. Miami-Dade County is within the Southeast Florida Intrastate Air Quality Control Region established by 40 CFR § 81.49 and is currently in attainment for all criteria pollutants according to the USEPA's Green Book (USEPA 2024b).

Greenhouse gases (GHGs) trap heat in the atmosphere. Carbon dioxide, methane, and nitrous oxide can enter the atmosphere as the result of human activities such as the burning of fossil fuels, solid waste, and other chemical reactions. Methane is emitted from coal, natural gas, and oil production and transport activities. It is also released from livestock and the decay of organic waste in landfills. The combustion of fossil fuels and solid waste, and other agricultural and industrial activities release nitrous oxide. The accumulation of GHGs in the atmosphere influences the earth's temperature, consequently leading to climate change–induced impacts.

EO 14008, Tackling the Climate Crisis at Home and Abroad (2021), identifies policies to reduce GHG emissions and to increase resilience to climate change impacts. In accordance with EO 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, federal agencies are directed to capture the costs of GHG emissions as accurately as possible, including by taking global damages into account to facilitate sound decision-making, recognizing the breadth of climate impacts, and supporting the international leadership of the United States on climate issues. The current estimate of the social cost of carbon (SCC) is $54 per metric ton (Interagency Working Group on the Social Cost of Greenhouse Gases [IWG-SCGHG] 2021). The SCC is an estimate of the monetized damages associated with incremental increases in GHG emissions, such as reduced agricultural productivity, human health effects, property damage from increased flood risk, and the value of ecosystem services. The EO further directs the CEQ to update its 2016 guidance, Final Guidance for Federal Department and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Review. Consistent with this direction, the CEQ issued interim National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change in January 2023. EO 14057, Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability, establishes government-wide emissions goals and reaffirms the federal government as a leader in sustainability.

3.4.8 Hazardous Materials and Waste

3.4.8.1 Existing Conditions

Hazardous materials include, but are not limited to, hazardous and toxic substances (biological, chemical, and/or physical) and waste, and any materials that pose a potential hazard to human health and the environment because of their quantity, concentration, or physical and chemical properties. Hazardous waste is characterized by ignitability, corrosivity, reactivity, or toxicity. Hazardous materials and waste, if not controlled, may either (1) cause or significantly contribute to an increase in mortality, serious irreversible illness, or incapacitating reversible illness or (2) pose a substantial threat to human health or the environment. The primary relevant federal regulations include those promulgated under the Resource Conservation and Recovery Act, which governs the "cradle to grave" management of hazardous waste, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a statutory scheme that imposes joint and several liability for hazardous waste cleanup costs on owners, operators, arrangers, and transporters of such waste.

The FDEP's Division of Waste Management is charged with implementation of state and federal laws to protect the environment from the improper handling and disposal of solid and hazardous waste. The division also oversees and contracts out remediation efforts at sites contaminated with petroleum products, dry cleaning solvents, or other hazardous waste. Chapter 62-730 of FAC establishes the regulations for the control, handling, and disposal of hazardous waste, and Chapter 62-257 of FAC

establishes the asbestos removal program administered by Florida DEP. The USEPA maintains guidance on management and inspection of facilities that may have lead-based paint. The USEPA regulates lead-based paint hazards through Title IV of the Toxic Substances Control Act and the Residential Lead-Based Paint Hazard Reduction Act.

The study area for hazardous materials and waste includes all areas to be disturbed temporarily or permanently or otherwise converted to another use, in association with the implementation of the Proposed Action. **Figure 3-5** documents the location of FDEP Division of Waste Management's list of cleanup sites, which includes (among other things) Superfund sites, sites contaminated with chemicals not regulated under CERCLA, PFAS (Perfluoroalkyl and polyfluoroalkyl substances) sites, and brownfield sites. The FDEP defines brownfields as "abandoned, idled, or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination" (FDEP 2024).

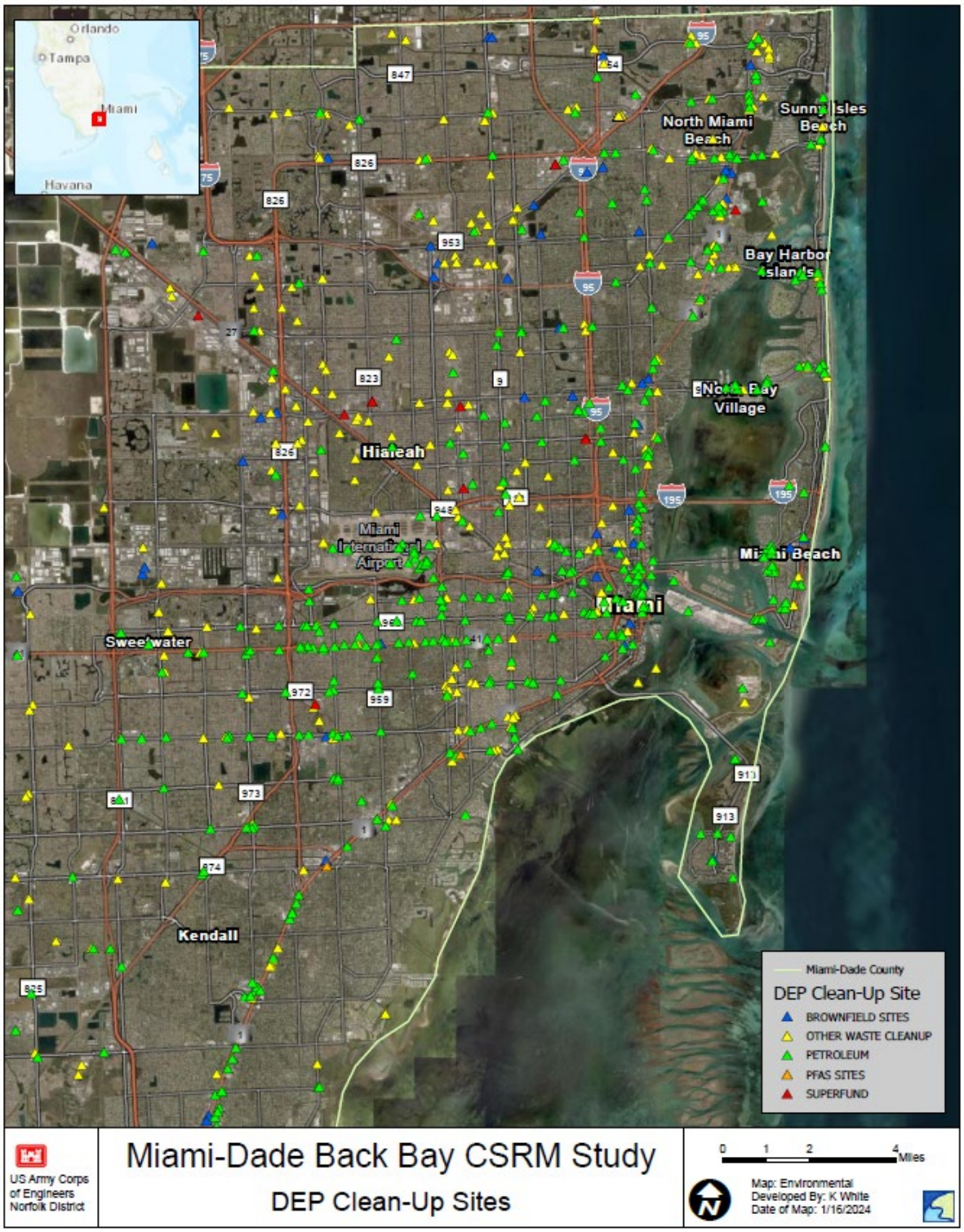


Figure 3-5. Florida Department of Environmental Protection Cleanup Sites in Miami-Dade County

3.4.9 Noise

3.4.9.1 Existing Conditions

Noise is generally defined as loud, unpleasant, unexpected, or undesired sound that is typically associated with human activity and that interferes with or disrupts normal activities of humans and wildlife. Consistent noise levels that characterize a defined area are referred to as ambient noise levels. Miami-Dade County's noise ordinance, Code of Ordinances Chapter 21, Article IV, § 21-28, Noises; Unnecessary and Excessive Prohibited, contains time restrictions on specific types of noise-producing activities, such as construction and excessive residential noise, and aims to protect citizens from offensively loud noise and vibration. Municipal ordinances are also implemented to regulate noise from various sources, as well as to regulate the distance between noises that can occur near certain public buildings, such as hospitals or schools.

Miami-Dade County is a developed county with vast land use; heavy industrial, commercial, military, and cargo ship traffic; and extensive recreational boating activities. The County and its associated municipalities incorporate various noise abatement and mitigation strategies to reduce noise levels, where appropriate.

The extent of noise impacts for the RP includes the footprint of nonstructural areas (as well as locations of CI), including an approximate 500-foot buffer. Ambient noise may include sounds characteristic of residential areas such as traffic/transit and recreation activities near parks. Ambient noise surrounding CI depends on the surrounding location and its proximity to transit, waterways, or other commercial/industrial activities.

3.4.10 Utilities

3.4.10.1 Existing Conditions

This section focuses on the following major utilities and associated infrastructure: water/wastewater, stormwater, power, and telecommunication. Potential impacts and mitigation measures related to the implementation of the Proposed Action are assessed based on their effects in relation to the existing utility infrastructure. Analysis of the environmental impacts of any utility relocations, in contrast to the impacts to existing utilities, is considered in Sections 7.13 (Recommended Plan), 7.17.13 (Nature-Based Solutions Pilot Program), and 7.18.13 (Nonstructural Program) of this Report.

Articles IV and V of Chapter 24, Environmental Protection, of the Miami-Dade County Code of Ordinances include the regulations for both stormwater management and stormwater utilities. Established in 1991, the Stormwater Utility of Miami-Dade County is responsible for the operation, maintenance, and governance of Countywide stormwater management systems as set forth in the local program required under Section 403.0891 of the Florida Statutes. Local municipalities, such as the City of Miami, serve as the permitting authority for all land-disturbing activities and oversee all aspects of stormwater management and inspection of stormwater facilities within their jurisdictional limits.

The SFWMD is one of five regional management districts in the State of Florida and is responsible for the management and protection of water resources and ecosystems from Orlando to the Florida Keys, covering 16 counties to include Miami-Dade County.

3.4.10.2 Water/Wastewater

Miami-Dade County is the largest water and sewer utility in the southeastern United States. The Miami-Dade Water and Sewer Department (WASD) maintains more than 7,700 miles of underground water lines, 6,200 miles of sewer lines, and three regional water plants, serving 2.3 million residents and thousands of visitors. WASD withdraws approximately 300 million gallons of water every day from the Biscayne aquifer (Miami-Dade County 2017b). WASD owns a force sewer main in a submarine crossing within the Biscayne Bay, leading from downtown Miami to its Virginia Key Wastewater Treatment Plant. Additionally, WASD owns a water main in a submarine crossing leading from Fisher Island to Lummus Island.

The WASD service area relies on underground pipes and aboveground facilities to transport wastewater to its three major treatment plants as well as septic tank systems. Where needed, the service area also has pump stations to lift wastewater from lower to higher elevations. Within Miami-Dade County, there are approximately 730 facilities with private pump stations and approximately 1,420 public pump stations currently in operation (Miami-Dade County 2019b). Effluents from wastewater treatment plants in Miami-Dade County discharge to an ocean outfall, deep well injection, and/or are used for underground irrigation.

3.4.10.3 Stormwater

The primary drainage system in Miami-Dade County consists of approximately 320 miles of canals and associated features managed by SFWMD and USACE. The secondary drainage system consists of canals and associated features owned and/or operated by Miami-Dade County or by designated public or private entities. The secondary drainage system may discharge to receiving lakes, coastal water bodies, or the primary drainage system. Such secondary systems operate under permits issued by the SFWMD. Tertiary systems consist of canals and other local drainage features generally located on public right-of-way or on private lands that provide localized drainage benefit and discharge into retention/detention areas and/or the secondary drainage system. Tertiary drainage systems are generally operated and regulated by permits issued by SFWMD or local municipal authorities.

The SFWMD, the County, and the cities' local municipalities coordinate for pre-, during, and post-event system management activities to maximize flood protection. Flooding may occur during extreme storm events that exceed the system capacity, which is designed as required by applicable codes. The goal during extreme storm events is to keep water from entering buildings and living spaces, to keep evacuation routes open to vehicular traffic, and to keep other roads and properties flood-free in the shortest amount of time possible. However, roads and properties may experience local flooding when a storm event exceeds the design capacity.

The City of Miami's Comprehensive Stormwater Master Plan (SWMP) was updated in 2021. The SWMP is directly associated with Miami-Dade County's Comprehensive Development Master Plan (CDMP). The City of Miami passed the "Miami Forever Bond" in November 2017, which includes a $400,000,000 program to help the city combat sea level change and flooding toward building a more resilient future.

The Village of Miami Shores, City of North Miami, and other municipalities all within Miami-Dade County have similar stormwater plans and ordinances governing stormwater management systems, implementation of best management practices, associated maintenance and improvements, and funding

through stormwater utilities. The stormwater utilities are operated as a normal utility that bills regularly to consumers.

3.4.10.4 Power and Telecommunication

Florida Power & Light Company (FPL) services more than 5 million customer accounts in Florida. According to its website, FPL is working on initiatives to strengthen power lines, upgrade grid technology, and conduct hardening of main power lines that serve critical community facilities and services. The term "hardening" means to install structures with stronger materials that can withstand hurricane-force winds and to shorten the distance between poles and/or underground installation. In 2018, FPL initiated the Storm Secure Underground Program to identify areas that would receive the most benefit from replacing overhead neighborhood power lines with underground lines for improved resilience during storm events (FPL 2024).

Telecommunication utilities and associated infrastructure, such as fiber-optic cabling and cellular communication towers, are present throughout the study area, allowing residential and commercial access to services for purchase such as high-speed internet and wireless communications. All communication is directed through wire centers, which are physical locations that contain telecommunications switches, including mobile services. Wire centers are vulnerable to flooding.

3.5 Built Environment

The U.S. Census totals the area of land within Miami-Dade County as 1,899.9 square miles. While Dade County was established in 1836, voters changed the name to Miami-Dade County in 1997. Miami-Dade County has grown rapidly and is nearly fully developed. An urban development boundary (UDB) was established in Miami-Dade County that discourages development outside its bounds.

Much of the Miami-Dade County area consists of federally owned land (e.g., Everglades National Park) that is outside the UDB and not addressed in this study. According to Miami-Dade County land use data (last updated December 2023), nine percent of the total land in Miami-Dade County is classed as vacant; however, 12 percent of those lands are protected. These protected lands are owned by the government, publicly owned, or are under conservation/environmental mechanisms. Whether government-owned or publicly owned, this results in seven percent vacant, unprotected land in Miami-Dade County, six percent of which is within the UDB. Since Miami-Dade County is 94 percent built out in the UDB, most future development will be the infill of structures on the limited vacant land, redevelopment, or intensification. Any redevelopment is expected to be constructed to established higher standards, including freeboard above the FEMA base flood elevation or one percent AEP. **Figure 3-6** shows the land use map for Miami-Dade County depicting the vacant lands still available for construction within the UDB.

Section 1.4 includes a brief description of ongoing federal projects and/or studies near Miami-Dade County. Other local projects include municipal stormwater improvement projects and other resilience projects implemented as part of the Resilient305 Strategy. The Resilient305 Strategy aims to improve climate resilience by addressing vulnerabilities and current challenges through actionable projects implemented through intergovernmental and community collaborative efforts (Greater Miami & the Beaches 2019).

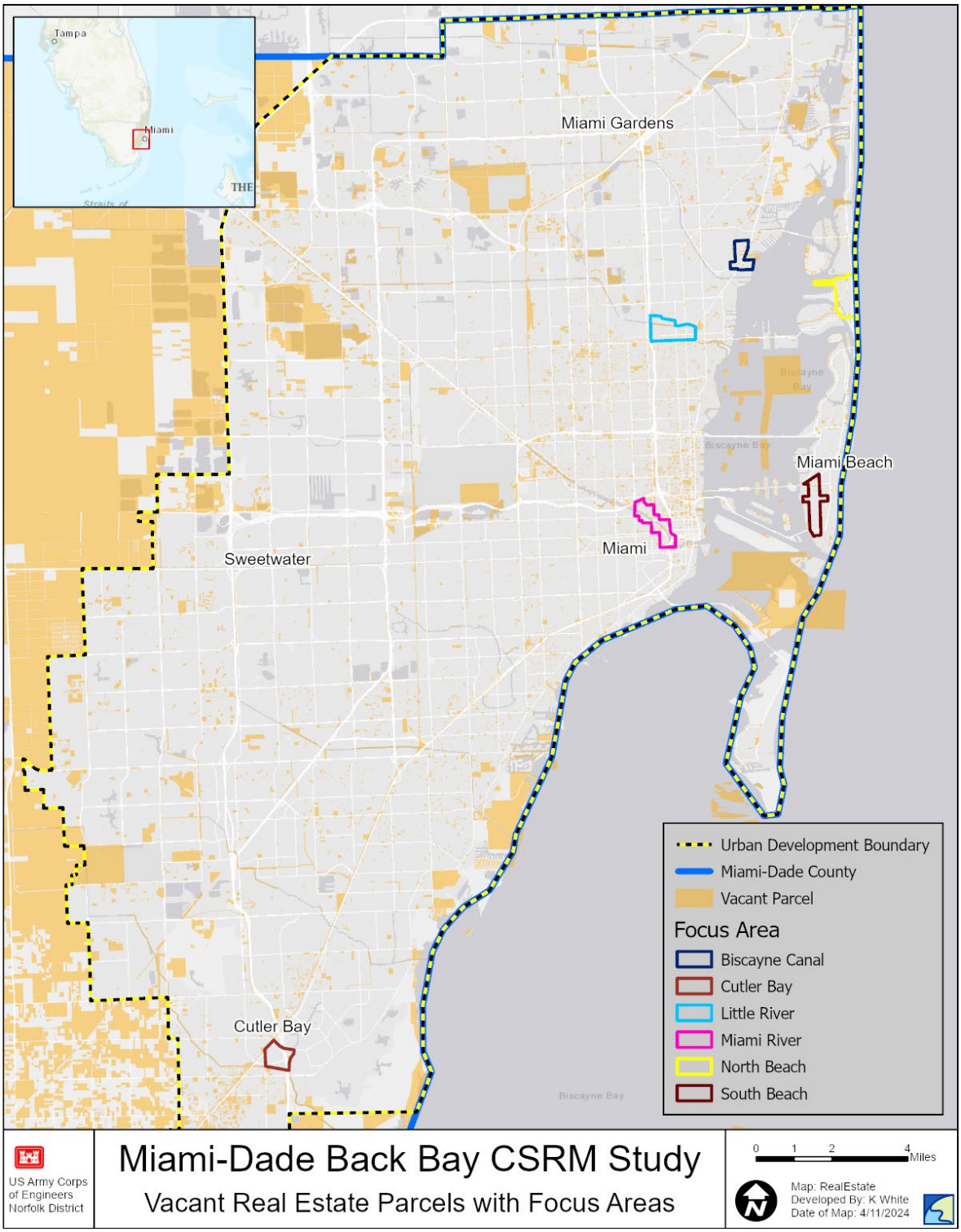


Figure 3-6. Vacant Capacity Inside the Urban Development Boundary

3.6 Economic Environment

3.6.1 Socioeconomics

3.6.1.1 Existing Conditions

The socioeconomic evaluation considers how the Proposed Action may affect elements of the human environment, such as population, employment, and education.

Pertinent demographic information, including age, race, and income of the populace, is vital to framing both a socioeconomic analysis and an analysis of environmental justice conditions. Section 3.6.2 discusses environmental justice considerations. The U.S. Census Bureau, Bureau of Labor provided the existing demographic and economic information. The impacts of implementing the Proposed Action to various segments of the population are considered, especially with regard to the geographic distribution of these population elements and the impacts of the Proposed Action in these areas.

EO 13166, Improving Access to Services for Persons with Limited English Proficiency, was issued on August 11, 2000, and requires federal agencies to examine the services they provide, identify any need for services to those with limited English proficiency, and develop and implement a system to provide meaningful access to agency services for individuals with limited English proficiency.

3.6.1.2 Demographics

Approximately 2,675,000 people reside in Miami-Dade County as of July 1, 2022 (U.S. Census Bureau 2024). General population characteristics of Miami-Dade County include a median household income (in 2022 dollars) of $64,215, and approximately 14.5 percent of the population identified as persons in poverty. Miami-Dade County is culturally diverse, with approximately 54 percent of the population born outside of the United States and approximately 75 percent of persons age 5+ speaking a language other than English at home. **Table 3-2** and **Table 3-3** present the race and ethnicity data collected by the U.S. Census Bureau.

Table 3-2. Distribution of 100 Percent of All Races in Miami-Dade County

Race	Percent (%)
White alone	79.4
Black or African American alone	17.1
American Indian and Alaska native alone	0.3
Asian alone	1.7
Native Hawaiian and other Pacific Islander alone	0.1
Two or more races present	1.3

Source: U.S. Census Bureau 2024

Table 3-3. Distribution of Ethnicity in Miami-Dade County

Ethnicity	Percent (%)
Hispanic or Latino	69.1
Non-Hispanic or Latino	30.9
White alone not Hispanic or Latino	13.8

Source: U.S. Census Bureau 2024

3.6.1.3 Economics

Tourism plays a central role in the economy of Miami-Dade County, with Miami Beach drawing tourists from all over the world. Miami-Dade County's location on the shipping lanes and air routes makes it an important nexus between the United States, the Caribbean, and Latin America.

The 2023 Biscayne Bay Economic Study Update, released by Miami-Dade County and the SFWMD in September 2023, concludes that the collective economic impact of Biscayne Bay–related activities is approximately $64 billion and further highlights the direct influence of the Biscayne Bay watershed on the Miami-Dade County economy (Hazen and Sawyer 2023). The value of Biscayne Bay's economic output is through jobs (primarily port shipping, cruising, and recreation), property values, Port Miami economic contributions, recreation, and commercial fishing.

PortMiami is a vital asset to the U.S. trade and cruise industries. Many modes of transportation and industry are directly and indirectly associated with the port, for both people and goods. The freight network and all of its components which are designated as Florida Strategic Intermodal System (SIS) facilities also includes warehouse locations specific to food and fuel distribution associated with hurricane response and recovery. Facilities that comprise the SIS include hubs, corridors, intermodal connectors, and military access facilities. SIS is listed as the highest priority network of transportation systems to support the State's economy and mobility (Marlin Engineering 2018). Damage to critical transportation corridors can have substantial economic impacts across the region due to interruption in the movement of goods and services.

The Florida Department of Transportation (FDOT) regulates the establishment and maintenance of public transportation projects within the State of Florida. FDOT's District Six is responsible for planning, designing, building, and maintaining all State-owned roadways and bridges in Miami-Dade. The Miami-Dade Transportation Planning Organization oversees the federally mandated regionally based long-range transportation planning process for urbanized areas to ensure that federal regulations and projects are in accordance with endorsed plans and programs.

3.6.2 Environmental Justice

3.6.2.1 Existing Conditions

EO 14096, Revitalizing Our Nation's Commitment to Environmental Justice for All (2023), defines environmental justice as follows:

> *(b) ''Environmental justice'' means the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the environment so that people: (i) are fully protected from disproportionate and adverse human health and environmental effects (including risks) and hazards, including those related to climate change, the cumulative impacts of environmental and other burdens, and the legacy of racism or other structural or systemic barriers; and (ii) have equitable access to a healthy, sustainable, and resilient environment in which to live, play, work, learn, grow, worship, and engage in cultural and subsistence practices.*

Fair or just treatment means that no group of people, including racial, ethnic, or socioeconomic characteristics, should bear a disproportionate share of the negative environmental consequences resulting from the execution of federal, state, local, and tribal programs and policies. In accordance with EO 14096, federal agencies must identify, analyze, and address disproportionate and adverse human health and environmental effects (including risks) and hazards of their activities, including those related to climate change and cumulative impacts of environmental and other burdens on communities with environmental justice concerns.

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (1994), directs each federal agency to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." EO 12898 aims to ensure that the environmental effects of federal actions do not fall disproportionately on low-income and minority populations. EO 14008, Tackling the Climate Crisis at Home and Abroad (January 2021), reasserts the national commitment to environmental justice through the Justice40 Initiative. The Justice40 Initiative is a whole-of-government initiative to advance environmental justice with the goal of delivering 40 percent of the overall benefits of federal investments in numerous categories, including climate change, to disadvantaged communities that are marginalized, underserved, and overburdened by pollution.

Most recently, EO 14096 directs executive agencies to (among other things) address and prevent disproportionate and adverse environmental and health impacts on communities, including the cumulative impacts of pollution and other burdens like climate change; strengthen engagement with communities and mobilize federal agencies to confront existing and legacy barriers and injustices; expand interagency coordination and launch a new Office of Environmental Justice within the White House Council on Environmental Quality; and conduct new assessments of their environmental justice efforts and develop, implement, and periodically update an environmental justice strategic plan (White House Fact Sheet 2003).

EO 13045, Protection of Children from Environmental Health Risks and Safety Risks, ensures that federal agencies' policies, programs, activities, and standards address environmental health and safety risks to children. EO 13045 requires all federal agencies to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and ensure that its policies, programs, activities, and standards address disproportionate risks to children that may result from environmental health risks or safety risks.

Environmental justice was considered during development of the refined Focus Areas for the RP. The Focus Areas include populations of individuals and families with incomes at or below the federal poverty level and underserved populations that may have limited access to public resources. Community residents may speak English as a second language, or little to no English. The CEQ's Climate and Economic Justice Screening Tool (CEJST) was used as a starting point to inform where census tracts with underserved populations reside in Miami-Dade County. The CEJST uses thresholds, or cutoffs, to determine whether a census tract is considered underserved. A census tract is considered disadvantaged, or underserved, if it is equal to or exceeds the threshold for at least one environmental, climate, or other burden and if it is equal to or exceeds the threshold for an associated socioeconomic burden. Some of these communities are also located in the lowest lying areas of Miami-Dade County, making them especially vulnerable during a coastal storm event (**Figure 3-7**). Additionally, underserved communities specifically identified by municipalities were prioritized over data from the CEJST. This included areas within the City of Miami and the City of Miami Beach.

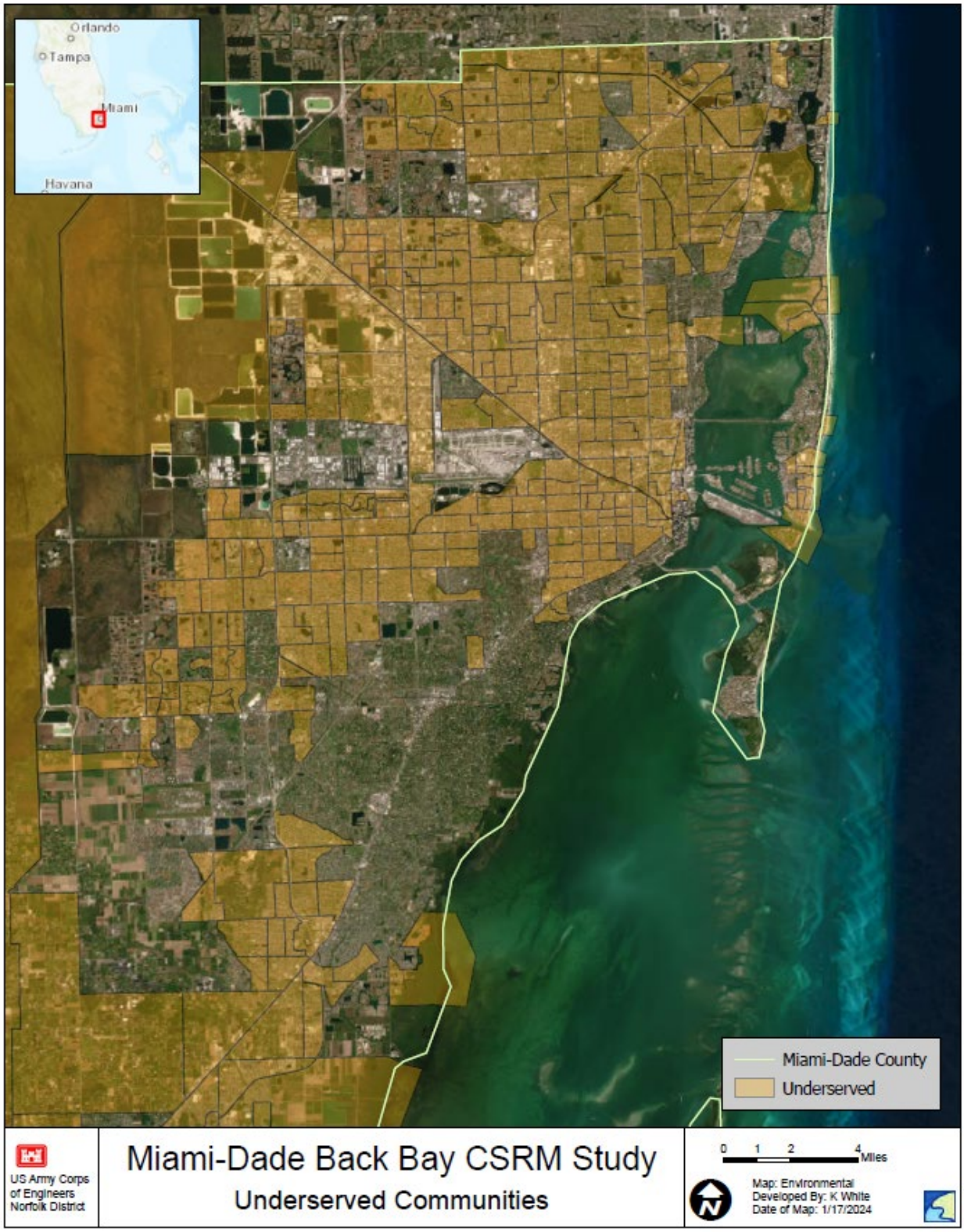


Figure 3-7. Census Tracts Identified as Underserved by the Climate and Economic Justice Screening Tool (CEQ 2022)

3.6.3 Recreational Resources

3.6.3.1 Existing Conditions

Recreational facilities are those amenities that provide for relaxation, rest, exercise, activity, enjoyment, education, or opportunities for leisure and community support that enrich the quality of life. Tourism is a quintessential part of Miami-Dade County's local economy. Countless opportunities for recreation, creativity, and relaxation draw tourists from around the world to visit and participate in land-based and aquatic recreational activities available in Miami-Dade County. One of the leading parks systems in the country, Miami-Dade Parks boasts 280 county parks, 17 miles of beaches, five golf courses, six marinas, and more than 40,000 acres of land (Parks Foundation of Miami-Dade 2018).

4 PLAN FORMULATION AND EVALUATION

This section of the Integrated Feasibility Report and Environmental Assessment (IFR/EA) covers plan formulation, which describes how plans were developed, evaluated, and selected.

4.1 Planning Framework

Plan formulation is the process of developing and evaluating alternative plans that meet the objectives of the study. First, identify management measures. Second, formulate alternatives. Third, reformulate plans. Engineering Regulation (ER) 1105-2-103, Planning Policy for Conducting Civil Works Planning Studies, Paragraph 2-4.c(1) states:

> *"The planning team will use the objectives and constraints to formulate measures and alternatives, along with contributions from the partner, Tribes, stakeholders, and the public. Planners will also use the four formulation and evaluation criteria to guide the development of alternatives: completeness, effectiveness, efficiency, and acceptability. However, application of the four criteria requires an explicit consideration of the effects of climate change, environmental justice, nature-based solutions (NBS), and sea level change."*

Following are the definitions of each criterion according to ER 1105-2-103:

- ***Completeness*** is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other federal and nonfederal entities. Completeness must consider the sustainability and long-term aspects of the plans and whether all resource requirements are included. Completeness does not mean that all planning objectives are fully realized, only that the required resources and actions are included to achieve the estimated benefits.
- ***Effectiveness*** is the extent to which an alternative alleviates the specified problems and achieves the specified opportunities. Effectiveness does not mean that all planning objectives need to be addressed or fully realized.
- ***Efficiency*** is the extent to which an alternative plan is a cost-effective means of solving the problem and achieving the objectives. Efficiency is determined through a comparison of the costs and benefits of each alternative.
- ***Acceptability*** is the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public and compatibility with existing laws, regulations, and public policies. Acceptability has two dimensions – implementability and satisfaction. Implementability means the extent to which the alternative is feasible from technical, financial, and legal perspectives. Satisfaction is the extent to which the plan is welcome from a political or preferential perspective.

As mentioned in Section 1.10, Study Scope, the expedited process of this study included a process which identified Focus Areas based on the most vulnerable areas. Vulnerable areas were categorized as such because of high-frequency flooding potential and social vulnerability. Plan formulation strategies were developed to meet the objectives of this study while providing coastal storm risk management (CSRM) solutions to the Focus Areas. Following are the objectives of this study:

1. Increase the resiliency of Miami-Dade County to function effectively before, during, and after coastal storm events by decreasing the vulnerability of critical infrastructure (CI) to flooding damage from storm surge with consideration for sea level change over the period of analysis.
2. Manage coastal storm risk by reducing economic damage to buildings in Miami-Dade County communities that have been identified as vulnerable to severe damage from storm surge with consideration for sea level change over the period of analysis.
3. Manage risk to human health and life safety throughout Miami-Dade County over the period of analysis.

The U.S. Army Corps of Engineers (USACE), with the help of the nonfederal sponsor (NFS) and other stakeholders, first identified measures applicable to the Miami-Dade County area during meetings, charrettes, and other public involvement. Based on this information, the Project Delivery Team (PDT) developed a list of CSRM measures that could reasonably address the identified problems and opportunities. This list included structural, nonstructural, and NBS measures for further consideration.

Measures were then screened on the ability to meet the study objectives while avoiding planning constraints. They were also screened based on varying factors, such as cost, environmental, social, historical, or cultural impacts, and avoiding inducing any flooding. These measures were then combined into different viable alternative plans, which comprise one or more measures functioning together to address one or more planning objectives.

Additional stakeholder input was incorporated into the plan comparison through public meetings, meetings with cooperating agencies, and meetings with the NFS. Federal lands were not a part of this study. According to ER 1105-2-103, Appendix E, work to protect shorelines owned by federal agencies is generally only performed on a reimbursable basis and upon request by the agency. Here, no federal agency requested participation in the study throughout any of the public scoping processes.

Section 4.3 includes a more detailed discussion of the measures considered to address the objectives and the screening process.

4.2 Assumptions

To move forward in the risk-informed decision-making process, the Miami-Dade County Back Bay CSRM PDT made certain assumptions and simplifications while scoping the study and formulating the Future Without Project (FWOP) and Future With Project (FWP) scenarios. Critical assumptions from various disciplines were deliberated within USACE and communicated with decision-makers in the form of a risk register.

4.2.1 Economics

Building Inventory

The PDT had data regarding approximately 14,000 elevation certificates within the Miami-Dade County and Broward County areas; however, of those, only 240 are within the Focus Areas. These data were used to create triangulated foundation heights per building, which were used to calculate estimated first-floor elevations of every building. Foundation types and construction types had to be assumed based on localized data since Miami-Dade County's parcel data did not include that information populated on a building-by-building basis.

Depth Damage Functions

Specific depth damage functions (DDFs) were not available local to Miami-Dade County or even the Florida region. The PDT had to use DDFs established within the North Atlantic Coast Comprehensive Study Physical Depth Damage Function Summary Report (USACE 2015) for residential and nonresidential buildings. Functions developed as part of the Nonresidential Flood Depth Damage Functions Derived from Expert Elicitation Report in 2013 (Davis 2013) were included to provide a wider range of DDFs to match the building inventory more closely. A facility level DDF was developed for the Central District Wastewater Treatment Plant, as described in Appendix A-5.

Section 308 of the Water Resources Development Act of 1990

The PDT assumed that all buildings were compliant with Section 308 of the Water Resources Development Act (WRDA) of 1990, P.L. 101-640. Section 308 states that buildings built in the 100-year floodplain with a first-floor elevation of less than the 100-year flood elevation after July 1, 1991, must not be included in the benefit base for justifying federal coastal storm risk management and flood risk management projects. The buildings were assumed to be compliant since Miami-Dade County joined the National Flood Insurance Program (NFIP) in 1994, and Miami-Dade County building officials indicated they strictly enforce NFIP regulations.

Freeboard

As described under Section 1.4.2 Resilience Actions by Miami-Dade County, the Federal Emergency Management Agency (FEMA) defines freeboard as "[a]n additional amount of height above the Base Flood Elevation (BFE) used as a factor of safety […] in determining the level at which a building's lowest floor must be elevated or floodproofed to be in accordance with state or community floodplain management regulations." (FEMA 2020).

This study used FEMA's freeboard in the economic model's repetitive damage criteria in the FWOP condition since that is what the NFS would follow regardless of a USACE project. That is the elevation in feet NAVD88 of first-floor as defined by the lowest horizontal member of the lowest walking floor that the building should be elevated to for repetitive damages in the FWOP condition. The FWP design elevation does not consider freeboard since it is against USACE policy to consider local ordinances even if it based

on another federal law or program; however, with the addition of SLC, majority of the times that requirement is usually met.

4.2.2 Engineering

LiDAR Data

The digital elevation model created for the South Atlantic Coastal Study (SACS) was used to determine ground elevations at each building. Surveys will need to be conducted in the Preconstruction, Engineering, and Design (PED) Phase to verify the ground elevations and first-floor elevation data.

Sea Level Change

This study is formulated to consider the impacts that sea level change will have on future conditions, both with and without project alternatives in place, and it is consistent with ER 1100-2-8162 (USACE 2019), Incorporating Sea Level Change in Civil Works Programs. Research by climate science experts predict continued or accelerated climate change for the 21st century and possibly beyond, which would cause a continued or accelerated rise in the sea level in the Miami-Dade County area. The resulting sea level change will impact future USACE coastal projects and system performances. As a result, coastal studies must consider how sensitive and adaptable both environmental and engineered systems are to the effects of relative sea level change (RSLC) and climate change.

The projection for Miami-Dade County includes a sea level change for the 50-year period of analysis of 2040 to 2089. As shown in **Figure 4-1**, according to the USACE Sea-Level Change Calculator, water levels will rise 0.69, 1.34, and 3.39 feet North American Vertical Datum of 1988 (NAVD88) for the USACE Low, Intermediate, and High Curve estimates, respectively, to the year 2089. Other entities, such as the National Oceanic and Atmospheric Administration (NOAA), have made sea level change predictions for the area as well, which are included in **Figure 4-1**. The NOAA predicts higher rates of sea level change for the High Curve than USACE, at nearly 5.5 feet NAVD88 by 2089. For this study, the USACE High Curve was used as a starting point. Appendix A-1 provides rationale for this decision, which was coordinated and approved by the USACE Climate Preparedness and Resilience Community of Practice.

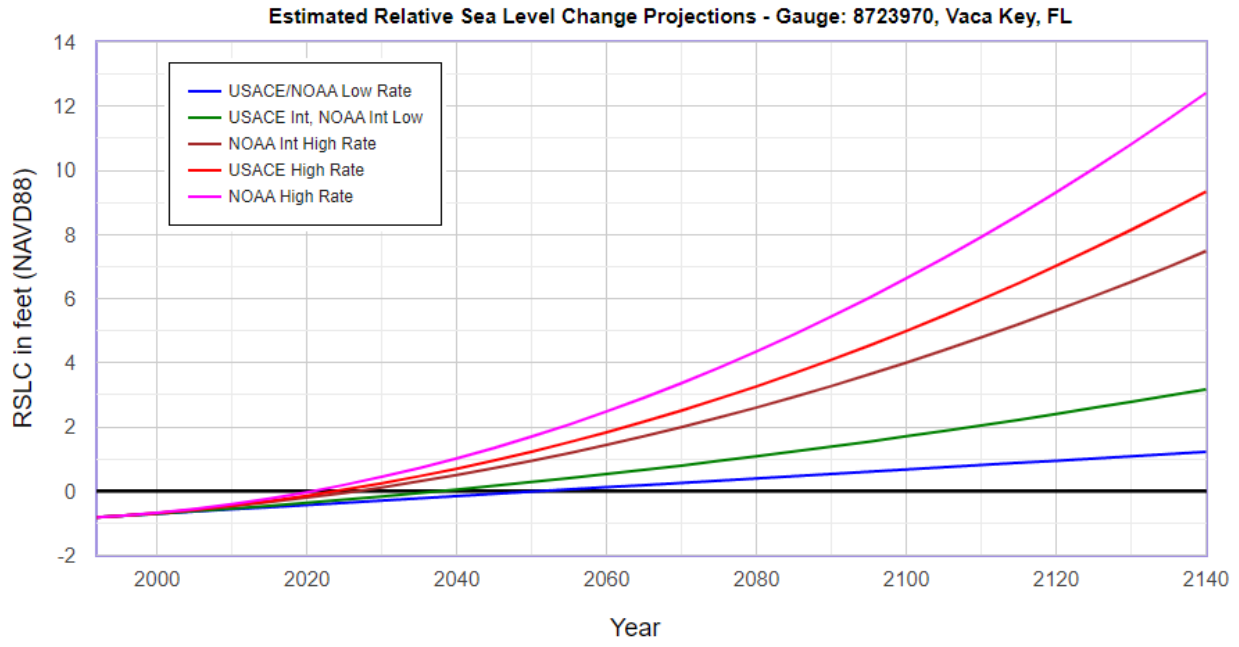


Figure 4-1. Estimated USACE and NOAA Sea Level Change Projections to 2140

Table 4-1 shows the projected water surface elevation in feet NAVD88 feet for the USACE and NOAA low, intermediate, and high rates of future sea level rise at the Vaca Key, Florida Bay, FL gauge to the year 2140.

Table 4-1. Estimated USACE and NOAA Sea Level Change Projections to 2140

Year	USACE Low / NOAA Low	USACE Int / NOAA Int Low	NOAA Intermediate High	USACE High	NOAA High
1992	-0.82	-0.82	-0.82	-0.82	-0.82
2000	-0.71	-0.71	-0.69	-0.69	-0.68
2010	-0.57	-0.55	-0.48	-0.45	-0.41
2020	-0.44	-0.37	-0.21	-0.15	-0.04
2030	-0.3	-0.17	0.11	0.24	0.44
2040	-0.16	0.04	0.5	0.69	1.02
2050	-0.02	0.28	0.94	1.22	1.7
2060	0.12	0.53	1.44	1.83	2.48
2070	0.25	0.79	1.99	2.51	3.36
2080	0.39	1.08	2.6	3.26	4.35
2090	0.53	1.38	3.27	4.09	5.44
2100	0.67	1.71	4	4.99	6.63
2110	0.81	2.04	4.79	5.97	7.92
2120	0.94	2.4	5.63	7.02	9.31
2130	1.08	2.78	6.52	8.14	10.81
2140	1.22	3.17	7.48	9.34	12.41

4.3 Management Measures

A measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. Measures become more specific and better defined as planning progresses. CSRM measures consist of three basic types: structural, nonstructural, and NBS.

4.3.1 Structural Measures

Structural CSRM measures are human-made, constructed engineering solutions to manage flood risk and reduce damage from coastal storms by physically limiting flood water inundation. This includes measures such as storm surge barriers (which can consist of miter gates, sector gates, tainter gates, sluice gates, etc.), levees, and floodwalls/ringwalls that are implemented to protect people and property. Structural measures would incorporate pump stations, if required, to ensure that measures do not induce flooding. Additionally, real estate actions are anticipated to implement structural measures.

4.3.2 Nonstructural Measures

Nonstructural CSRM measures are permanent or contingent measures applied to a building and/or its contents that prevent or provide resistance to damage from flooding. Nonstructural measures differ from structural measures because they focus on managing risk (likelihood and consequences) of flooding instead of focusing on reducing the probability of flooding.

Real estate actions are anticipated to implement nonstructural measures. For example, in some circumstances, a parcel may not be large enough to accommodate equipment needed for the elevation of the residence. A Temporary Work Area Easement (TWAE) instrument may be used for the extra space needed to complete the elevation on the subject property.

The following nonstructural measures considered for this study represent techniques commonly used in managing flood risk and the damage associated with flooding.

Elevating Buildings

This nonstructural measure typically involves raising the lowest floor elevation of residential buildings to at least equal to or greater than the FEMA one percent AEP flood plus any additional local freeboard requirements. This can be done to buildings regardless of whether they have a crawl space, slab, or basement foundation; however, some variations require filling in the basement first. Most of the buildings in Miami-Dade County consist of stem wall slab foundations. A small portion of the buildings have crawl spaces that were more common in the pre-1960s. Basements are very limited because of the high water table.

Floodproofing Buildings

Dry Floodproofing

This nonstructural measure involves making an area watertight so no water can enter the building. This can be done using waterproof coatings, impermeable membranes, sealants, and shields/gates applied to doors and windows. A sump pump can also be installed to help keep the area dry and prevent flooding. Because water's lateral force against a wall increases as the depth of water increases, the maximum allowable flood depth for floodproofing is approximately 3 feet. Tests showed that walls exposed to depths greater than three feet of water either collapsed or suffered serious structural damage (USACE 1988). Floodproofing beyond three feet is acceptable and is occurring in the industry; however, a structural analysis of the wall strength would be required. Dry floodproofing is typically done to nonresidential buildings because the NFIP does not provide premium rate reductions for floodproofing done to residential buildings. This concept does not work with basements or crawl spaces. For buildings with basements and/or crawlspaces, dry floodproofing can only be considered successful if the first floor is made impermeable to the passage of floodwater. Floodproofing is not permitted in FEMA Coastal High Hazard Areas, which are areas subject to inundation by the one percent AEP event with additional hazards from storm-induced velocity wave action (FEMA 2024).

Wet Floodproofing

Unlike dry floodproofing, this nonstructural measure involves allowing water to enter a building. Wet floodproofing requires buildings to be built with materials that are water resistant. Buildings also need to be properly anchored, and all mechanical and utility equipment must be elevated above a design water elevation. This measure is generally not applicable to deep flood depths and high-velocity flows. Additionally, it would present considerable remaining life safety risk for community members residing in single-family residential homes with no ability to evacuate vertically. For these reasons, wet floodproofing was not analyzed as a potential measure in this study effort but could be considered as a potential measure in the future study efforts following completion of this report for WRDA 2024 authorization. FEMA's Wet Floodproofing Requirements for Structures Located in Special Flood Hazard Areas, in accordance with the NFIP Technical Bulletin 7 / May 2022, has more information on this measure.

4.3.3 Nature-Based Solutions

NBS are either natural features or constructed features that mimic natural features, which provide CSRM benefits such as wave attenuation and storm surge reduction. Real estate actions are anticipated to implement NBS. Section 5 provides additional information on NBS.

4.3.4 Critical Infrastructure

CI, as defined by the Patriot Act of 2001 (42 U.S.C. § 5195c(e)), are "systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters." Management measures for CI vary based on the type of CI asset. Individual or combinations of the management measures described above could be implemented to manage risk at CI facilities. Priority critical infrastructure were identified in coordination with the nonfederal sponsor,

Miami-Dade County, for this study effort. Additional consideration will be given to other types of critical infrastructure as part of future study efforts.

4.3.5 Separable and Complementary Measures

Separable measures are measures that can provide a level of risk management to an area on its own. Separable measures are individually justified and can be combined with other justified measures to form alternatives. For instance, several floodwalls may be recommended throughout an area, but each floodwall on its own could be a separable measure if it can provide risk management by itself without needing to be connected to other floodwalls. This is usually possible if there is high ground available for the floodwall to tie into or if the measures are spread out throughout an area.

Complementary measures are those measures that provide risk management in the residual floodplains of structural measures to provide a uniform level of risk management throughout the County. For example, engineering constraints may limit the location of a structural measure such that part of a neighborhood is left unprotected. Providing a complementary measure, typically nonstructural, which will provide a similar level of risk management, allows for a more holistic approach to countywide or Focus Area–wide flood risk management.

4.3.6 Screening of Measures

Screening is a form of decision-making based on criteria. Screening is necessary to keep the study focused on its goals and objectives. Screening criteria for this study were determined at initial workshops with Miami-Dade County and included:

- Meeting the objectives of reducing damage to CI and buildings from coastal storm risk within the Focus Areas
- Avoiding or minimizing impacts to cultural and/or historic resources
- Minimizing environmental impacts
- Ensuring there is no inducing of flooding without appropriate mitigation

As mentioned in Section 1.10, Study Scope, the PDT, along with Miami-Dade County, stakeholders, and the public, determined applicable measures for all Miami-Dade County. That effort led to the development of the multiple-lines-of-defense concept, further discussed in Section 2. **Table 4-2** lists typical measures applicable for a CSRM study. The table also depicts whether these measures meet the objectives for this study, were screened out, carried forward as actionable measures in this study for further analysis and specific authorization in the Chief's Report, or shifted for potential analysis in a future study effort and/or programmatic authorization.

Table 4-2. Measures Screening

Measure	OBJECTIVES			INCLUSION		
	#1 Increase resilience for CI	#2 Reduce economic damage to buildings	#3 Manage life safety risk	(A) Screened out for 2024 Study	(B) Carried forward in 2024 Study	(C) Shifted for potential analyses in future efforts
Acquisition (building removal) and Relocation	N/A	Yes	Yes	Yes	No	-
Elevate Single-Family Residential Buildings and Multifamily up to Four Units	Yes	Yes	Yes	No	Yes	-
Elevate Multifamily Buildings Four+ Units	Yes	Yes	Yes	Yes	No	Yes
Floodproofing Nonresidential Buildings	Yes	Yes	Yes	No	Yes	-
Floodproofing CI	Yes	No	Yes	No	Yes	-
Floodproofing Hospitals	Yes	No	Yes	Yes	No	Yes
Enhanced Flood Warning and Evacuation Planning	No	No	Yes	Yes	No	-
Floodwalls and/or Levees	Yes	Yes	Yes	Yes	No	Yes
Shoreline Stabilization (i.e., revetments or seawalls)	No	No	No	Yes	No	-
Storm Surge Barriers	Yes	Yes	Yes	Yes	No	Yes
Dune or Road Raising	Yes	N/A	Yes	Yes	No	Yes
Breakwaters / Groins	N/A	N/A	No	Yes	No	-
Drainage Improvements	No	Yes	No	Yes	No	-
Living Shorelines	Yes	No	No	Yes	No	Yes
Hybrid Reef Structure	Yes	No	No	Yes	No	Yes

Measure	OBJECTIVES			INCLUSION		
	#1 Increase resilience for CI	#2 Reduce economic damage to buildings	#3 Manage life safety risk	(A) Screened out for 2024 Study	(B) Carried forward in 2024 Study	(C) Shifted for potential analyses in future efforts
Vegetation / Mangroves / Wetlands Restoration	Yes	Yes	No	Yes	No	Yes

In **Table 4-2**, the "Screened out for 2024 Study" column (Column A) identifies measures that were screened out for specific authorization in this study. Measures that might be included in the programmatic authorizations in this study are identified as being screened out because specific measures will be recommended in future, later-tier studies. The "Carried forward in 2024 Study" column (Column B) indicates which measures are being pursued in this study and potentially recommended for specific authorization. Measures that were screened out in Column A because they required additional time and effort to conduct a thorough analysis for future studies are shown in "Shifted for potential analyses in future study or programs" (Column C). Column C does not represent the full suite of measures that will be analyzed in future studies because that scope is not developed yet. Those measures will be identified as potential solutions to the Miami-Dade County area during charrettes and meetings with Miami-Dade County, stakeholders, and the public. Section 2 provides further discussion as part of the Comprehensive Framework for Miami-Dade County.

4.4 Arrays of Alternatives

Alternatives are a set of one or more management measures functioning together to address one or more planning objectives. All measures carried forward were included in the development of alternatives to ensure that each was represented in the proposed array, either as a standalone measure or a combination of measures creating an alternative specific to the Focus Areas.

The Focus Area includes a total of 4,875 buildings. Of those buildings, 140 buildings did not contain sufficient parcel data to inform the PDT of the occupancy types, construction types, foundation hypes, or foundation heights to run economic analysis in the FWOP condition. The FWOP condition run in economics included 4,735 buildings. **Table 4-3** depicts the alternatives considered for this study, and detailed information of each alternative is below the table which also includes the number and type of buildings analyzed in the FWP condition for each alternative.

Table 4-3. Alternatives Descriptions

Alternative Number	Alternative Name	Brief Description
1	No Action / FWOP	No action.

Alternative Number	Alternative Name	Brief Description
2	CI Alternative	Analyzing nonstructural measures, primarily floodproofing, for CI within the Focus Areas.
3	Nonstructural Alternative	Elevating single-family residential buildings, elevating multifamily residential buildings of up to four units, and dry floodproofing nonresidential buildings within the Focus Areas.
4	CI + Nonstructural Alternative	Combination of Alternatives 2 and 3.
5	CI + Subset of Nonstructural Alternative	Similar to Alternative 4 but focuses on residential buildings that are at the highest risk to coastal storm surge.

The No Action/Future Without Project Alternative (Alternative 1) is required to be included and analyzed by the National Environmental Policy Act (NEPA) in an Environmental Assessment (EA). The No Action/FWOP Alternative would involve no federal project or USACE action to manage risk from coastal storms. This alternative is an important part of analyses because it serves as the basis for comparison between the FWOP and FWP conditions. The No Action Alternative, or FWOP condition, is compared against other project alternatives that represent potential FWP conditions, and the difference between these alternatives comparisons produces the economic, environmental, and social effects of the actionable alternatives that are used in decision-making and plan selection.

The CI Only Alternative (Alternative 2) investigated solutions for managing coastal storm risk to priority asset categories throughout and nearby the Focus Areas. The risk management method applicable to CI is dry floodproofing. The PDT received significant input from municipalities, stakeholders, and the NFS regarding which CI facilities were the most at risk and posed the most potential risk to life safety and human health if damaged or taken offline during/after coastal storms. The team also worked closely with the Miami-Dade Water and Sewer Department (WASD) to analyze pump stations and water treatment plant facilities. The Central Wastewater Treatment Plant on Virginia Key was a notable critical facility that was not included in the analyses and recommendation but will be a priority for further consideration in post-2024 feasibility efforts. The economics Appendix A-5 contains more details on the coordination to develop a new DDF for this facility. Alternative 2 includes floodproofing 27 CI that were coordinated extensively with Miami-Dade County, municipalities, resource agencies, and other key stakeholders. The full list is shown in **Table 9-4**.

The Nonstructural Alternative (Alternative 3) recommends solutions that can be implemented by incorporating flood mitigation features at the individual property level in the Focus Areas. Elevating and floodproofing are the recommended solutions for nonstructural measures. Elevation would only be applicable to single-family residential buildings and multifamily residential buildings of four units or less, whereas floodproofing applies only to nonresidential buildings. This alternative does not significantly change the overall floodplain, but it prevents and/or reduces the impact of inundation on these buildings.

Nonstructural measures are permanent or contingent measures applied to a building and/or its contents that prevent or provide resistance to damage from flooding. Nonstructural measures differ from structural measures because they focus on reducing the consequences of flooding instead of focusing on reducing the probability of flooding. Alternative 3 includes floodproofing 403 nonresidential buildings and elevating 1,731 single-family residential buildings and 326 multifamily residential buildings of four units or less.

The CI and Nonstructural Alternative (Alternative 4) is a combination of Alternatives 2 and 3 which includes floodproofing 27 CI and 403 nonresidential buildings and elevating 1,731 single-family residential buildings and 326 multifamily residential buildings of four units or less. This only includes 2,487 buildings out of the total 4,875 buildings in the Focus Area since buildings that were not carried forward for analyses in this alternative included the buildings for which sufficient data was lacking to complete modeling/evaluations and assess the potential benefits/impacts of applying a CSRM measure. Because of the schedule constraints for including recommendations in WRDA 2024, the team made the risk-informed decision to shift these buildings to further consideration and analyses in the study effort post-2024 WRDA when there is anticipated to be sufficient time for collecting and/or developing the modeling data needed. These buildings will be a priority for analyses and evaluation in the next feasibility effort and are described in further detail in **Table 4-4** below:

Table 4-4. Priority Buildings for Future Study Efforts

Asset Category	Count	Description
Multifamily Residential	2,160	Multifamily residential buildings for all unit sizes
Nonresidential	84	Hotels, Religious buildings, nursing home or dormitories, clinics, and high rise buildings. There were 4 communication buildings listed as CI, but further investigation determined that the critical component was on the rooftop and not at risk.
Critical Infrastructure	4	3 hospitals, Central Wastewater Treatment Plant
Unknown	140	Parcel data was insufficient.

Multifamily residential buildings of 4 units or more along with hospitals would be further investigated in the Nonstructural Program described in Section 6. Nonresidential, CI including the Central Wastewater Treatment Plant, and the unknown parcels would be further investigated in post-WRDA 24 study efforts.

The CI and Subset of Nonstructural Alternative (Alternative 5) is an optimized version of Alternative 4 that includes both CI and nonstructural measures for residential and nonresidential buildings. This optimized alternative screened out the individual buildings that were not incurring flood inundation damages, meaning they were determined to be at low risk to coastal storm damage. Low-risk buildings also included those of which the building's first-floor elevation is already at, or near, the design water surface elevation. Alternative 5 includes floodproofing 27 CI and 403 nonresidential buildings and

elevating 460 single-family residential buildings and 324 multi-family residential buildings of four units or less.

4.5 Plan Evaluation

Evaluating plans helps decision-makers understand the difference each plan can make. The differences are usually quantified by comparing FWOP and FWP conditions to identify the effects of alternative plans. The main purpose of plan evaluation is to determine whether a plan that has been formulated is worthy of further consideration.

4.5.1 Four Evaluation Accounts

In the 1970 Flood Control Act, P.L. 91-611, Congress identified four, equal national objectives for use in water resources development planning (42 U.S.C. § 1962-2). These objectives are National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). All four categories of plan effects remain important considerations of water resource projects.

4.5.1.1 National Economic Development Account

The NED Account displays changes in the economic value of the national output of goods and services. It is referred to repeatedly throughout the planning process and forms the basis of the federal objective. Alternatives that reasonably provide the largest net NED benefits are referred as the "NED Plan." **Table 4-5** shows the economic results for each refined Focus Area with the estimated damages. The benefits include benefits accrued during construction based on randomizing buildings being selected to be built first throughout the construction period. There are two CI in the City of Aventura, which has been included under Biscayne Canal because that is the nearest Focus Area.

Table 4-5. Future With and Without Project Condition Results ($1,000s)

Measure	Focus Area	Present Value Future Without Project Estimated Damage	Present Value Future With Project Estimated Damage	Benefits over 50 Years
CI	Biscayne Canal	$11,000	$8,000	$3,000
	Cutler Bay	$5,000	$2,000	$3,000
	Miami River	$73,000	$37,000	$36,000
	North Beach	$40,000	$13,000	$27,000
	South Beach	$195,000	$12,000	$183,000
Nonstructural	Biscayne Canal	$252,000	$168,000	$84,000

Measure	Focus Area	Present Value Future Without Project Estimated Damage	Present Value Future With Project Estimated Damage	Benefits over 50 Years
	Cutler Bay	$564,000	$219,000	$345,000
	Little River	$527,000	$368,000	$159,000
	Miami River	$629,000	$440,000	$189,000
	North Beach	$1,268,000	$943,000	$325,000
	South Beach	$1,153,000	$836,000	$317,000
Total		$4,717,000	$3,046,000	$1,671,000

The FWP in **Table 4-5** is based on elevating residential buildings 12' above ground elevation and floodproofing nonresidential and CI 4' above ground elevation. Further analysis would be needed in the PED Phase when surveying each building to identify if buildings are sufficiently structurally stable and reinforced to be floodproofed.

Net Remaining Benefits per Alternative

The PDT also needed to determine which alternative produces the most benefits for every dollar of cost. **Table 4-6** shows the economic analysis for all the alternatives previously discussed in Section 4.4.

Table 4-6. Benefit-to-Cost Ratio and Net Benefits of All Alternatives

Alternative	Total Average Annual Benefits	Total Average Annualized Cost	Project First Cost	Benefit-to-Cost Ratio (BCR)	Net Annual Benefits
Alternative 1. No Action / FWOP	$0	$0	$0	N/A	$0
Alternative 2. CI	$9,000	$5,000	$110,000	1.8	$4,000

Alternative	Total Average Annual Benefits	Total Average Annualized Cost	Project First Cost	Benefit-to-Cost Ratio (BCR)	Net Annual Benefits
Alternative 3. Nonstructural	$53,000	$116,000	$2,550,000	0.46	-$63,000
Alternative 4. CI + Nonstructural	$62,000	$121,000	$2,660,000	0.51	-$59,000
Alternative 5. CI + Subset of Nonstructural	$56,000	$74,000	$1,560,000	0.76	-$18,000

Note: October 2023 FY(24) price level, Period of Analysis: 50 years, Values displayed in $1,000's, Rounded, Interest Rate 2.75%

The total average annualized cost (AAC) shows the total project cost, which includes interest during construction and operation and maintenance, annualized over the economic period of analysis of 50 years. The total average annual benefits (AAB) are multiplied by the capital recovery factor (CRF) of 0.037, which is based on the interest rate of 2.75 percent to annualize the benefits. Calculation of the CRF was based off the 2024 federal water resources discount rate, which was the most up-to-date rate at the time of that analysis. The benefit-to-cost ratio (BCR) is the annualized benefit divided by the annualized cost. The BCR of a project must be greater than or equal to one for the federal government to make an investment in a project. This can be obtained solely on damage reduction benefits, or a combination of one of the other four accounts described later in this section. **Table 4-6** shows that Alternative 2 is the alternative that reasonably maximizes net NED benefits as required by ER 1105-2-103, which results in the NED Plan.

4.5.1.2 Environmental Quality Account

The EQ Account displays nonmonetary effects on ecological, cultural, and aesthetic resources. During plan formulation, avoidance and minimization of impacts to the human environment, to the extent practical, was considered an integral component of plan formulation. Section 7, Environmental Compliance, provides an analysis of environmental impacts associated with each alternative.

4.5.1.3 Regional Economic Development Account

The RED Account displays the regional and localized economic impacts that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income,

employment, output, and population. Appendix A-5, Economic Environment and Social Considerations, provides more information on this account.

4.5.1.4 Other Social Effects Account

The OSE Account registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts. Miami-Dade County and the PDT reviewed the array of four alternative action plans, in addition to the FWOP alternative, based on OSE metrics. Consideration was given to the public and stakeholder feedback and comments received throughout the study process. The rating scheme used to rank the plans was based on the Institute for Water Resources' handbook for Applying Other Social Effects in Alternatives Analysis (2013). Scores were assessed relative to the impact an alternative would have on a specific metric in relation to the No Action Alternative. The assessment was made from an overall planning perspective and not based on impacts on individuals or small groups. **Table 4-7** summarizes the metrics used for comparison and evaluation of the alternative plans.

Table 4-7. Other Social Effects Comparison and Evaluation Metrics

Factor	Metric	Description
Health and Safety	Human Health	Issues affecting a person's physical health (e.g., air quality, diseases) or mental health such as anxiety and stress (e.g., threat of flooding, transportation concerns, noise)
	Life Safety	Safety issues that could cause bodily harm to a person (e.g., flood waters, crime)
Economic Vitality	Business Climate	Issues affecting the ability of a community to retain and attract businesses
	Tourism Revenue	Issues affecting the tourism industry (e.g., visitation numbers, hospitality industry)
	Real Estate Values	Issues affecting the value of property and real estate
Social Connectedness	Community Cohesion	Issues affecting local social networks, including personal networks
	Local / Cultural Identity	Issues affecting sense of community, local, and/or cultural identity within a community (e.g., historical significance, cultural significance, how others see the area)

Factor	Metric	Description
Community Resilience[1]	Prepare and Participate	Promoting community education and awareness, including emergency planning and buying flood insurance to improve interaction and influence on social outcomes
	Absorb	Improving community resilience by reducing future impacts of coastal storm surge
	Recover	Considering CI, such as police stations, fire stations, utilities, evacuation routes, hospitals, and emergency shelters, that increase the speed with which an impacted community can recover from an event
	Adapt	Considering nonstructural measures, e.g., zoning, relocation
Environmental Justice	Socially Vulnerable Populations	Issues affecting socially vulnerable groups (e.g., low income, minority, elderly, children, disabled)
Recreation	Recreational Opportunities	Issues affecting available leisure time, and access to, or availability of, recreational activities (e.g., parks, trails, water access)

[1]Based on the four USACE Resilience Principles, community resilience is defined as the probability of a community being damaged or negatively affected by hazards and its ability to recover from a traumatic event.

This method uses a -3 to 3 scale, representing the possible range of impacts and effects the proposed alternative has on the specific metric:

-3: High negative impacts

-2: Moderate negative impacts

-1: Minor negative impacts

0: Negligible effects (no impact)

1: Minor beneficial effects

2: Moderate beneficial effects

3: High beneficial effects

All metrics were scored for each of the four action alternatives, and the No Action/FWOP alternative, with consideration regarding how that alternative would impact the metric in the future. The scores for each metric were then summed to determine the total impact of each alternative, with a higher positive value indicating the alternative with the most significant beneficial effects. **Table 4-8** displays the OSE matrix. **Table 4-3** (Section 4.4) provides descriptions of each alternative number.

Table 4-8. Other Social Effects Matrix

Factor	Metric	Alternatives					Reasoning
		1	2	3	4	5	
Health and Safety	Human Health	0	1	1	3	2	Risk management of CI improves emergency response following a storm event. Risk management of residential and nonresidential buildings manages coastal risk of damages to buildings and contents. An action alternative provides a future condition that most likely represents less stress and anxiety on the occupant and/or owner knowing after evacuating and returning post-storm that their building and contents could be potentially less damaged and more livable. Even during non-storm events, populations are more likely to have a better peace of mind knowing emergency response would be available and houses would experience reduced risks. **The combination of CI and nonstructural measures would have better results than CI alone or nonstructural measures alone. Together, these measures complement each other to more positively protect human health than when either CI or nonstructural measures are implemented individually.** This categorical quantitative analysis is based on the impacts of comparing Alternative 2 (27 CI floodproofings only with 95% residual risk); Alternative 3 (no action for CI and 2,057 residential elevations with 70% residual risk); Alternative 4 (27 CI floodproofings and 2,057 residential elevations with 65% residual risk); and Alternative 5 (27 CI floodproofings and 784 residential elevations with 76% residual risk) to the No Action Alternative.
	Life Safety	0	1	3	3	2	Risk management of CI improves emergency response and services during and following a storm event. Life loss analysis shows more lives would be saved implementing Alternatives 3 and 4 with assumed evacuation rates and building populations. The estimated number of "lives saved" for Alternative 1 would be zero; Alternative 2 would be minimal; Alternative 3 would be 437; Alternative 4 would be 437; and Alternative 5 would be 79. The economic model did not analyze lives at risk for CI. However, based on local information, some emergency responders would be at their stations during the event.
Economic Vitality	Business Climate	0	1	2	2	2	Nonstructural measures, specifically dry floodproofing, that manage risk to 403 nonresidential buildings for Alternatives 3, 4, and 5 would increase community

Factor	Metric	Alternatives					Reasoning
		1	2	3	4	5	
							resilience and the potential for business retention. Risk management of CI improves resiliency of emergency response following a storm event.
	Tourism Revenue	0	0	0	0	0	Hotels, which represent the residency for tourists, were not assigned measures to reduce damages from storm surge. Although nonstructural measures to residential and nonresidential buildings and CI would increase community resilience and improve the reentry time, the future condition of the hotel would not change.
	Real Estate Values	0	0	2	2	1	Values of properties may reduce because of recurring flooding events. It is not known if values of properties increase once a measure is applied; however, homes that are elevated most likely can get more offers because of the reduced risk of flooding, potentially increasing real estate values.
Social Connectedness	Community Cohesion	0	1	1	3	2	Not having any measures could adversely impact social cohesion of neighborhoods because of recurring or large flood events. Risk management of CI improves emergency response **following** a storm event, which can make residents feel safer in those neighborhoods. Nonstructural measures manage risk to residences and businesses for improved community resilience, which can improve local social and personal networks; however, this is a voluntary program and not everyone may participate. **The combination of CI and nonstructural measures would have better results than CI alone or nonstructural measures alone. Together, these measures complement each other to elicit more positive change in community cohesion than when either CI or nonstructural measures are implemented individually.** This categorical quantitative analysis is based on the impacts of comparing Alternative 2 (27 CI floodproofings only with 95% residual risk); Alternative 3 (no action for CI and 2,057 residential elevations with 70% residual risk); Alternative 4 (27 CI floodproofings and 2,057 residential elevations with 65% residual risk); and Alternative 5 (27 CI floodproofings and 784 residential elevations with 76% residual risk) to the No Action Alternative.
	Local / Cultural Identity	0	1	1	3	2	Nonstructural measures manage risk to residences and businesses for improved community resilience, which can improve how others see the area and improve local

Factor	Metric	Alternatives					Reasoning
		1	2	3	4	5	
							identities. The reasons to rate this metric align with those of community cohesion.
Community Resilience (Based on 4 USACE Resilience Principles)	Prepare	0	1	1	3	2	Promoting community education and awareness, including emergency planning, and buying flood insurance would prepare communities to be more resilient. Risk management measures would improve community resilience by reducing future impacts of coastal storm surge. Recovery would be dependent upon functioning CI, such as police stations, fire stations, utilities, reentry routes, and hospitals, to increase the speed with which an impacted community can recover from a storm surge event. This study does not address impacts to utilities, reentry routes, or hospitals. Nonstructural measures would adapt CI, residences, and nonresidential communities to be more resilient. Risk management of CI would improve emergency response during and following a storm surge event. Those alternatives that include nonstructural measures for both CI and residential and nonresidential buildings would most likely prepare communities better than alternatives that do not address either CI or residential and nonresidential buildings.
	Absorb	0	1	1	3	2	
	Recover	0	1	1	3	2	
	Adapt	0	1	1	3	2	
Environmental Justice	Socially Vulnerable Populations	0	1	2	3	2	Focus Areas for this study were based on identifying CSRM measures in environmental justice communities; therefore, all action alternatives will directly increase the resiliency of environmental justice communities.
Recreation	Recreational Opportunities	0	0	1	2	1	While direct recreational activities are not being managed for risk, action alternatives may increase some opportunities for residential homeowners to return to a home quicker if it needs fewer repair post-storm, leading to more time for recreational opportunities.
Total Score:		0	10	17	33	22	

The OSE matrix shows Alternative 1, the No Action/FWOP Alternative, as a neutral point because it is the baseline for comparing the action alternatives. The estimated change in the number of impacts on the communities from the No Action Alternative to the action alternative defines the numeric value assigned to the rating. In the No Action Alternative, the CI and residential and nonresidential buildings would become flooded or experience worsened flooding during future storm events. Those conditions would

negatively impact important commercial interests, residential buildings and social communities, and nonresidential buildings, and would directly threaten life safety and human health. However, since the No Action Alternative is a baseline condition and neutral, the rating score is zero. This allows the possibility of a full range of scoring from -3 to 0 to +3—from negative effects to negligible effects to significantly positive effects—for the action alternatives. Appendix A-5, Section 4.3.1 Life Loss Analysis, provides more information regarding how life loss is calculated.

Alternative 2 has the lowest positive score because it includes CI only and lacks any risk management for residential and nonresidential properties. Alternative 3 has the third highest positive score because it includes risk management for residential and nonresidential properties only, without any CI. Alternative 5 scores the second highest because it includes CI and nonstructural measures, with a reduced subset of residential buildings. Alternative 4 scores the highest with a value of 33. The high score for Alternative 4 is a result of the significant positive impacts made across OSE metrics, allowing Miami-Dade County to be the most resilient and providing the greatest level of risk management. Alternatives 4 and 5 have the same number of CI, nonresidential buildings, and multifamily residential buildings. However, Alternative 5 includes fewer single-family residential buildings, resulting in less impact across the OSE metrics, which results in a lower score than Alternative 4.

This analysis was used in addition to other analyses performed throughout the study to inform the PDT's decision-making process for choosing the alternative that best meets the project objectives and most reasonably maximizes economic net benefits while minimizing adverse impacts.

5 MIAMI-DADE BACK BAY NATURE-BASED SOLUTIONS PILOT PROGRAM

5.1 Introduction

Nature-Based Solutions (NBS) are currently being considered under several United States Army Corps of Engineers (USACE)–sponsored Coastal Storm Risk Management (CSRM) feasibility studies throughout the nation. NBS are engineered features designed to act in concordance with natural features to provide flood risk management (Section 1184 of Water Resources Development Act [WRDA] 2016, P.L. 114-322). Similarly, the International Guidelines on Natural and Nature-Based Features for Flood Risk Management defines natural and nature-based features (NNBF) as the use of landscape features to produce flood risk management benefits (Bridges et al. 2021a). Historically, incorporating NBS as a solution for managing coastal storm risk has been a challenge for feasibility studies because of the difficulty in quantifying the economic benefits associated with these measures and minimal agency guidance. In some studies, NBS are investigated under a project authority for hurricane and storm damage reduction and ecosystem restoration, such as the Coastal Texas Protection and Restoration Feasibility Study authorized under Section 4091, WRDA 2007, Public Law 110-114, allowing for the combination of CSRM and ecosystem restoration measures as part of a comprehensive approach for risk

What are Nature-Based Solutions?

Nature-based solutions are flood risk management solutions

that use natural features with sustainable engineering design to enhance resilience to coastal storms while also providing additional environmental co-benefits.

management and restoration. A recent USACE policy directive, Comprehensive Documentation of Benefits in Decision Document (January 2021), widens the lens of "benefits" of a Civil Works planning study to a comprehensive consideration of total project benefits, including economics, environmental, and social categories. Additionally, the International Guidelines on Natural and Nature-Based Features [NNBF] for Flood Risk Management released in 2021 provide extensive documentation for informing the use of NBS in support of flood risk management goals and objectives (Bridges et al. 2021b). Nevertheless, study teams are still challenged with the absence of consistent methodology and data to evaluate the performance of different types of NBS to inform comprehensive benefits evaluation. NBS can be useful and independently justified (i.e., apart from other types of measures) for managing risk during high-frequency, less-intense storm events by providing flood and erosion risk benefits that may accumulate over time, as evidenced in the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay CSRM Feasibility Study (USACE 2019). However, NBS alone are insufficient for completely managing risk associated with powerful and life-threatening storm surge events. Thus, the Miami-Dade Back Bay NBS Pilot Program's (NBS Pilot Program) primary objectives are to 1) inform knowledge gaps and USACE guidance related to quantifying the benefits associated with various types of NBS and 2) contribute toward the County's comprehensive coastal resilience strategy.

5.2 Purpose and Need

The NBS Pilot Program's purpose is to develop a suite of demonstration projects that will individually inform the calculation of CSRM benefits provided by different types of NBS, and collectively contribute to a greater understanding of how NBS reduce coastal storm damage to property and infrastructure in the study area. The future pilot projects will be independently justified measures that support Miami-Dade County's resilience objectives of managing coastal storm risk using a multiple-lines-of-defense strategy. Pilot projects are needed to address specific data and information gaps associated with the quantitative evaluation of CSRM benefits and to examine the effectiveness of CSRM solutions while simultaneously leveraging environmental co-benefits. Additional co-benefits achieved through the future implementation of pilot demonstration projects may include:

a. Enhancing public safety
b. Restoring and protecting aquatic ecosystem habitats
c. Stabilizing and enhancing shorelines
d. Promoting recreation
e. Supporting risk management adaptation strategies
f. Providing ecosystem services

What is a Pilot Project?

A pilot project is defined herein as a demonstration project utilizing nature-based features with the explicit intent to inform the developing science (i.e., modeling tools, analysis and evaluation methods) across the USACE to determine level of performance and economic justification of NBS for incorporating NBS in future CSRM feasibility studies.

To contribute to a broader understanding of the effectiveness of NBS and inform the benefits NBS provide, the Miami-Dade Back Bay CSRM Feasibility Study includes a programmatic authorization to establish a Pilot Program. Under the NBS Pilot Program's framework, multiple NBS pilot demonstration projects throughout Miami-Dade County would be evaluated, designed, implemented, and monitored to evaluate

their effectiveness. A pilot demonstration project is defined herein as a nature-based feature constructed as a demonstration project to inform the developing science (i.e., modeling tools, analyses, and evaluation methods) used across USACE to determine the level of performance and economic justification of NBS for incorporation in future CSRM feasibility studies. Additionally, future pilot projects (and thus the NBS Pilot Program) have independent utility from the broader measures to be considered as part of the current study and other future studies to address coastal storm surge. Nevertheless, project implementation would contribute to local and municipal efforts toward building resilience across Miami-Dade County.

USACE has previously implemented the "pilot project" concept. Most notably, numerous pilot projects were authorized as part of the Comprehensive Everglades Restoration Plan (CERP) in WRDA 2000, P.L. 106-541, to demonstrate aquifer storage and recovery (ASR) technology, seepage management technology, and wastewater reuse technology. Section 1122 (a) through (h) of WRDA 2016, P.L. 114-322, directs the secretary to establish a pilot program consisting of 10 pilot projects for the beneficial use of dredged material for certain specified purposes. The pilot projects are currently in various stages of design and construction. USACE has also conducted targeted pilot studies to test innovative ideas and develop policy and guidance to improve knowledge across USACE regarding climate change impacts and adaptation (September 2012). Site-specific pilot demonstration projects would be proposed in the future for implementation as part of the NBS Pilot Program.

5.3 Background

NBS are designed to incorporate the processes and functions of natural systems resulting in solutions for flood risk management that are flexible, adaptable, and have the potential for natural recovery (Bridges et al. 2021b). General flood risk management benefits of NBS may include reducing storm surge water levels, attenuating wave energy, reducing erosion, floodwater retention, and stabilizing sediments. The International Guidelines on NNBF for Flood Risk Management distinguish benefits into two categories: (1) risk management and resilience benefits and (2) co-benefits (**Figure 5-1**).

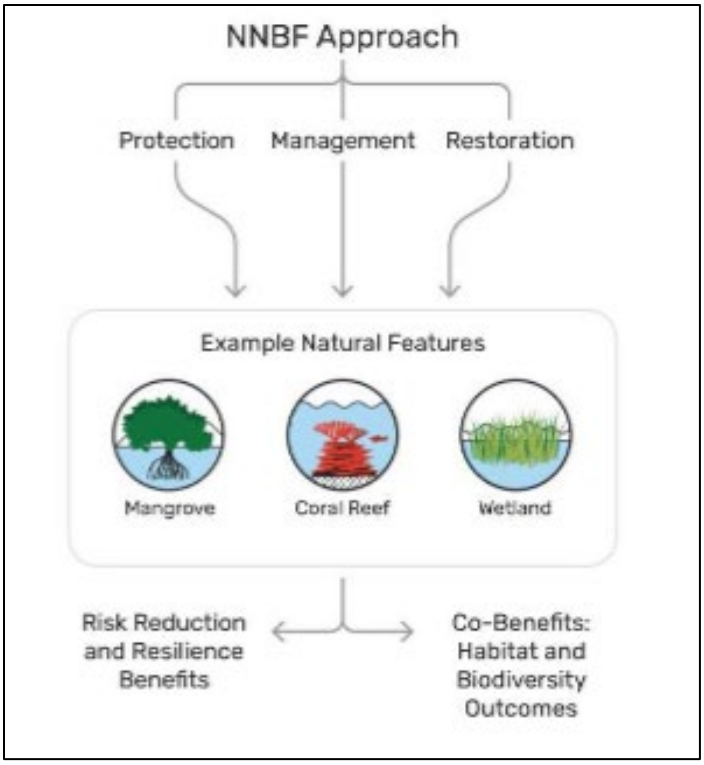


Figure 5-1. Visualization of Benefit Categories for Natural and Nature-Based Features (Van Zanten et al. 2021)

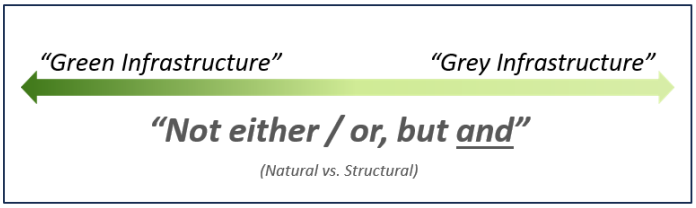
Risk management and resilience benefits focus on flood risk management and erosion control through various risk management properties, such as storm surge or wave attenuation, overtopping, or flood storage. Co-benefits encompass other environmental and social benefits, such as habitat creation, water quality improvement, carbon sequestration, tourism and recreation, or human health benefits.

In recent years, public and stakeholder interest in advancing NBS as a CSRM measure to improve community resilience has greatly expanded and is documented as part of stakeholder and public comments for several ongoing CSRM feasibility studies. While interest in NBS has increased within communities and at the grassroots level, Executive Order (EO) 14072, Strengthening the Nation's Forests, Communities, and Local Economies (April 2022), underscores federal recognition of the importance of NBS for addressing the climate crisis and enhancing resilience.

While some stakeholders are familiar with USACE designing and implementing nature-based features as part of other previously authorized ecosystem restoration studies like Biscayne Bay Southeastern Everglades Ecosystem Restoration (BBSEER), there may be less familiarity with considering NBS for mitigating storm surge risk in urbanized areas. Public and stakeholder input throughout the course of the current Miami-Dade Back Bay CSRM Feasibility Study, including the one-year evaluation period that occurred between August 2022 and August 2023, generated substantial interest in considering NBS to manage coastal storm risk in Miami-Dade County. However, extensive urbanization and coastal development, particularly for major metropolitan areas such as Miami-Dade County, presents a challenge for implementing NBS (Guerry et al. 2022). Based on the feedback received from the public, resource

agencies, local governments, and USACE stakeholders during the charrettes held in November 2022 and March 2023, opportunities exist throughout Miami-Dade County to construct NBS as independently justified projects that contribute to a multiple-lines-of-defense strategy for CSRM.

Miami-Dade County's vision for CSRM reflects a multiple-lines-of-defense strategy that focuses on leveraging or enhancing existing natural infrastructure features in combination with other built CSRM measures across the geographic landscape, to provide a regional approach to risk management. The multiple-lines-of-defense strategy incorporates redundancies and establishes or enhances "lines of defense" against coastal storms, thereby contributing to robust and resilient coastal communities (refer to Figure 2-1). From east to west, the Florida Reef Tract (offshore) is the first natural line of defense against coastal storms. The second natural line of defense includes the barrier islands beaches/dunes. Within Biscayne Bay, human-made islands and existing natural features such as mangroves/seagrasses attenuate wave energy, though seagrass habitat in Biscayne Bay has experienced substantial declines in recent years because of poor water quality conditions. Living shorelines, such as the Brittany Bay Park project in Miami Beach completed in 2023, also provide flood risk management benefits, in addition to numerous environmental and social co-benefits.



While NBS can independently mitigate some coastal storm risk, natural infrastructure alone is insufficient to completely address coastal storm risk in Miami-Dade County's existing built environment, particularly with the increasing trend of stronger and more frequent storms and powerful storm surges that threaten human health and safety. For example, Hurricane Ian made landfall near Cayo Costa in Lee County, Florida, in September 2022, with reported storm surges between 12 and 14 feet, resulting in devastating impacts to numerous coastal communities. It is important to acknowledge the residual risk that remains, particularly for coastal storms characterized by devastating storm surges. Consequently, the spectrum of solutions for managing coastal storm risk should be a multiple-lines-of-defense approach, and it should include green and gray infrastructure, where appropriate; the two are not mutually exclusive. **Figure 5-2** depicts a range of general typologies of green and gray infrastructure for shoreline protection. Sutton-Grier et al. (2015) document the ability of natural (i.e., green, such as wetlands, coral reefs, and mangrove forests) infrastructure to maintain pace with sea level change as one of several strengths of this type of infrastructure in comparison with conventional (i.e., gray) infrastructure, which has a built lifespan and does not adapt with changing conditions such as sea level change.

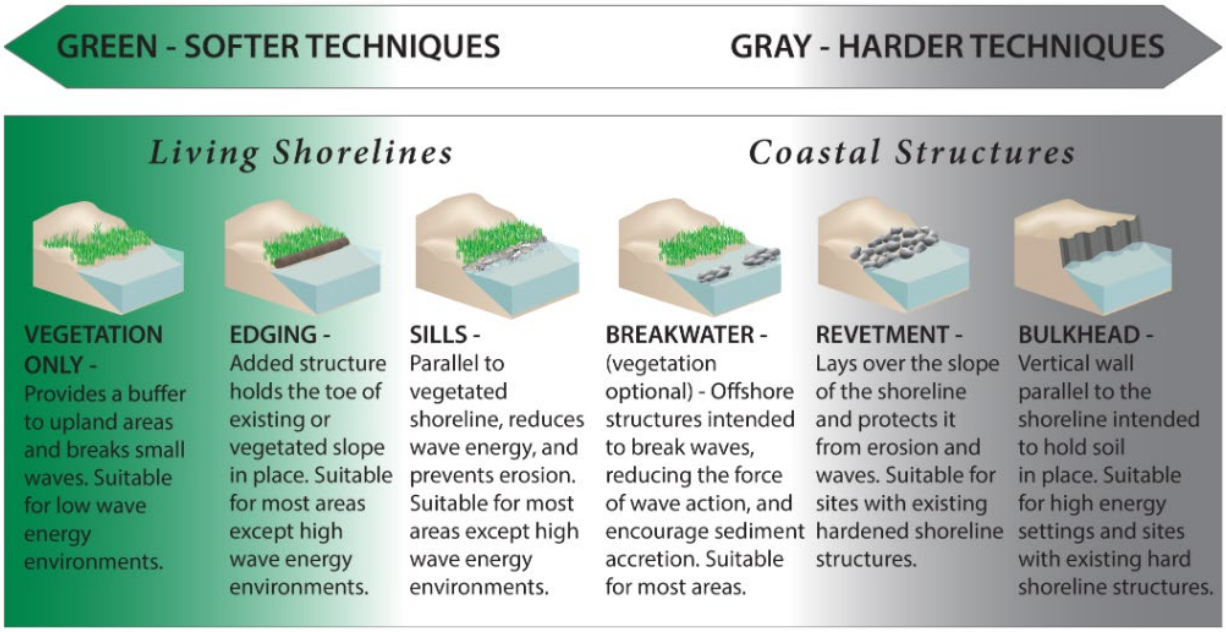


Figure 5-2. Green and Gray Infrastructure Concepts (Source: NOAA 2024b)

The long-term success of various adaptation strategies to address coastal storm surge risk should include a combination of both green and gray infrastructure projects that demonstrate independent utility and benefits consistent with Miami-Dade County's resilience strategy. Additionally, the integration of federal, state, and local efforts undertaken to address risk in the context of a changing climate must also be considered as part of a comprehensive resilience strategy.

The economic valuation of benefits provided by different types of natural infrastructure, such as mangroves, for example, is documented, and ongoing laboratory and field research efforts continue to inform the expanding knowledge base of risk management benefits. Using a coupled modeling approach, Menendez et al. (2020) concluded that mangroves provide more than $500 million annually in avoided property damages for some cities, such as Miami and Cancún. Mangroves are recognized for their ability to reduce surge heights, reduce water flow velocities, and reduce inundation levels caused by coastal storms (Dasgupta et al. 2019; Zhang et al. 2012; Krauss et al. 2009). As part of an Engineering With Nature (EWN) technical note, Tomiczek et al. (2021) documents a thorough review of previous empirical, field, and laboratory studies on the efficacy of mangroves for coastal protection. This technical note also identifies existing knowledge gaps, such as the need to define standardized engineering performance metrics, as well as the need to quantify the collective contribution of co-benefits of mangrove systems. Mangroves serve as nursery habitats and foraging grounds for numerous species, and they provide extensive ecosystem benefits ranging from erosion reduction benefits (Penings et al. 2021) to carbon sequestration (Ezcurra et al. 2016).

Another example of natural infrastructure that can provide numerous environmental co-benefits and dissipate wave energy is coral reefs (Ferrario et al. 2014). Beck et al. (2018) estimated annual expected benefits of coral reefs in terms of avoided flood damages and concluded that the United States ranked among the top 10 countries globally that receive the most flood protection benefits from coral reefs, at an

estimated $94,000,000 in annual averted damages. Storlazzi et al. (2021) quantified the coastal flood risk increase caused by damages sustained by existing reef systems in Florida and Puerto Rico during Hurricanes Irma and Maria in 2017 and concluded that the annual value of increased flood risk is at a minimum $181.5 million (in 2010 United States dollars). Novel engineering designs for hybrid (i.e., the combination of green and gray infrastructure features) reef structures are under development and evaluation to better understand their potential for attenuating wave energy and improving coastal resilience. Recent grant-funded research efforts led by the University of Miami include the development of innovative wave-attenuating structures that promote coral settlement and growth to understand their effectiveness at reducing erosion, attenuating wave energy, and increasing resilience. These research efforts are being conducted under the Reefense program sponsored by the Defense Advanced Research Projects Agency (DARPA). The Reefense program aims to develop hybrid, engineered solutions capable of self-healing (Campbell 2022). In March 2023, hybrid honeycomb-shaped structures were deployed off Miami Beach as part of a separate initiative under the Engineer Coastal Resilience Through Hybrid Reef Restoration, or ECoREEF, supported by the University of Miami's Laboratory for Integrative Knowledge (U-LINK) and the City of Miami Beach

Seagrasses can attenuate wave energy (Paul and Amos 2011) in addition to providing a myriad of ecosystem services such as improving water quality, providing nursery habitat, stabilizing sediments, and preventing erosion. However, the wave-attenuating performance of seagrasses during strong storm events is not well understood (James et al. 2021). Manousakas et al. (2022) conducted a laboratory modeling effort and concluded that seagrass vegetation may reduce wave runup; however, various factors such as vegetation type, density, and location may also play an important role in the effectiveness of seagrass at mitigating wave energy. James et al. (2021) conclude that native Caribbean seagrass meadows can sustain major storm events and note the importance of surrounding ecosystems, such as coral reefs and shoreline vegetation. Furthermore, Guannel et al. (2016) conducted a modeling effort to investigate the collective contributions of coral reefs, seagrass meadows, and mangroves for coastal protection and concluded the importance of considering an integrated approach for assessing risk management provided by different types of marine habitats.

5.3.1 Geographic Considerations

The NBS Pilot Program would consider site recommendations for individual projects that reflect a diverse array of NBS types throughout Miami-Dade County and Biscayne Bay. Proposed site-specific pilot demonstration projects are not being identified at this time to maximize flexibility as the program moves forward; however, a process for informing site identification and selection follows. Initial preliminary screening efforts would take place to identify and select suitable locations for pilot demonstration projects using the principal criteria listed in Section 5.4.

Figure 5-3 delineates the three geographic regions of Miami-Dade County—north, central, and south—primarily by inlet contributing areas or the watershed area that drains from the land to the ocean through an identified inlet (Pickering and Baker 2015). This approach is consistent with Miami-Dade County's efforts for watershed-scale planning (Pickering and Baker 2015). Following is a summary of existing coastal landscapes of each region and a map depicting representative habitats of Miami-Dade County (**Figure 5-4**).

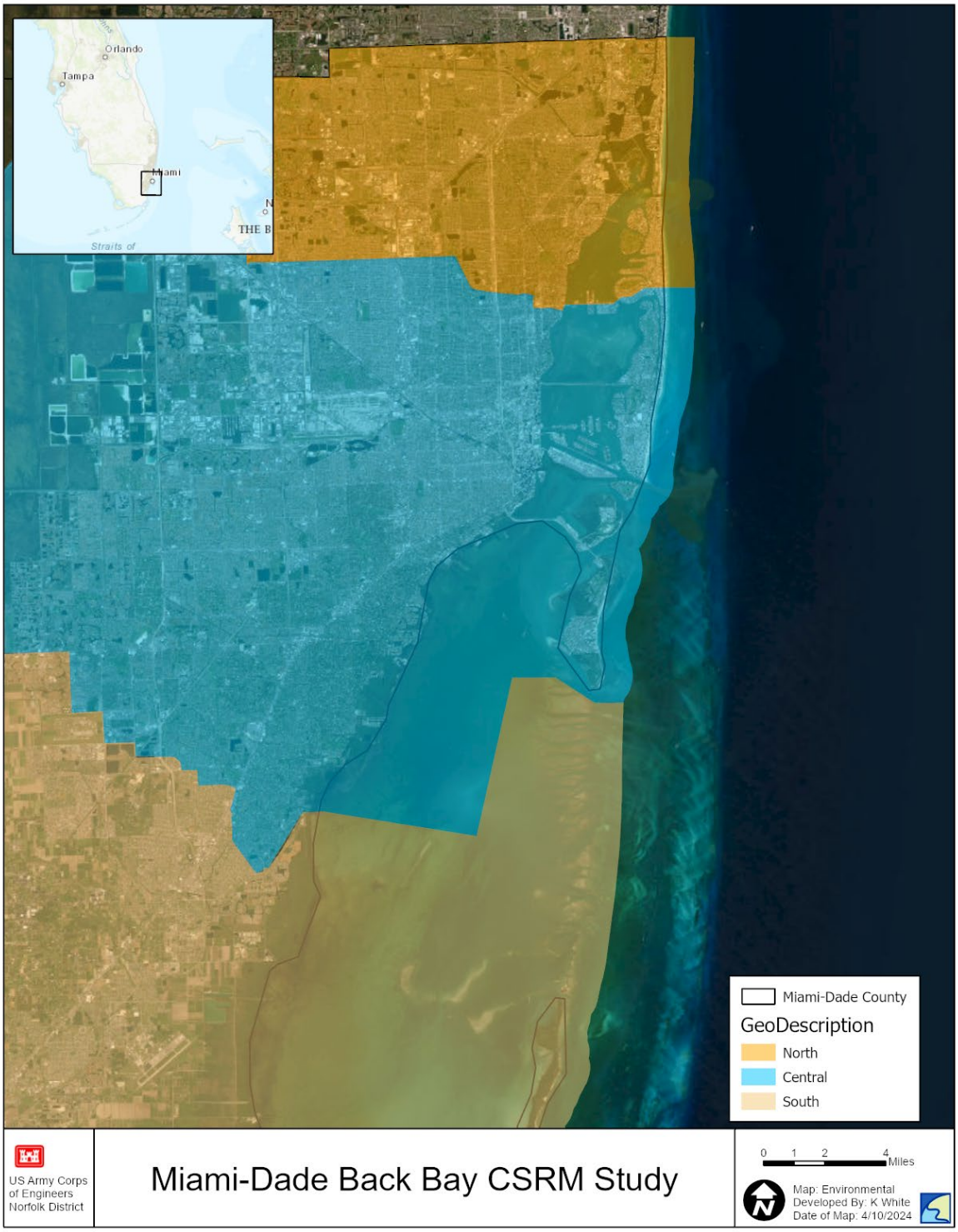


Figure 5-3. Geographic Regions of Miami-Dade County

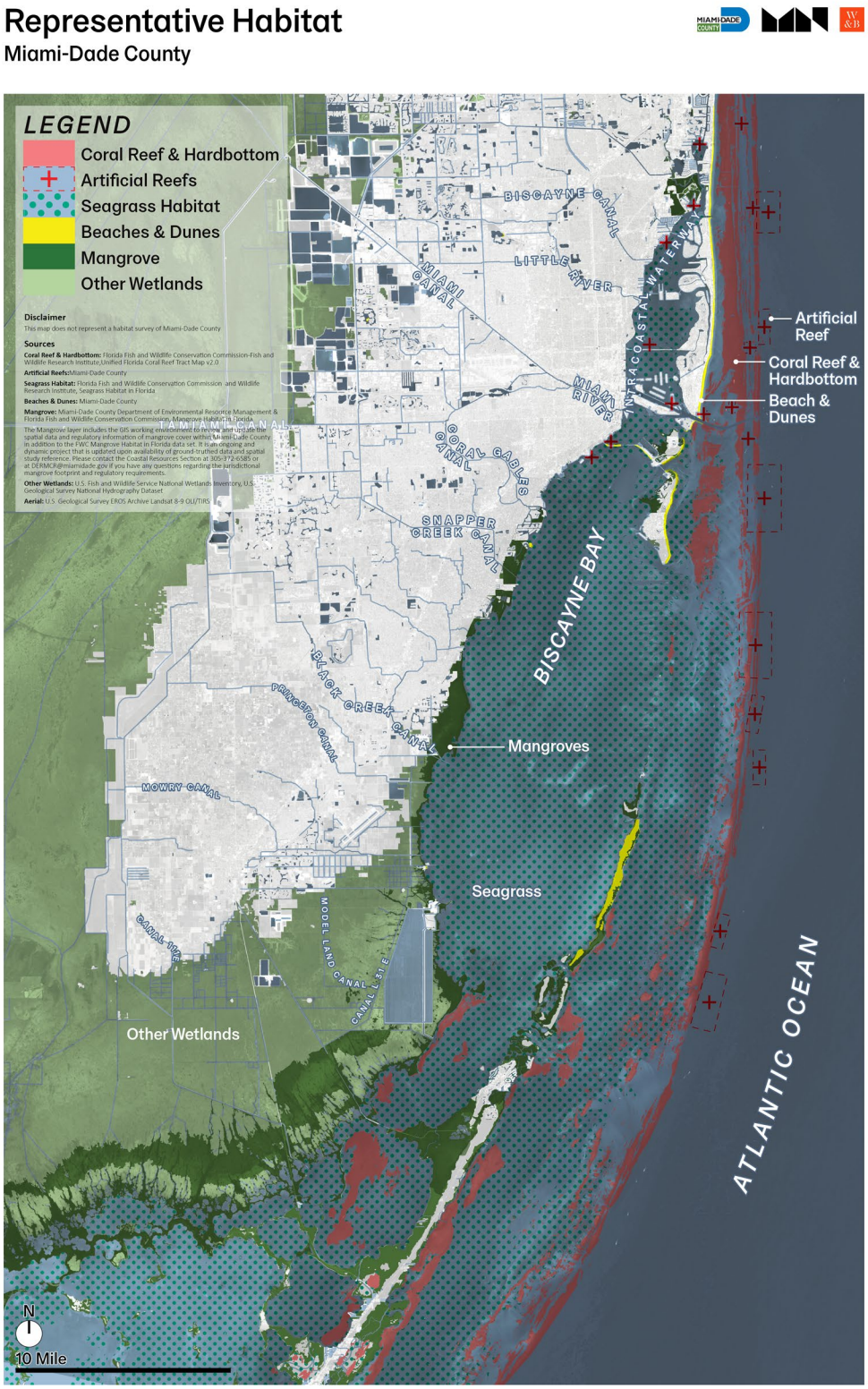


Figure 5-4. Representative Habitats of Miami-Dade County

North Miami-Dade County

The area identified as North Miami-Dade County begins at the northernmost extent of the study area and extends south to Interstate-195 (Julia Tuttle Causeway) and westward to the limits of Miami-Dade County. This geographic area includes beaches/dunes along the barrier islands of the Atlantic coastline. Included for reference purposes, the Florida Reef Tract is located offshore and is within the Kristin Jacobs Coral Reef Ecosystem Conservation Area. The Florida Reef Tract extends from St. Lucie Inlet in Martin County to the Dry Tortugas in the Gulf of Mexico. Offshore reefs provide the first natural line of defense against coastal storms for Miami-Dade County. Along the eastern portions of the Back Bay and within the Biscayne Bay Aquatic Preserve, shorelines adjacent to private property are developed in most of the area, which is also characteristic of the western coastline of the Back Bay. Natural shorelines composed of mangrove forests are located within the boundaries of Oleta River State Park to the north. Haulover Inlet is a major recreational thoroughfare between northern Biscayne Bay and the Atlantic Ocean. Several human-made islands previously constructed from dredge material, which also serve as recreational hotspots, are located throughout northern Biscayne Bay.

Central Miami-Dade County

Central Miami-Dade County's northern extent begins at Interstate-195 (Julia Tuttle Causeway) and extends to the northern extent of Biscayne National Park and westward to the limits of Miami-Dade County. This region also includes a portion of the barrier islands and dunes along the City of Miami Beach, which borders the Atlantic Ocean. Along the mainland western segment, the coast is highly developed with residential and commercial properties and marinas. Small pockets of natural shorelines are located adjacent to parks and recreational facilities. Similar to North Miami-Dade County, human-made islands previously constructed of dredged material are also present in this area.

South Miami-Dade County

The area identified as South Miami-Dade County begins at the southern extent of Virginia Key and extends south to the limits of the Miami-Dade Back Bay study area and westward to the Miami-Dade County limits. South Miami-Dade County is home to extensive stretches of coastal wetlands and mangrove forests. In contrast to much of the north and central coastlines of Miami-Dade County, extensive natural wetland and mangrove coastlines exist in this area, a large portion of which are encompassed within the boundaries of Biscayne National Park, which is managed by the National Park Service.

Table 5-1 presents CSRM-focused problems and opportunities for the three regions**.** The list is intended to identify current problems and opportunities that may be expanded upon in the future. It is not intended as a comprehensive, detailed list.

Table 5-1. Problems and Opportunities with a Coastal Storm Risk Management Focus Throughout Miami-Dade County

Problems	Opportunities
• Degraded shorelines and low-lying, unprotected areas vulnerable to storm surge. • Critical infrastructure facilities and evacuation routes located in low-lying areas near the coast. • Beach public access paths in some areas may serve as conduits for storm surge and increase coastal storm risk. • Erosional hotspots along segments of barrier island beaches. • Remnant canals/ditches (Cutler Bay area) may serve as conduits for storm surge to vulnerable, low-lying inland communities.	• Reduce erosion to low-lying areas from storm surge. • Reduce flood depths and duration from storm surge events adjacent to critical infrastructure locations and evacuation routes. • Mitigate risk and remove areas that serve as conduits for storm surge through dune modifications. • Address CSRM risk with a multilayered approach that includes a suite of adaptation strategies. • Further attenuate wave energy and eliminate pathways for storm surge and improve existing degraded habitat through canal modifications. • Complement existing restoration efforts conducted by USACE and other entities.

5.3.2 Gaining Momentum: From Natural and Nature-Based Feature to a Nature-Based Solutions Pilot Program

Following the restart of the Miami-Dade Back Bay CSRM Feasibility Study in 2022, the study team requested stakeholder and public feedback on NNBFs as potential opportunities to address some of the problems listed in **Table 5-1**. Stakeholder feedback was requested through various forums, including planning charrettes, virtual public webinars, and interagency meetings (Section 10.2). **Table 5-2** presents general descriptions of NNBF types proposed by Miami-Dade County staff, stakeholders, and the public throughout the different regions.

Table 5-2. Summary of Natural and Nature-Based Feature Types Proposed by Miami-Dade County and Stakeholders

NNBF Type	Description	Region
Hybrid reef structures	Attenuate wave energy and contribute to coral restoration efforts using hybrid structures.	North Central
Dune reinforcement and/or modifications	Eliminate storm surge pathways using structural enhancements such as sheet-pile reinforcements. Restore coastal dune vegetation to prevent erosion.	North Central
Human-made island enhancements	Enhance existing human-made islands using hybrid green/gray infrastructure to mitigate storm surge risk.	North Central

NNBF Type	Description	Region
		South
Living shorelines	Buffer against storm surge and reduce erosion by enhancing hardscape inshore with layered, natural features.	North Central
Hybrid oyster reefs*	Attenuate wave energy and promote oyster settlement and growth using hybrid structures.	N/A
Restoration of canal/mosquito ditches and dredge holes	Eliminate pathway for storm surge and manage risks to low-lying communities by filling previously dredged canals/ditches and restoring with mangrove and seagrass plantings.	South
Hydrological parks	Restore areas collocated to low-lying features adjacent to built environments and drainage infrastructure that are vulnerable to storm surge. Restore habitat areas collocated to drained sloughs and provide water storage benefits when storm surge is pushing water inland.	North South

*While hybrid oyster reefs with the Eastern oyster (*Crassostrea virginica*) may be successful elsewhere (i.e., northeast United States), they are not likely to be successful in Biscayne Bay where they have not historically persisted in the context of their ecological requirements and hydrologic history of Biscayne Bay.

The stakeholder input shared with the study team and reflected in Table 4-2 illustrates the community-level support for considering CSRM solutions that leverage natural features of the existing environment and considers a spectrum of solutions to improve coastal resilience in Miami-Dade County.

With the progression of the Miami-Dade Back Bay CSRM Feasibility Study over time, the terminology has also shifted from the use of the term NNBFs to NBS. Furthermore, formal study guidance (presented as Appendix A-8) recommends consideration of potential demonstration project types to include submersed/emergent NBS, dunes and dune raising, mangrove study/analysis, and other measures for managing flood risk. Collectively, the work completed to date and the study guidance establish the foundation for the NBS Pilot Program with the possibility for innovative demonstration project types beyond those listed to also be considered for the NBS Pilot Program.

5.4 Program Framework

USACE's standard plan formulation process requires an evaluation and comparison of reasonable alternatives and contributions to National Economic Development (NED) through the economic justification of a Recommended Plan and consideration of effects to each of the four evaluation accounts (Section 4.5). However, the plan formulation process for the NBS Pilot Program differs from the standard process. The NBS Pilot Program requires a framework to evaluate the effectiveness of different types of NBS to quantify CSRM benefits for proposed NBS solutions with the intent to extrapolate the findings to inform other CSRM studies/resilience efforts. As such, it is possible that economic justification of individual NBS projects constructed for the purposes of CSRM may not be fully achieved. However, the potential co-benefits would still be expected to result in anticipated benefits considered under the Environmental Quality (EQ) and Other Social Effects (OSE) accounts, and these benefits would be provided by the NBS

features regardless of whether other CSRM features are approved and constructed in the future. The full range of functions, services, and benefits provided by NBS, such as water quality improvements, tourism, and habitat for commercial and recreationally important species, must be considered as part of a systems approach for improving resilience and coastal risk management (Bridges et al. 2015). Following are the key questions to be answered through the implementation and monitoring of pilot demonstration projects:

1. Are NBS demonstration projects effective at mitigating coastal storm surge? How can their effectiveness be measured and quantified?
2. How do NBS perform under different storm conditions?
3. Can the outcomes be extrapolated to inform the design of future projects (beyond the 2026 and/or 2028 study efforts) as part of Miami-Dade County's broader, comprehensive strategy for managing risk?
4. What methodologies can be developed to quantify CSRM benefits based on different types of NBS demonstration projects?
5. Are there opportunities for innovative designs, data collection, or model development that can be implemented to address specific knowledge gaps?
6. How do NBS demonstration projects contribute to a multiple-lines-of-defense strategy for resilience?
7. How will comprehensive benefits (i.e., flood risk management benefits and environmental and social co-benefits) be quantified for NBS pilot demonstration projects?

Performance criteria and metrics should adhere to three primary principles: efficacy, efficiency, and effectiveness (Piercy et al. 2021). Piercy et al. 2021 define efficacy as the ability of an NBS to influence the hazard pathway to meet project-specific flood risk management objectives. Efficiency is the ability to achieve project objectives with the least minimal impact, and effectiveness reflects the ability to achieve the broader project objectives, such as minimizing storm surge risk (Piercy et al. 2021).

Principal criteria that USACE and Miami-Dade County developed for site assessment and selection include:

1. Proposed projects must prioritize CSRM as the primary purpose consistent with the study objectives, though ancillary risk management for other types of flooding may result.
2. Proposed projects must align with existing environmental regulations.
3. Proposed project site locations should reflect geographic variability to ensure desired benefits are spread throughout Miami-Dade County.
4. Proposed projects should be sited adjacent to low-lying areas at risk of inundation from a coastal storm event, such as repetitive loss areas.
5. Proposed projects should advance our knowledge to make informed recommendations for future projects.

Problems

The following general problems focus on NBS in terms of managing coastal storm risk. Highly developed coastal landscapes in Miami-Dade County limit the implementation of large-scale NBS because of insufficient space/resource requirements. The efficacy of different types of NBS for managing coastal

storm risk requires further examination to understand their broader applicability to CSRM feasibility studies. However, there is no current formal USACE guidance that identifies a standard process for quantifying and evaluating CSRM benefits associated with different types of NBS. Table 5-1 provides a list of problems and opportunities specific to Miami-Dade County. This program will inform the necessary policy development in this area.

Opportunities

The urban coastal landscape and general low-lying topography of Miami-Dade County offers a unique opportunity to investigate the effectiveness of different types of NBS through small-scale pilot demonstration projects within Miami-Dade County's geographical boundaries. Implementing pilot projects would reduce uncertainties associated with NBS performance in terms of CSRM, while simultaneously improving habitat quality and expanding ecosystem benefits. Pilot demonstration projects may also serve as valuable resources for data collection, expanded research efforts, and educational opportunities.

Objectives

The NBS Pilot Program seeks to provide a framework for identifying, evaluating, and implementing NBS pilot demonstration projects in Miami-Dade County designed to manage coastal storm risk, examine the benefits resulting from a specific type of NBS, and inform the methodology for quantitative evaluation of comprehensive benefits. The information collected under the NBS Pilot Program may be used to inform the evaluation and justification of NBS as a CSRM measure for other feasibility studies. The NBS Pilot Program may also serve as a model approach for broader application across the enterprise. Individual pilot demonstration projects to be implemented under the NBS Pilot Program would be designed to manage coastal storm risk, reduce uncertainties associated with the performance of NBS, and contribute to more resilient and healthy ecosystems. Long-term outcomes would also further inform the strategy for layered solutions to managing coastal risk and improving community resilience.

Constraints

The constraints for the NBS Pilot Program are primarily focused on existing environmental considerations, including laws in place that afford protections to the sensitive aquatic resources of Miami-Dade County. The pilot demonstration projects that are implemented under the NBS Pilot Program must be designed in alignment with existing federal and state laws and regulations to ensure individual projects do not adversely affect resources and permits can be secured. This includes, but is not limited to, the following federal laws: the Coastal Zone Management Act (CZMA), Endangered Species Act (ESA), Magnuson–Stevens Fishery Conservation and Management Act, Section 106 of the National Historic Preservation Act (NHPA), and Clean Water Act (CWA).

Real estate requirements must also be considered. Real estate instruments will be required to be secured by Miami-Dade County as the nonfederal sponsor (NFS). Acquisition of easements may be required depending on the location of the demonstration projects. Appendix A-4 provides more information on real estate requirements.

5.5 Implementation Framework

The framework shown in **Figure 5-5** depicts the program implementation phases following programmatic authorization, Congressional appropriation of funding, and signing a Project Partnership Agreement (PPA) with Miami-Dade County as the NFS. Following are more detailed descriptions of each phase identified in **Figure 5-5**. A tiered approach is currently proposed to achieve National Environmental Policy Act (NEPA) compliance, with this Integrated Feasibility Study and Environmental Assessment (IFR/EA) serving as the first tier of review (Tier 1) for the NBS Pilot Program authorization and subsequent tiers containing the more specific review for NBS types and site selection. As follows, subsequent tiers would include the (Tier 2) Information/Data Collection, Planning, and NEPA Compliance Phase, and, if necessary, the (Tier 3) site-specific environmental compliance during the PED and Construction Phase. As set forth in Section 7.17, this Programmatic EA for the NBS Pilot Program considers the high-level environmental impacts, including beneficial impacts, and general mitigation strategy for impacts for the NBS Pilot Program.

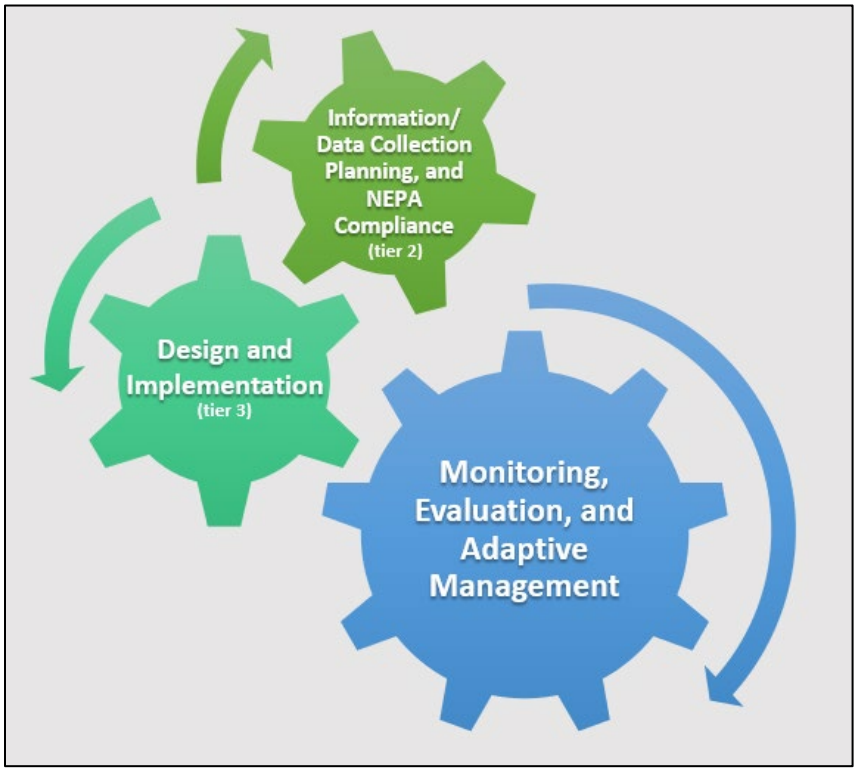


Figure 5-5. Miami-Dade Back Bay Nature-Based Solutions Pilot Program Phases

5.5.1 Information/Data Collection, Planning, and National Environmental Policy Act Compliance Phase

The second tier, or phase, would include the key components depicted in **Figure 5-6**. Stakeholder identification and engagement would occur at the onset to inform potential sites to be considered as part of an alternatives analysis required under NEPA. To analyze the environmental effects of alternatives and

to inform site selection under NEPA, a Detailed Project Report and second-tier NEPA document will be prepared that determines the project's feasibility with a level of detail appropriate to the plan's scope and complexity. This phase would include an associated environmental compliance and mitigation plan, sufficient to proceed directly to the PED and Construction Phase. An alternatives evaluation would be incorporated into NEPA documentation to include, at minimum, a Proposed Action, No Action Alternative, and reasonably foreseeable alternatives to inform the identification and selection of pilot project sites. Pilot demonstration projects would be identified and selected based upon demonstrating independent utility as a means of managing coastal storm risk. **Figure 5-6** identifies key considerations of this phase. This phase is anticipated to take up to two years.

Figure 5-6. Key Considerations for the Information/Data Collection, Planning, and Second-Tier National Environmental Policy Act Phase

The NEPA documentation type (EA or Environmental Impact Statement [EIS]) would be determined at the onset of this phase. The pilot demonstration projects would be designed to leverage existing natural landscape features to the maximum extent possible while avoiding and minimizing overall environmental impacts. As part of the NEPA process, temporary and permanent effects to the natural and human environments resulting from the pilot demonstrations projects would be considered and qualitatively evaluated against existing baseline conditions. Estimated values for environmental resource impacts, where applicable, would be based upon best available scientific data and information.

Other environmental compliance requirements would be identified and initiated during this phase with the appropriate federal/state agencies. Early and continuous coordination with resource agencies will inform the need for environmental surveys, such as seagrass or hardbottom/coral surveys, and mitigation

requirements. These surveys are necessary to identify the presence/absence of sensitive resources, as well as inform the quantitative impact analysis to these resources that may result from the proposed pilot demonstration projects. Environmental resource surveys would be conducted during the second-tier phase to quantify resource impacts in support of site-specific environmental compliance requirements (e.g., consultations). Survey methodology would be coordinated in advance with resource agencies to ensure data collection is sufficient to inform required consultations and permitting requirements. Mitigation may be required because of construction access requirements or other project-related impacts. Mitigation requirements would be coordinated with resource agencies to ensure a streamlined consultation and permitting process. Extensive coordination with Florida Department of Environmental Protection (FDEP) will occur to ensure that the proposed pilot demonstration projects minimize impacts on Biscayne Bay Aquatic Preserve and to ensure the projects are consistent with the protection of the preserve as required under Florida Administrative Code (FAC) 18-18. This includes the requirement of FAC 18-18.005(2), that "[n]o new lands will be created by filling or spoiling unless no other alternative exists to accomplish the stated purposes, and project is designed to require the minimum filling to accomplish the stated purpose of the activity consistent with the protection of the preserve."

Full compliance with applicable federal laws documented through the consultation process (i.e., ESA, Fish and Wildlife Coordination Act, Magnuson–Stevens Fishery Conservation and Management Act, and Section 106 of the NHPA) and a 404(b)(1) evaluation would be anticipated to be completed. Compliance with Section 401 of the CWA (i.e., obtaining a water quality certification) and federal consistency concurrence pursuant to the CZMA may be deferred to the subsequent PED and Construction Phase with an adequate letter of confirmation from FDEP.

This phase concludes with a Tier 2 NEPA document that identifies pilot demonstration project sites.

5.5.2 PED and Construction Phase

During the PED and Construction Phase, pilot demonstration projects would proceed through the engineering design process (**Figure 5-7**). During this phase, field investigations would be conducted as needed to obtain the information necessary to inform a final design. Topographic and hydrographic surveys would be conducted as determined necessary. The engineering design process may take up to two years and will conclude with construction completion.

Site-specific environmental compliance requirements would be completed, and required permits would be secured in accordance with applicable federal and state laws. All NEPA requirements would be anticipated to be complete during the prior Planning and NEPA Compliance Phase (Tier 2); therefore, a Tier 3 or supplemental NEPA document is not currently anticipated.

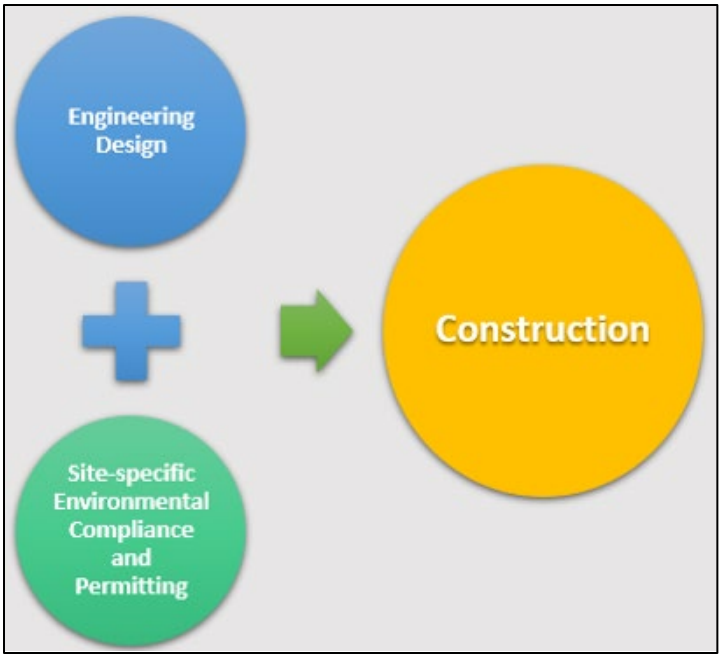


Figure 5-7. Key Considerations for the PED and Construction Phase

Preconstruction/baseline data may be collected as determined necessary and an approximate minimum of one year before project construction. Monitoring during construction is also anticipated. The type of baseline data to be collected will be determined once pilot demonstration project sites have been identified. Examples of types of baseline data that may be collected include site elevation, bottom type, hydrology, wave and surge data during storm hazard conditions, existing vegetation, and water quality data. The construction duration will depend on the features and scale of individual pilot demonstration projects; however, this phase is estimated to take up to 24 months for each pilot demonstration project. Implementation will include any required mitigation, if necessary.

5.5.3 Monitoring, Evaluation, and Adaptive Management Phase

Monitoring and adaptive management provides a directed iterative approach to achieve project goals and objectives by focusing on strategies promoting flexible decision-making that can be adjusted as outcomes are better understood. **Figure 5-8** identifies elements of this phase. For each pilot demonstration project, a Monitoring and Adaptive Management Plan (MAMP) would be prepared to enable the project team to identify and resolve key uncertainties and other potential issues that may influence project outcomes. Each individual MAMP will identify project-specific performance measures and success criteria, or decision-making triggers, which can be used to identify the need for potential implementation of adaptive management actions. The development and implementation of the MAMP will reduce uncertainty over time, provide a basis for evaluating project performance and making project adjustments to meet success criteria, and promote interagency collaboration and productive stakeholder participation, as these are key elements to success.

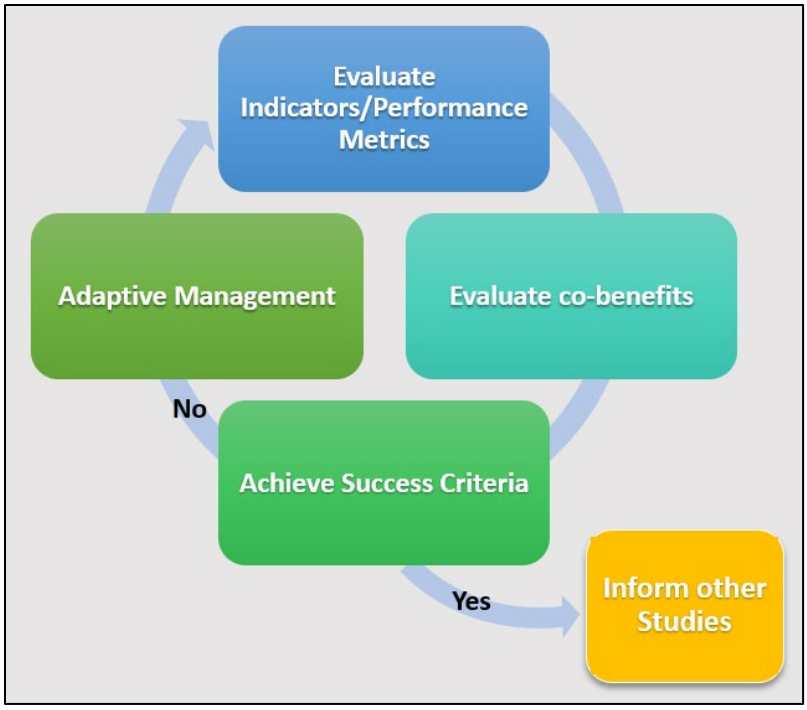


Figure 5-8. Elements of the Monitoring, Evaluation, and Adaptive Management Phase

Early coordination to develop the MAMP will result in a pilot project that can better succeed under a wide range of uncertain conditions and can be adjusted as necessary. Furthermore, strategic monitoring of the pilot demonstration project outcomes will contribute to the NBS Pilot Program objectives focused on understanding the effectiveness of NBS in terms of managing coastal storm surge risk, quantifying the benefits resulting from a specific type of NBS, and informing the quantitative evaluation of comprehensive benefits. The frequency of monitoring would be identified early in the process and would be dependent on the type of NBS.

As part of the monitoring and adaptive management process, an Adaptive Management Team (AMT) will be established early in the process to review and assess monitoring results. In addition, the AMT will recommend adaptive management actions if success criteria are not being met. The AMT will be composed of USACE staff, including support from USACE's Engineering Research and Development Center (ERDC) and EWN Program, Miami-Dade County, resource agencies, and other stakeholders. USACE, in coordination with Miami-Dade County, will have final determination on all adaptive management actions recommended and are responsible for ensuring that monitoring data and assessments are properly used in the adaptive management decision-making process. USACE and Miami-Dade County are also responsible for project documentation, reporting, and stakeholder communication.

An effective monitoring program will be required to determine whether the pilot project outcomes are consistent with the goals and objectives of the NBS Pilot Program. A carefully designed monitoring program is the central component of the Adaptive Management Plan; it not only supplies the information to assess whether the project is functioning as planned, but it will also inform CSRM practitioners broadly on the efficacy of NBS concepts and approaches. To provide information on efficacy, study designs may incorporate Before-After-Control-Impact designs to the maximum extent practicable. Monitoring must be

closely integrated with the adaptive management components because it is the key to evaluating adaptive management needs. The need for non-ecological monitoring and inspections of NBS features will also be considered and incorporated where appropriate. Objectives must be considered to determine appropriate indicators to monitor. To be effective, monitoring must distinguish between ecosystem responses that result from project implementation (i.e., management actions) and natural ecosystem variability.

Monitoring will continue until the measures of project success are achieved as defined by project-specific objectives or the total project cost has been reached. To understand the long-term project performance in terms of CSRM, it may be appropriate to consider project-specific monitoring and adaptive management up to 15 years. The monitoring plan should explicitly recognize that the collection of data will depend upon data and storms and describe with specificity criteria for determining success. Once success has been achieved or the total project cost has reached the maximum amount (Section 5.6), monitoring will no longer be performed. If success cannot be determined within the total project cost, any additional required monitoring would be the responsibility of Miami-Dade County as the NFS at full nonfederal cost.

5.5.4 Stakeholder and Public Coordination During the Miami-Dade Back Bay NBS Pilot Program

As noted in Section 5.3, substantial public input has been received during the feasibility study phase on NBS, in general. Miami-Dade County and USACE are committed to ensuring coordination efforts and public engagement continue as an integral component of the NBS Pilot Program. Potential types of public engagement opportunities in the future will include virtual and/or in-person public meetings and workshops. Public engagement opportunities also will be considered in the broader context of integration with other federal, state, and municipal projects. The implementation of pilot demonstration projects to understand the performance of NBS for managing coastal storm risk may also provide collaborative research opportunities for local universities and institutions throughout various phases of the program, including the Monitoring, Evaluation, and Adaptive Management Phase.

5.6 Miami-Dade Back Bay Nature-Based Solutions Pilot Program Cost Limit

To assess their efficacy and to quantify the economic benefits of NBS, multiple projects located within varying geographic regions of Miami-Dade County would be needed. To achieve the goals of the NBS Pilot Program, varied projects would be designed, implemented, monitored, and adaptively managed. The information gained from the pilot demonstration projects would then be used to inform the development of NBS as CSRM measures across the USACE enterprise. Using the implementation framework identified in Section 5.4, a suite of NBS pilot demonstration projects would be implemented for a total programmed amount of $180,000,000.

Phase 1: Anticipated costs related to information/data collection, planning, and continued tiered NEPA compliance for projects implemented under the NBS Pilot Program are anticipated to be similar in scope and duration to USACE feasibility studies, typically scoped for completion in three years or less at a cost of no more than $3,000,000 (Planning Bulletin 2012-04; Section 1001 of the Water Resources Reform and Development Act of 2014, P.L. 113-121).

Phase 2: To inform PED and Construction costs, the study team compiled construction costs for NBS projects within Miami-Dade County and across the United States. Appendix A-3 provides the list for reference. The study team compiled this list to inform the development of the overall program estimate while also considering the unique environmental resources and associated environmental compliance responsibilities within the Miami-Dade County area. The compiled list is not exhaustive but represents a suite of potential NBS project types that could be implemented. Not included in Appendix A-3 are mitigation costs. Because of the sensitive aquatic resources, mitigation is anticipated; these costs can vary substantially, depending on the resource and extent of impact. Mitigation costs will be determined on a site-specific project-by-project basis during Phase 1 and are incorporated in the per-project cost limit estimate of $17,000,000 for Phase 2, Preconstruction, Engineering, and Design (PED) and Construction Phases.

Phase 3: Monitoring, evaluation, and adaptive management costs were developed with input from the ERDC–EWN, USACE leadership, and Miami-Dade County. This phase is planned to occur over 15 years following construction and may cost upward of $300,000 per year for adaptive management and novel evaluations of social, environmental, and CSRM benefit accrual. Individual NBS pilot demonstration project costs will vary depending on site-specific vulnerabilities and existing conditions, scale, and complexities of the project, and specific project objectives. **Table 5-3** includes a sample cost breakdown for an individual pilot demonstration project. Note: This sample should not be applied to all pilot projects, because each will be unique. This sample is intended to portray how costs may be divided within an individual pilot project.

Table 5-3. Sample Cost Breakdown for a Pilot Demonstration Project

Phase	Estimated Cost
Phase 1: Information / Data Collection, Planning, and Continued Tiered NEPA Compliance	$3,000,000
Phase 2: PED and Construction	$17,000,000
Phase 3: Monitoring, Evaluation, and Adaptive Management	$5,000,000

5.7 Cost Sharing

The cost-share requirements for the proposed NBS Pilot Program are anticipated to adhere to the standard provisions set forth in Section 103 of the WRDA of 1986, P.L. 99-662 (33 U.S.C. § 2213), as amended. For projects using nonstructural, natural, or nature-based features, 33 U.S.C. § 2213(b)(1) states that the nonfederal share of the cost of a flood risk management or hurricane and storm damage risk management measure using a nonstructural feature or a natural feature or nature-based solution, must be 35 percent of the cost of such measures. The nonfederal interests for any such measures will be required to provide all lands, easements, rights-of-way, dredged material disposal areas, and relocations necessary for the project. Using the total requested cost limit of $180 million, according to these requirements, the total federal cost-share for the NBS Pilot Program would be $117 million and the total nonfederal cost-share would be $63 million.

5.8 Operation, Maintenance, Repair, Replacement, and Rehabilitation

Consistent with other USACE CSRM projects, the operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) of site-specific pilot demonstration projects within the NBS Pilot Program will be conducted at no cost to the federal government, in a manner compatible with the project's authorized purposes, and in accordance with applicable federal laws and regulations and any specific directions prescribed by the federal government as specified in any future PPA. The anticipated OMRR&R activities and associated costs will be developed once the program is authorized and the site-specific formulation, analyses, and NEPA compliance documents are completed. The OMRR&R requirements will be developed on a site-specific project-by-project basis to address their unique site conditions and project requirements.

5.9 Project Sequencing

Site-specific project sequencing would depend primarily on the features of the pilot demonstration projects selected. Project sequencing considerations are included herein, though project sequencing will not be finalized until the projects are identified in the future. The goal is to obtain important information concerning economic benefits of different types of NBS that also will be useful for informing the broader comprehensive plan for CSRM in Miami-Dade County. **Figure 5-9** provides a staggered sequencing chart. Projects that include mangrove plantings and/or restoration may require a longer time for CSRM benefits to accrue and subsequently be evaluated and quantified because of the time it takes for mangroves to become established and reach maturity. Therefore, pilot demonstration projects with mangrove or other wetland restoration components should be sequenced first. These projects are also more likely to experience a more streamlined design and environmental compliance phase provided they are not associated with hardened structures. Projects with in-water impacts may require environmental resource surveys to inform consultation requirements and the permitting process, and they may take comparatively longer to reach construction. However, these types of projects may begin to accrue CSRM benefits and environmental co-benefits sooner. Land-based projects with no in-water impacts would be recommended as the final category of NBS demonstration projects to be sequenced in terms of initiating individual project design. Stakeholder coordination may also inform project sequencing.

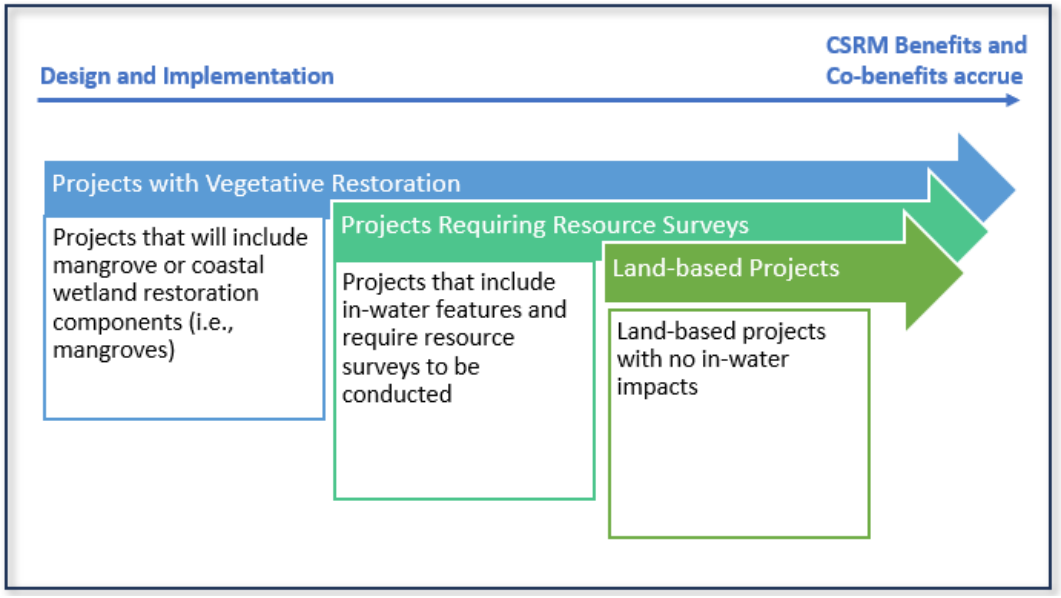


Figure 5-9. Recommendation for Staggered Design Sequencing of Nature-Based Solutions Pilot Demonstration Projects

5.10 Anticipated Outcomes

With most of the coastal landscape highly developed, Miami-Dade County would serve as a proving ground for the implementation of NBS to mitigate coastal storm surge risk to adjacent low-lying communities and infrastructure in urban coastal environments. The results of pilot demonstration project implementation and monitoring would further inform the effectiveness of different NBS types for managing coastal storm risk and the extent to which a series of independently justified projects contribute to Miami-Dade County's multiple-lines-of-defense strategy for managing coastal storm surge risk and improving resilience.

5.11 Addressing Uncertainties

Although NBS pilot demonstration projects in Miami-Dade County would be anticipated to provide demonstrable ecosystem benefits and improvements, there is uncertainty regarding their effectiveness against mitigating coastal storm surge risk under varying storm conditions. The construction and long-term monitoring of different types of pilot demonstration projects throughout Miami-Dade County would inform their performance levels and effectiveness in terms of mitigating coastal storm surge risk. The collection of in-situ data from these projects would also further inform how CSRM benefits can be quantified. Additionally, this would further inform the need for project implementation on a broader scale. Uncertainty also exists surrounding the effectiveness of NBS in a changing climate, resulting in increasingly stronger and more frequent storm events. Sea level change would be accounted for during the PED and Construction Phase, and a comprehensive adaptive management strategy would be established to safeguard the long-term success of individual demonstration projects.

6 MIAMI-DADE BACK BAY NONSTRUCTURAL PROGRAM (MDBBNSP)

6.1 Introduction

Nonstructural interventions are one type of risk management measure considered in USACE–sponsored CSRM feasibility studies throughout the nation. USACE defines nonstructural measures as "permanent or contingent measures applied to a structure and/or its contents that manage risk of damage from flooding. Nonstructural measures differ from structural measures in that they focus on reducing the consequences of flooding instead of focusing on reducing the probability of flooding" (USACE 2024). Examples of both physical and nonphysical nonstructural measures commonly considered in USACE feasibility studies include structure elevations, dry floodproofing, wet floodproofing, relocation, acquisition, flood emergency preparedness plans, flood warning systems, land use regulation, zoning, risk communication, and evacuation plans (USACE 2024).

While USACE nonstructural policy and practice continue to evolve in Miami-Dade County and other densely populated urban areas, the current suite of nonstructural interventions is limited by the state of the practice. For example, in most cities, land values are very high so placing multiple units that share utility hookups on one building footprint has historically been the only economical way to build. Nonetheless, when land values are high, interventions such as relocation and acquisition are difficult to justify because a) buildings are very expensive, and b) housing stock is extremely limited so there are few appropriate alternatives for the many people who would be displaced. While structure elevations are extremely popular with the public given that they generally only require temporary inconvenience, these types of interventions have not been determined to be well-suited for larger structures such as multiunit housing, apartment buildings, and complex critical infrastructure, like hospitals, since there are physical and social characteristics that raise a number of issues requiring further thought, greater expense, and potentially new ways of working within a community. USACE's existing suite of nonstructural interventions focuses on single-family detached residences because they are relatively easy to elevate; however, in urban areas, much of the population—and a larger proportion of the socially vulnerable and/or historically disenfranchised residents—live in multiunit dwellings.

The Opportunity

Since 2021, USACE policy has focused on a broader definition of public benefits and has begun to encourage teams to think more holistically about Civil Works interventions, especially within the Flood Risk Management and CSRM mission areas. While life loss and other social effects have been part of the agency's planning analysis since publishing the Principles and Guidelines in 1981, there is new emphasis on using such criteria as grounds for decision making. As such, it is appropriate to consider interventions that may be justified by benefits traditionally excluded from the standard NED analysis, which focused on benefits that were generally simple to monetize. For example, USACE does not put a monetary value on human life, and benefits associated with life saving measures are not accounted for in USACE BCRs. While avoiding loss of life, even if not monetized, has been relatively easy to incorporate into project justification, there are other benefit categories that USACE has deemed important that are much more difficult to measure—foremost among them, community resilience. Both avoidance of loss of life and community resilience are now major benefit categories to be accounted for, and they will have greater effects in

densely populated urban areas because there are many people at risk and multiple communities affected by the same events.

USACE's longstanding partnership with Miami-Dade County, the public demand for less disruptive coastal storm management interventions, and the more holistic accounting of benefits present an opportunity to explore ways to integrate coastal resilience measures that may be more suitable to urban, residential areas characterized by multifamily dwelling units and other complex critical infrastructure. The following approaches are examples:

- Vertical Evacuation in Combination with Permanent Emergency Backup Power: Vertical evacuation means evacuating residents who live on the lower floors of mid- or high-rise buildings onto upper floors. Exploring vertical evacuations within cities has received limited consideration in USACE efforts While a coastal storm generally allows people time to evacuate horizontally because it is a notice event, horizontal evacuation is complicated in densely populated urban areas. Vertical evacuation, where available, could save lives and may, arguably be preferable in places where it is possible, people do noy have easy access to automobiles, or people live in relatively insular communities, defined by language or ethnicity, from which they may not have somewhere to evacuate to. Ultimately, the preference is for residents to leave their structures when faced with the threat of storm surge and vertical evacuation should only be used in a worst-case scenario.
- Wet Floodproofing First Floors of Residential Buildings: Upon walking among the large apartment buildings in Miami Beach and skyscrapers near Biscayne Bay, a pedestrian will notice that developers have already constructed buildings where the first floor is essentially sacrificial. That floor may be devoted to parking or temporary/seasonal uses and is generally not designed as living space in order to limit risk to people and property. This is a model of development that has only begun to be explored in other cities and has thus far been limited to new, tall buildings. Nonetheless, this example may provide inspiration for interventions in multi-unit residences that currently have first floor units. It could be that changes in local zoning codes may make it worthwhile for a landlord of a multi-unit building to consider removing first floor units, for example if the removal of such units would allow for additional building height. However, an additional consideration is the lack of affordable housing within Miami-Dade County.
- Developing Nonstructural Solutions that Add to the Overall Resilience of Miami-Dade County: Exploring other nonstructural solutions for complex critical infrastructure would help ensure Miami Dade County's resilience. As an example, hospitals provide a literal lifeline to their communities and serve as a natural destination for people looking for safety. They also serve as major loci of employment in most US cities, and the ability to return to work is critical to storm recovery. Such structures require unique and costly flood risk management measures. One way to add to easily add to community resilience could be to floodproof local hospitals. This type of thoughtful intervention could benefit Miami-Dade County and surrounding communities and add to the overall resilience in a meaningful way.

The list above should not be considered a complete accounting of potential interventions but rather evidence that USACE is seeking risk management opportunities in urban areas that go beyond the current menu of nonstructural measures and present potential opportunities to make Civil Works investments that better serve the nation's communities.

The MDBBNSP as a Proving Ground

Miami-Dade County already faces high risk from coastal storms compounded with sea level change and would benefit from implementing measures that would limit that risk. In the same vein, USACE needs to better understand what types of nonstructural interventions work best in densely populated urban areas. This IFR/EA seeks programmatic study authority for $6,000,000 for the Nonstructural Program. Given this situation, the MDBBNSP is anticipated to function as a proving ground for considering nonstructural measures in urban areas. Such an opportunity would benefit communities in Miami-Dade County, the USACE Civil Works Program, and the nation as a whole as it will allow USACE to determine what measures could work. t To that end, USACE is recommending authorization of $6M to fund a comprehensive urban nonstructural program (MDBBNSP) to innovate, formulate, and assess nonstructural measures, with potential to carryout limited conceptual tests in areas within Miami-Dade County, and these efforts will benefit other at-risk areas. Future Congressional authorization would be required to implement pilot and demonstration nonstructural projects and monitor their success. Currently, it is anticipated that such a program, including both future studies and construction, could be implemented with approximately $200,000,000 authorized appropriations.

6.2 Purpose and Need

The MDBBNSP's purpose is to further innovate, formulate and assess nonstructural measures for vulnerable infrastructure and buildings, specifically measures for multifamily housing and complex critical infrastructure facilities such as hospitals. This includes consideration of new (for USACE) nonstructural measures for various kinds of multifamily residential housing, as well as analyses and consideration of innovative nonstructural measures for hospitals, a complex category of critical facilities for which significant formulation, design, and coordination is needed to determine the appropriate design, evaluate the effectiveness of, and implement any risk management measures. The formulation, environmental consultations pursuant to NEPA, and detailed design of innovative nonstructural measures for multifamily residences and hospitals in Miami-Dade County will contribute to a greater understanding of these nonstructural formulation/implementation practices and inform the development of nonstructural policy guidance for use in future CSRM feasibility studies.

6.3 Implementation Framework

6.3.1 Planning and Environmental Compliance Phase

In this programmatic evaluation, USACE considers the potential environmental impacts of programmatic study authorization at a general level and analyzes the alternatives of program authorization and no action (i.e., not authorizing the program). Following this first-tier programmatic NEPA review, and the subsequent programmatic authorization and Congressional appropriation of funding, stakeholder identification and engagement would be initiated to inform the alternatives analysis of specific measures required under NEPA.

Planning and Environmental Compliance Phase

During the Planning and Environmental Compliance Phase, potential complex critical infrastructure locations and multifamily housing units at risk from storm surge, would be identified for evaluation and inclusion in the Nonstructural Program. In coordination with municipalities, USACE and Miami-Dade County would develop a site-selection screening process informed by public and stakeholder input that would culminate in a list of structures to be included in the Nonstructural Program. Various factors to be considered include the following: inundation risk from storm surge, waves and future sea level change as defined by the hydrology and hydraulics evaluated in the feasibility study, real estate requirements, community-identified needs, and environmental justice considerations.

The Environmental Compliance Phase and Report will document the methods considered and the specific environmental effects on the selected structures, as well as determine the project's feasibility with a level of detail appropriate to the plan's scope and complexity. This phase would include an associated environmental compliance and mitigation plan, which is anticipated to take two to three years. The NEPA documentation type (EA or Environmental Impact Statement [EIS]) would be determined at the onset of this second tier or phase. The nonstructural projects would be designed to avoid and minimize overall environmental impacts. As part of the NEPA process, temporary and permanent effects to the natural and human environments resulting from the projects would be considered and qualitatively evaluated against existing baseline conditions. Estimated values for environmental resource impacts, where applicable, would be based upon best available scientific data and information. It is anticipated that all environmental compliance requirements would be identified and completed during this phase, with the appropriate federal/state agencies, as there would be no in-water impacts.

6.3.2 Preconstruction, Engineering, and Design Phase

Following the completion of Planning and Environmental Compliance, additional Congressional authorization would be necessary to implement the selected nonstructural project and proceed into preconstruction, engineering and design phase. At the beginning of this phase, field investigations would be conducted as needed to obtain the information necessary to inform a final design. Topographic, geotechnical, and structural surveys would be conducted as determined necessary. The engineering design process may take two to three years and concludes with the advancement of a nonstructural project into implementation.

Implementation Phase

The construction duration for individual nonstructural projects will depend on the features, scale, and complexity of the building(s), as well as the novelty of the risk management measure(s). However, this phase is estimated to take up to six months per multifamily residence and up to 24 months per complex critical infrastructure project. Monitoring during construction is anticipated..

6.4 Nonstructural Program and Project Limits

To assess the feasibility of nonstructural solutions for complex facilities, such as multifamily residences and hospitals, multiple projects across various facility types and/or housing categories is suggested. As a result, the Nonstructural Program is proposed as two categories with specified program limits that result

in a total requested programmatic study cost limit of $6,000,000 (**Table 6-1**). The following two categories comprising the Nonstructural Program are intended to be separable elements.

6.4.1 Multifamily Residential Projects

Multifamily residences can vary greatly by building size, complexity, structure condition, and number of dwellings. The term "multifamily residences" encompasses a variety of building types, including, for example, multifamily buildings with greater than four-unit dwellings. These buildings provide affordable housing throughout Miami-Dade County to underserved and overburdened communities. The Project Delivery Team (PDT) recommends that the Nonstructural Program incorporate a programmatic study cost not to exceed $2,500,000 for analysis and preliminary design of innovative risk management measures for multifamily residential projects. This recommended study cost assumes minimum of six different multifamily housing categories to ensure a sampling of different building types. However, it is possible that additional multifamily housing categories could be included, based on variations in building size, complexity, or risk management measure to be investigated. Ultimately, the cost of a multifamily residence project will vary depending on the site-specific vulnerabilities, existing conditions, and the scale and complexities of the project; therefore, the multifamily residence projects' implementation costs are provided as a range.

6.4.2 Complex Building Projects: Hospitals

Complex critical infrastructure would also be considered under the nonstructural program, and hospitals are a representative example of a unique and complex building type, although other building types may also be considered under the program. Building closures, flooded roads, power outages, and supply shortages during a coastal storm can lead to substantial impacts to hospitals and ultimately impact critical health care access and delivery. Tarabochia-Gast *et al*. investigated flooding risk from hurricanes to hospitals in Atlantic and Gulf Coast communities and concluded that even relatively weak hurricanes can result in flooding of hospitals in urban coastal areas and that sea level change may further exacerbate flooding risk (2022). In 2004, the Nichlaus Children's Hospital (formerly known as Miami Children's Hospital) completed construction on a state-of-the art retrofit to withstand hurricane force winds of up to 200 miles per hour, impact-resistant windows, and a strengthened roof through the Federal Emergency Management Agency's Hazard Mitigation Grant Program administered by the Florida Department of Community Affairs. Although the hospital improvements to the Nichlaus Children's Hospital were focused on mitigating wind-driven risks, the need to address flood-related risks to hospitals in the Miami-Dade County persist. There are 14 hospital facilities in Miami-Dade County, with two facilities located on Biscayne Bay: Mount Sinai Medical Center and Mercy Hospital.

Hospitals can vary in campus/building size, complexity, structure age, and criticality of specific buildings or equipment during coastal storms based on the functions and services provided. Therefore, the PDT recommends a programmatic study cost not exceeding $3,500,000 for analysis and preliminary design of risk management measures to site-specific complex critical infrastructure projects. The cost will vary depending on the site-specific vulnerabilities and existing conditions, and the scale and complexities of the project. The recommended programmatic study cost limit specific to complex critical infrastructure projects assumes a minimum of three projects at the maximum estimated potential implementation cost.

It is possible that additional complex critical infrastructure projects, if those facilities are determined to require risk management measures for only certain buildings or facilities, rather than all buildings, could be included at a significantly lower implementation cost. Therefore, the implementation costs are represented as a range, and the specified cost estimation for three complex critical infrastructure projects does not denote a requirement to address coastal storm risk to *only* three facilities.

Table 6-1. Miami-Dade Back Bay Nonstructural Programmatic Study Cost and Sample Cost Breakdown for Estimated Implementation

Nonstructural Program Programmatic Study Costs	
Complex, Critical Infrastructure Buildings (e.g., hospitals)	
Planning and Environmental Compliance	$3,500,000
Multifamily Residences	
Planning and Environmental Compliance	$2,500,000
Total Recommended Programmatic Study Cost Limit	**$6,000,000**

Sample Cost Breakdown of Estimated Implementation Costs	
Complex, Critical Infrastructure Buildings (e.g., hospitals)	
Pre-construction, Engineering, and Design (PED)	$3,500,000
Implementation of Complex Building Projects	Up to $23,000,000
Total Nonstructural Hospital Projects Cost Limit	$26,500,000
Multifamily Residences	
Pre-construction, Engineering, and Design	$2,500,000
Implementation of Multifamily Residential Projects	Up to $165,000,000
Total Nonstructural Multifamily Residence Projects Cost Limit	$167,500,000
Anticipated PED and Construction Cost	**$194,000,000**

6.5 Cost Sharing

Studies carried out pursuant to the recommended programmatic study authority would be cost shared in accordance with section 105 of the WRDA of 1986, as amended (33 U.S.C. § 2215). The cost-share requirements for the future implementation costs would be in accordance with Section 103 of the WRDA of 1986, as amended (33 U.S.C. §2213). The table below summarizes the cost-shares for each of the phases of the Nonstructural Program using the estimated total cost limit of $200 million.

Table 6-2. Nonstructural Program Estimated Total Cost Shares

Nonstructural Program Estimated Cost-Sharing and Anticipated Cost Breakdown	
Complex Critical Infrastructure Buildings (e.g., hospitals)	
Planning and Environmental Compliance Phase	**$3,500,000**
Federal Cost Share (50%)	$1,750,000
Nonfederal Cost Share (50%)	$1,750,000
PED and Construction Phase	**$26,500,000**
Federal Cost Share (65%)	$17,225,000
Nonfederal Cost Share (35%)	$9,275,000
Multifamily Residences	
Planning and Environmental Compliance Phase	**$2,500,000**
Federal Cost Share (50%)	$1,250,000
Nonfederal Cost Share (50%)	$1,250,000
PED and Construction Phase	**$167,500,000**
Federal Cost Share (65%)	$108,750,000
Non-Federal Cost Share (35%)	$58,625,000
Total Program Federal Cost-Share	**$129,100,000**
Total Program Nonfederal Cost-Share	**$70,900,000**
Total Cost, Nonstructural Program	**$200,000,000**

6.6 Operation, Maintenance, Repair, Replacement, and Rehabilitation

Consistent with other USACE coastal storm risk management projects, the operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) of site-specific projects within the Nonstructural Program will be performed by the local sponsor and conducted at no cost to the Federal government, in a manner compatible with the project's authorized purposes, and in accordance with applicable Federal laws and regulations and any specific directions prescribed by the Federal government as specified in any future Project Partnership Agreement. The anticipated OMRR&R activities and associated costs for each site-specific project will be developed once the program is authorized, the site-specific formulation, analyses, and NEPA compliance document is completed, and prior to start of implementation. The OMRR&R requirements will be developed on a site-specific project-by project basis to address their unique site conditions and project requirements and are not reflected in the total program costs shown in the tables above. It is anticipated that OMRR&R requirements may be considerably limited for nonstructural measures, just as they are for residential building elevations and floodproofing.

6.7 Project Sequencing

Project sequencing would depend on a variety of factors, including the level of flood risk, features or complexity of the nonstructural projects selected, the separable elements for nonstructural projects, the availability of funds to support design and/or construction efforts, the criticality of the facility, and whether the nonstructural project provides risk management to vulnerable environmental justice communities. It is anticipated that buildings within the same building category could have more streamlined design and implementation phases. Sequencing of nonstructural project implementation will be determined in coordination with the non-Federal sponsor, Miami-Dade County, and stakeholders.

6.8 Anticipated Outcomes

With most of the coastal landscape highly developed, Miami-Dade County would serve as a proving ground for the implementation of innovative nonstructural methods to manage risk from storm surge to adjacent low-lying communities and infrastructure in urban coastal environments. The results of the MDBBNSP would inform the use of nonstructural risk management methods in USACE feasibility studies by expanding the USACE's nonstructural toolkit. Additionally, the results of the MDBBNSP would support policy development to include both the use of accepted nonstructural measures to new (to USACE) building categories and new (to USACE) nonstructural measures used. The MDBBNSP would result in both immediate and long-term benefits by reducing flooding damages and increasing resilience following a coastal storm event. Nonstructural measures will continue to be communicated and recommended as one solution within a suite of water resources management solutions to manage coastal storm risk and improve the coastal resilience of Miami-Dade County.

6.9 Conclusions and Recommendations

The Nonstructural Program in Miami-Dade County, Florida, is recommended to further assess, innovate, and evaluate nonstructural measures to vulnerable infrastructure and buildings, specifically measures for multifamily housing and complex facilities such as hospitals, to manage coastal storm risk and improve coastal resilience within a densely populated urban environment. As part of these study efforts, this program could perform limited tests of innovative concepts as necessary to inform the efficacy of a proposed nonstructural measure. Further, while the focus of the complex, critical infrastructure discussed above is hospitals, the recommendation is to seek authority to study hospitals and other complex critical infrastructure facilities.

7 ENVIRONMENTAL COMPLIANCE

This section discusses the potential effects to the affected environment described in Sections 3.4, 3.5, and 3.7. As required by the National Environmental Policy Act (NEPA) (42 U.S.C. § 4332(2)(F), implemented by 40 Code of Federal Regulations [CFR] § 1501.5(c)(2)) and United States Army Corps of Engineers' (USACE's) NEPA regulations at 33 CFR § 230.10, this section presents the detailed effects analysis of the following alternatives defined in Section 4.4:

Alternative 1: No Action/Future Without Project

Alternative 2: Critical Infrastructure

Alternative 3: Nonstructural Alternative

Alternative 4: Critical Infrastructure and Nonstructural. **Recommended Plan**

Alternative 5: Critical infrastructure and Subset of Nonstructural

This section is organized by resource topic as described in Sections 3.3, 3.4, and 3.6 with the potential effects of each alternative described within each resource section. Sections 7.17 and 7.18 document the effects arising from the request for programmatic authorization of the Miami-Dade Back Bay Nature-Based Solutions (NBS) Pilot Program and Nonstructural Program, respectively. Section 5.5 discusses future tiers of NEPA documentation needed to evaluate projects proposed under the NBS Pilot Program. Section 6.3 discusses the future tier of NEPA documentation needed for the Nonstructural Program. Direct and indirect effects are evaluated and further identified as adverse or beneficial, and temporary or permanent. Cumulative effects can result from the incremental effects of an action when combined with other past, present, and reasonably foreseeable actions. Section 7.19 provides discussion of cumulative effects.

7.1 Wildlife Resources and Terrestrial Habitats

7.1.1 Alternative 1

Wildlife and terrestrial habitats would continue to be subject to development associated with urbanization. Common terrestrial forms of wildlife are generally acclimated to human-related impacts.

7.1.2 Alternative 2

Construction, maintenance, and staging activities to support the floodproofing of critical infrastructure (CI) would occur in existing disturbed areas and would result in adverse, temporary, minor effects to wildlife. Potential indirect impacts would occur because of ground disturbance and temporary relocation of wildlife during construction activities, which would be limited to the modification of existing buildings. Following construction completion, conditions would be restored and wildlife occupying the area would be expected to return. There would be no impacts to Coastal Barrier Resource System (CBRS) units, as shown in **Figure 7-1**.

7.1.3 Alternative 3

Direct impacts to terrestrial habitats, including the potential for tree removal to accommodate construction equipment, may occur for residential home elevations for which construction access to treat structures is required. Tree removal, if determined necessary, would adhere to time-of-year restrictions as described in Section 7.3.6. Indirect impacts would occur from ground disturbance and the temporary avoidance of the area by wildlife during construction. Therefore, impacts would be minor, adverse and range from temporary to permanent. There would be no impacts to CBRS units, as shown in **Figure 7-1**.

7.1.4 Alternative 4

Construction, maintenance, and staging activities to support the floodproofing of CI and commercial buildings would occur in existing disturbed areas and would result in adverse, temporary, minor effects to wildlife. Potential indirect impacts would occur because of ground disturbance and the temporary avoidance of the area by wildlife during construction activities, which would be limited to the modification of existing buildings. Following construction completion, conditions would be restored and wildlife occupying the area would be expected to return.

Direct impacts to terrestrial habitats (including the potential for tree removal to accommodate construction equipment) may occur for residential elevations for which construction access to treat structures is required. Tree removal, if determined necessary, would adhere to time-of-year restrictions as described in Section 7.3.6. There would be no impacts to CBRS units, as shown in **Figure 7-1**.

7.1.5 Alternative 5

The effects would be the same as described in Section 7.1.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

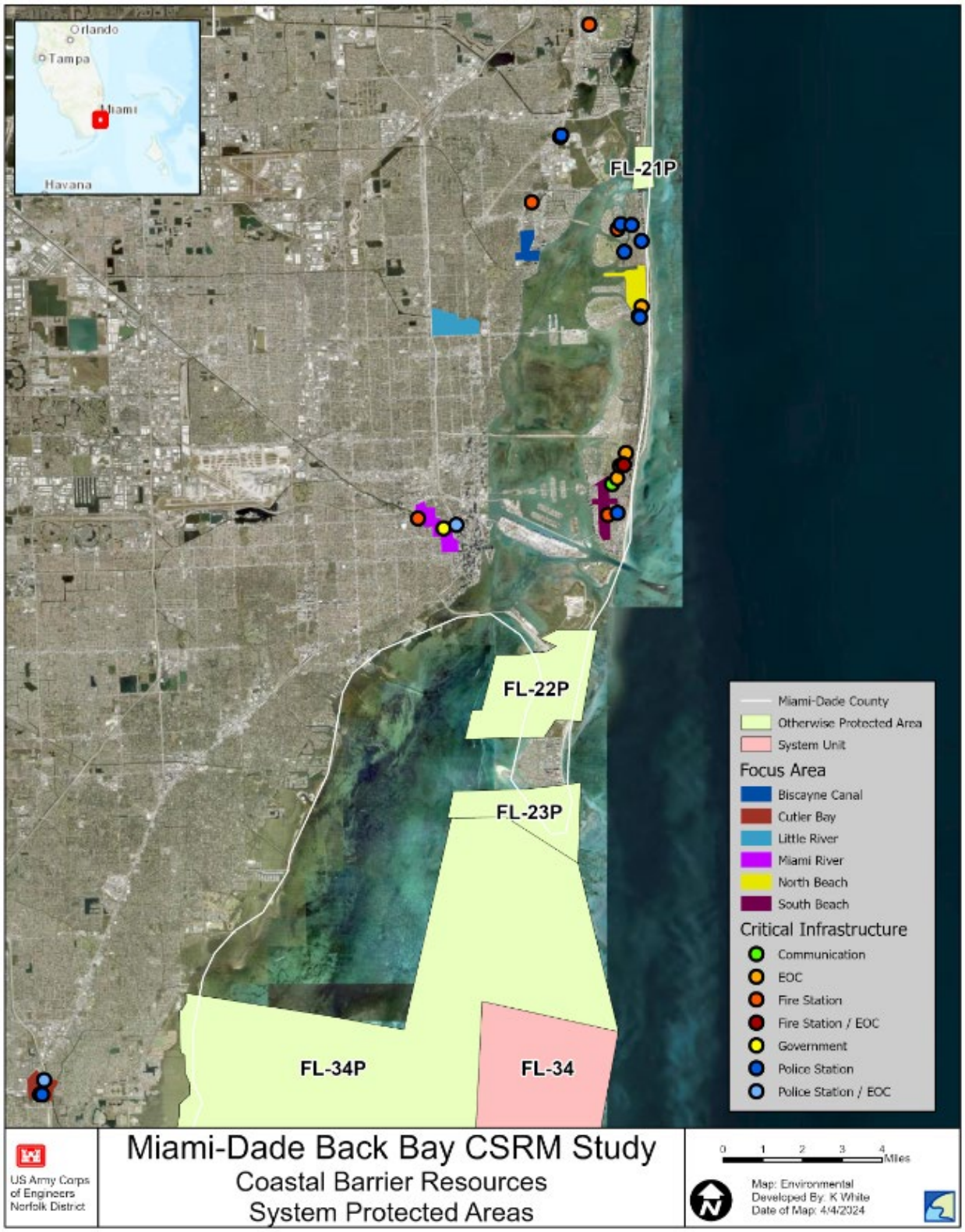


Figure 7-1. Coastal Barrier Resources System–Protected Areas and System Units in Miami-Dade County

7.2 Wetlands, Mangroves, and Seagrasses

7.2.1 Alternative 1

Wetlands, mangroves, and seagrasses would continue to persist in their current state. The No Action Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk.

7.2.2 Alternative 2

There would be no direct or indirect impacts to wetlands, mangroves, or seagrasses because construction would be limited to modifying existing buildings. No wetlands or mangrove resources would be removed or disturbed. Best management practices (BMPs) identified in Section 7.3.6 would be adhered to during construction.

7.2.3 Alternative 3

There would be no direct or indirect impacts to wetlands, mangroves, or seagrasses resulting from the modification of existing commercial buildings, residential elevations, or construction access and staging requirements. No wetlands or mangrove resources would be removed or disturbed. BMPs identified in Section 7.3.6 would be adhered to during construction.

7.2.4 Alternative 4

There would be no direct or indirect impacts to wetlands, mangroves, or seagrasses resulting from the floodproofing of existing CI and commercial buildings, residential elevations, or construction access and staging requirements. No wetlands or mangrove resources would be removed or disturbed. BMPs identified in Section 7.3.6 would be adhered to during construction.

7.2.5 Alternative 5

There would be no direct or indirect impacts to wetlands, mangroves, or seagrasses. No wetlands or mangrove resources would be removed or disturbed. BMPs identified in Section 7.3.6 would be adhered to during construction.

7.3 Special Status Species

7.3.1 Alternative 1

Listed species under the jurisdiction of United States Fish and Wildlife Service (USFWS), and other special status species that may be present in the study area, and their associated habitats would continue to be subject to anthropogenic impacts associated with development. The No Action Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk.

7.3.2 Alternative 2

There would be no direct impact to special status species because construction would be limited to the modification of existing buildings. A review of the Audubon's EagleWatch bald eagle nest locator indicates there are no active documented bald eagle nests located near CI locations. If special status species are present, avoidance behavior may result in indirect, temporary, minor impacts. Following construction completion, conditions would be restored and wildlife occupying the area would be expected to return. The proposed floodproofing of CI may affect, but is not likely to adversely affect, the Florida bonneted bat with adherence to the BMPs listed in Section 7.3.6.

7.3.3 Alternative 3

There would be no direct impacts to special status species resulting from floodproofing modifications to existing commercial buildings, residential elevations, or construction access and staging requirements. According to the Audubon's EagleWatch nest locator, there are no documented bald eagle nests located near nonstructural Focus Areas as of the 2023 nesting season. The closest documented bald eagle nest, as occupied during the 2023 nesting season, is located adjacent to the Little River and approximately 1.2 miles from the Little River nonstructural Focus Area. However, indirect impacts may occur if special status species are present in the vicinity and demonstrate avoidance behaviors. Nonstructural measures may affect, but are not likely to adversely affect, the Florida bonneted bat with adherence to the BMPs listed in Section 7.3.6. Tree removal, if required for construction access, would be conducted outside the breeding season for the Florida bonneted bat (January 1 through April 15).

7.3.4 Alternative 4

There would be no effects to special status species beyond those described in Sections 7.3.2 and 7.3.3. There would be no effects to trust resources under the purview of the National Oceanic and Atmospheric Administration (NOAA) Fisheries because no construction would occur in the water. Section 7.3.6 describes BMPs for special status species.

The proposed nonstructural measures, including floodproofing CI and nonresidential buildings, and residential elevations, may affect, but are not likely to adversely affect, the Florida bonneted bat with adherence to the BMPs listed in Section 7.3.6. Informal Section 7 consultation was completed with the USFWS for the Tentatively Selected Plan (TSP), now the Recommended Plan (RP), on June 14, 2024. Appendix A-3 provides the documentation.

7.3.5 Alternative 5

The effects would be the same as described in Section 7.3.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures. There would be no effects to NOAA trust resources.

7.3.6 Best Management Practices

The following standard Jacksonville District BMPs for migratory and shorebirds would be adhered to during construction:

a. All construction personnel will be advised that migratory birds are protected by the Florida Endangered and Threatened Species Act of 1977, Title XXVIII; the Migratory Bird Treaty Act of 1918; and the Endangered Species Act of 1973, as amended. The contractor may be held responsible for harming or harassing birds, their eggs, or their nests.
b. Construction activities will be under surveillance, management, and control to prevent impacts to migratory birds and their nests.
c. A qualified bird monitor will be present and will monitor the construction area from April 1 through August 31, unless there is an exception granted by a USACE biologist.
d. The bird monitor must be approved by a USACE biologist. The biologist must possess qualifications that include, but are not limited to, identifying bird species, nesting behavior, eggs and nests, and habitat requirements. They also must be familiar with state requirements and reporting procedures.
e. The bird monitor must record any nesting activity in accordance with reporting requirements. Should nesting begin within the construction area, a temporary 200- to 300-foot buffer, as specified by the monitor and the USACE biologist, must be created and marked with signs to avoid entry.
f. Strict erosion and sediment control measures should be used during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual (latest update July 2013 [or most current version]), as well as the conditions of any permits issued for the project.
g. Native vegetative seed mixes must be planted on disturbed land after construction is complete.

The following BMPs for development projects as identified in the 2019 Florida Bonneted Bat Consultations Guidelines would also be adhered to:

a. If potential roost trees or structures need to be removed, check cavities for bats within thirty days prior to removal of trees, snags, or structures. When possible, remove structure outside of breeding season (e.g., January 1 through April 15). If evidence of use by any bat species is observed, discontinue removal efforts in that area and coordinate with the USFWS on how to proceed.
b. When using heavy equipment, establish a 250-foot (76 meter) buffer around known or suspected roosts to limit disturbance to roosting bats.
c. Retain mature trees and snags that could provide roosting habitat. These may include live trees of various sizes and dead or dying trees with cavities, hollows, crevices, and loose bark.
d. Protect known Florida bonneted bat roost trees, snags, or structures and trees or snags that have been historically used by Florida bonneted bats for roosting, even if not currently

occupied, by retaining a 250- foot (76 meter) disturbance buffer around the roost tree, snag, or structure to ensure that roost sites remain suitable for use in the future.

e. Avoid and minimize the use of artificial lighting, retain natural light conditions, and install wildlife-friendly lighting (i.e., downward facing and lowest lumens possible). Avoid permanent night-time lighting to the greatest extent practicable.
f. If Florida bonneted bats have taken residence within a structure, contact USFWS and Florida Fish and Wildlife Conservation Commission prior to attempting removal or when conducting maintenance activities on the structure.
g. Construction activities would take place during daylight hours only, which will typically occur between 8:00 a.m. and 5:00 p.m.

7.4 Geology, Topography, and Soils

7.4.1 Alternative 1

Geologic and topographic conditions would continue to persist in their current state. Naturally occurring shorelines in Miami-Dade County may experience erosion as the result of storm surge with impacts dependent on storm strength, speed, and direction. As sea level changes over time, the morphological processes of erosion and siltation would occur, with potential impacts to naturally occurring shorelines. Erosion, subsidence, and flooding events in Miami-Dade County would continue.

7.4.2 Alternative 2

There would be negligible to minor, temporary, direct, adverse impacts from ground disturbance that may result from the modification of existing buildings, which may include elevating equipment associated with CI facilities, such as external heating, ventilation, and air conditioning (HVAC) units. Additionally, ground-disturbing activities may also be required to relocate utilities where determined necessary.

7.4.3 Alternative 3

Negligible to minor, temporary, direct, adverse impacts would occur from ground disturbance associated with construction access and potential staging requirements for residential elevations. Indirect impacts to soil resources may also occur as the result of relocating utilities associated with residential elevations.

7.4.4 Alternative 4

Negligible to minor, temporary, direct, adverse impacts to soil may result from construction-related ground disturbance associated with residential elevations and the potential elevation of equipment associated with CI facilities. Ground-disturbing activities may also be necessary to relocate utilities where determined appropriate.

7.4.5 Alternative 5

The effects would be the same as described in Sections 7.4.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

7.5 Bathymetry, Hydrology, and Tidal Processes

7.5.1 Alternative 1

There would be no changes to the existing bathymetry of Biscayne Bay or tidal processes. Potential climate change impacts may continue to influence the length and severity of rainfall events, which may contribute to compound flooding when combined with the effects of a coastal storm.

7.5.2 Alternative 2

There would be no direct or indirect effects to the bathymetry of Biscayne Bay, hydrology, and tidal processes. Impacts from climate change would continue to occur; however, the structures would be less likely to be subject to damages resulting from storm surge during a coastal storm event.

7.5.3 Alternative 3

There would be no direct or indirect effects to the bathymetry of Biscayne Bay, hydrology, and tidal processes. Impacts from climate change would continue to occur; however, the structures would be less likely to be subject to damages resulting from storm surge during a coastal storm event.

7.5.4 Alternative 4

There would be no direct or indirect effects to the bathymetry of Biscayne Bay, hydrology, and tidal processes. Impacts from climate change would continue to occur; however, the structures would be less likely to be subject to damages resulting from storm surge during a coastal storm event.

7.5.5 Alternative 5

There would be no direct or indirect effects to the bathymetry of Biscayne Bay, hydrology, and tidal processes. Impacts from climate change would continue to occur; however, the structures would be less likely to be subject to damages resulting from storm surge during a coastal storm event.

7.6 Water Quality

7.6.1 Alternative 1

There would be no direct or indirect effects to water quality, which would continue to be influenced by various factors. Ongoing county and municipal programs for septic to sewer conversions would continue

in parallel with local initiatives to improve water quality. Indirect, adverse water quality impacts may be exacerbated by climate change effects and during a coastal storm event.

7.6.2 Alternative 2

Modifications to existing critical facilities located on land would not directly or indirectly affect water quality. Ongoing county and municipal programs for septic to sewer conversions would continue in parallel with local initiatives to improve water quality. Water quality impacts may be exacerbated by climate change effects and during a coastal storm event. Erosion and sediment control BMPs would be adhered to during construction.

7.6.3 Alternative 3

Floodproofing of nonresidential buildings in addition to residential elevations would not directly or indirectly affect water quality. Ongoing county and municipal programs for septic to sewer conversions would continue in parallel with local initiatives to improve water quality. Water quality impacts may be exacerbated by climate change effects and during a coastal storm event. Erosion and sediment control BMPs would be adhered to during construction.

7.6.4 Alternative 4

Floodproofing of CI and commercial buildings in addition to residential elevations would not directly or indirectly affect water quality. Minor, beneficial impacts would be associated with the reduced risk of flood damage to structures and associated potential for floodwaters to transport debris or pollutants during a storm event. Ongoing county and municipal programs for septic to sewer conversions would continue in parallel with local initiatives to improve water quality. Climate change effects and coastal storm events may impact water quality.

7.6.5 Alternative 5

The effects would be the same as described in Sections 7.6.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

7.7 Floodplains

7.7.1 Alternative 1

With the No Action Alternative, residential, nonresidential, and CI buildings located in the project design floodplain would continue to be at risk of damage or destruction from storm surge flooding. Additional development within the floodplain would continue. Ongoing county and municipal programs would continue to address climate-related needs in vulnerable communities located in flood-prone areas. Planned municipal stormwater improvements would also alleviate some flooding issues.

7.7.2 Alternative 2

Dry floodproofing of CI would occur to existing facilities located in the project design floodplain; however, the activities proposed would not result in additional development in the floodplain (**Figure 7-2**). Where a project site is located near a natural floodplain area, any adverse impacts from construction activities to the natural floodplain would be negligible and temporary, because proper construction methods would be used accordingly. The dry floodproofing of CI would not alter or impact floodplain values, and it would result in the prevention of future damages to the facilities.

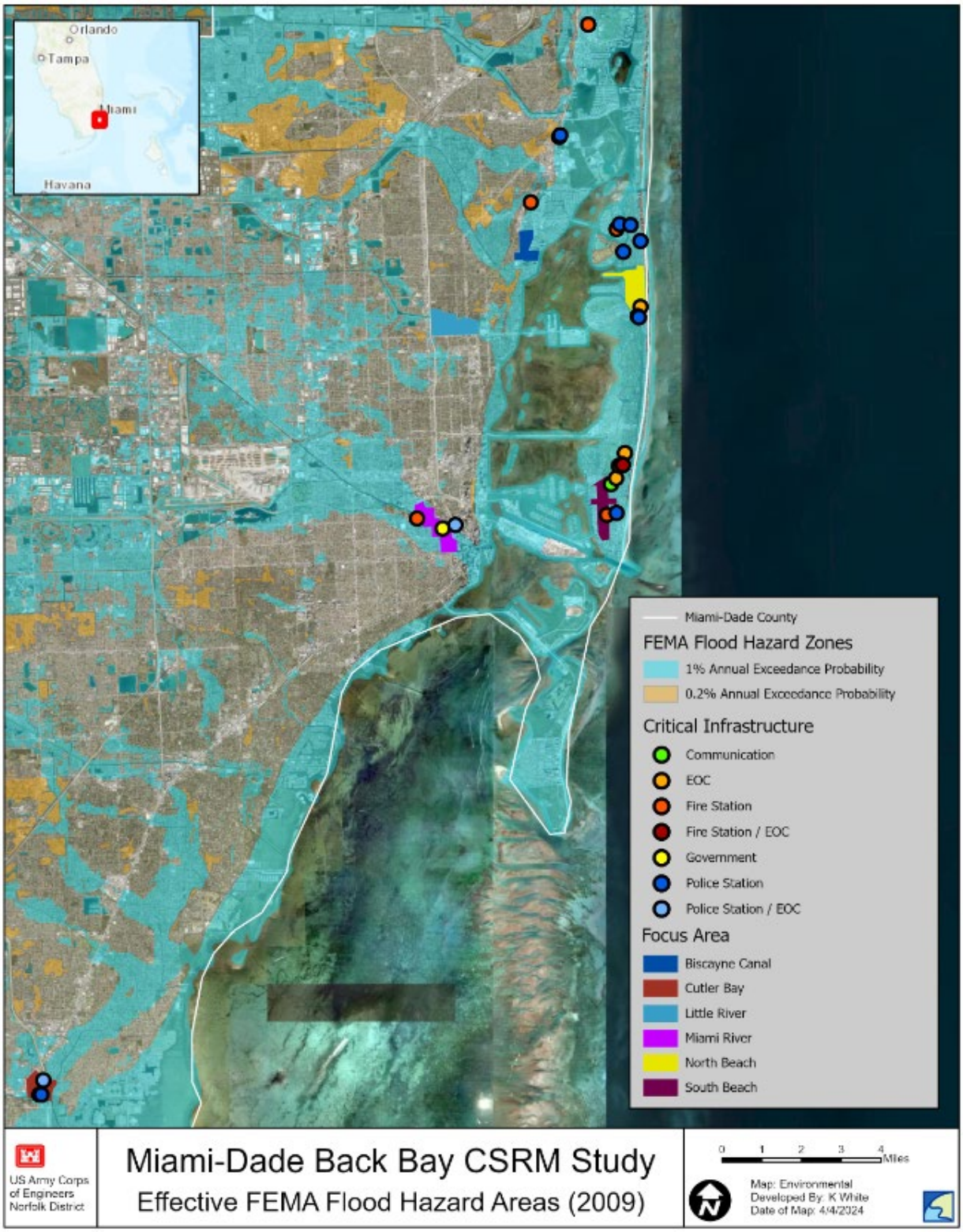


Figure 7-2. Effective Federal Emergency Management Agency Flood Hazard Areas in Miami-Dade County

7.7.3 Alternative 3

Nonstructural measures consisting of residential elevations and dry floodproofing of nonresidential structures would occur on existing structures only. The proposed activities would not result in additional development in the project design floodplain. Where a project site is located near a natural floodplain area, any adverse impacts from construction activities to the natural floodplain would be negligible and temporary, because proper construction methods would be used accordingly.

7.7.4 Alternative 4

There would be no additional development in the floodplain because the proposed measures include improvements to existing structures only. No additional land located in the project design floodplain beyond the site locations of CI facilities and private residences and nonresidential buildings would be affected. Where a project site is located near a natural floodplain area, any adverse impacts from construction activities to the natural floodplain would be negligible and temporary, because proper construction methods would be used accordingly.

7.7.5 Alternative 5

The effects would be the same as described in Section 7.7.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

7.8 Cultural Resources

7.8.1 Alternative 1

Cultural resources located in low-lying areas of Miami-Dade County remain vulnerable to storm surge and coastal storm events that may impact these areas. Potential climate change impacts may continue to influence the length and severity of rainfall events, which may contribute to compound flooding when combined with the effects of a coastal storm. Historic buildings would continue to be at risk of damage or destruction from coastal storm flooding. Archaeological sites could sustain adverse effects from flooding, but damages to historic buildings could make them unusable and lead to their demolition. Flood damage to historic districts, sites, buildings, structures, or objects eligible for the National Register of Historic Places (NRHP) could occur in the absence of storm risk management measures as proposed, which potentially impacts the viewshed of remaining historic properties. Similarly, flood damage of historic landscapes could adversely impact the viewshed of other remaining intact historic properties.

7.8.2 Alternative 2

Floodproofing of any potential historic CI could potentially result in permanent, moderate adverse to beneficial effects. Floodproofing would help to preserve the building, providing benefits; however, some measures have the potential to cause permanent, moderate adverse effects from physical or visual effects to historic characteristics as well. Some measures may involve ground disturbance, which

has the potential to adversely impact archaeological sites. For areas not yet surveyed for archaeological resources, potential impacts are uncertain. Regulations at 36 CFR § 800.14(b)(1)(ii) authorize USACE to develop a Programmatic Agreement (PA) when effects to historic properties cannot be fully determined before approving an undertaking. USACE will apply the provisions of the Jacksonville District's 2021 Programmatic Agreement (PA) Among the United States Army Corps of Engineers, the Florida State Historic Preservation Officer, the Bureau of Ocean Energy Management and the Advisory Council on Historic Preservation Regarding Compliance with Section 106 of the National Historic Preservation Act During Implementation of the United States Army Corps of Engineers, Jacksonville District Operations, Navigation and Shore Protection Programs (Appendix A-3) to this project. Archaeological and historic architectural surveys would be conducted, as needed, during the Preconstruction, Engineering, and Design (PED) Phase. Potential effects to historic properties from implementing this alternative would be considered through implementing stipulations of the PA. USACE notified the Advisory Council on Historic Preservation (ACHP), State Historical Preservation Office (SHPO), and tribal consulting parties to the PA that USACE intends to apply the PA to this project (Appendix A-3).

7.8.3 Alternative 3

Nonstructural measures include dry floodproofing and elevating buildings for coastal storm risk management (CSRM). The nonstructural alternative would potentially cause adverse effects to the historic character of buildings eligible for the NRHP but also make them viable for the future in the face of flood risks. These potential effects could result in permanent, moderate adverse to beneficial effects. The executed PA (Appendix A-3) described in Section 7.8.2 would also apply to this alternative. Archaeological and historic architectural surveys for the project would be phased as described above, and potential effects to historic properties would be considered through implementing stipulations of the PA.

7.8.4 Alternative 4

Potential impacts to historic buildings and archaeological resources from CI measures combined with nonstructural measures would be as described in Section 7.8.2 and 7.8.3. Measures such as wet and dry floodproofing and elevating structures would potentially cause adverse effects to buildings eligible for the NRHP but also make them viable for the future in the face of flood risks. The executed PA (Appendix A-3) described in Section 7.8.2 would apply to this alternative. Archaeological and historic architectural surveys for the project would be phased as described above, and potential effects to historic properties would be considered through implementing stipulations of the agreement.

7.8.5 Alternative 5

The effects would be the same as described in Section 7.8.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures. The executed PA (Appendix A-3) described in Section 7.8.2 would apply to this alternative. Archaeological and historic architectural surveys for the project would be phased as described above, and potential effects to historic properties would be considered through implementing stipulations of the agreement.

7.9 Aesthetics and Visual Resources

7.9.1 Alternative 1

The No Action Alternative would involve no additional action to mitigate the effects from surge impacts associated with a coastal storm event. Additional development would continue and may result in localized changes to the visual landscape of certain areas of Miami-Dade County. The potential impacts to visual resources following a coastal storm event would depend upon the strength and intensity of the event and, consequently, coastal storm damages. Potential damages from a storm surge event may degrade aesthetic and visual resources.

7.9.2 Alternative 2

Modifications to existing critical facilities would result in negligible, permanent, direct, adverse effects to aesthetic and visual resources. Floodproofing of CI, including elevations of exterior equipment, would have no direct effects on the landscape, but it would have a noticeable effect on the appearance of the building or structure that would be considered negligible to minor and permanent. Negligible to minor, permanent beneficial effects may result from managing the risk of storm surge-related flood damages and associated degradation of visual resources.

7.9.3 Alternative 3

There would be minor, permanent, adverse, direct effects to visual resources as a result of floodproofing commercial buildings in addition to residential elevations. The final elevation of the home would be a maximum of 13 feet above ground level (AGL), which is approximately equivalent to a single-story building. Home elevations would change the appearance of the home, and elevations would also make them visible from further distances, depending on the vantage point. The presence of equipment during construction would cause minor, temporary, adverse effects to the visual landscape. Negligible to minor, permanent, beneficial effects may result from managing the risk of storm surge-related flood damages and associated degradation of visual resources.

7.9.4 Alternative 4

There would be minor, permanent, adverse, direct effects to visual resources resulting from the floodproofing of CI and commercial buildings as well as residential elevations. Home elevations would change the appearance of the home and likely make the home visible from further distances. Negligible to minor, permanent, beneficial effects may result from managing the risk of storm surge-related flood damage and associated degradation of visual resources.

7.9.5 Alternative 5

The effects would be the same as described in Section 7.9.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

7.10 Air Quality

The largest anthropogenic source of greenhouse gases (GHG) is fossil fuel use, which is the primary source of carbon dioxide (CO_2). The GHG analysis was completed in accordance with the Council on Environmental Quality's (CEQ) NEPA Guidance on Consideration of Greenhouse Gas Emissions and Climate Change (January 2023).

7.10.1 Greenhouse Gas Emissions Analysis

The scope of this analysis is the climate change and air quality impacts of flood risk management measures proposed in the Miami-Dade Back Bay Feasibility Study. Proposed measures for residential buildings include elevation of existing structures. Proposed measures for CI assets and nonresidential buildings include dry floodproofing and elevation of critical exterior assets such as HVAC equipment.

Emissions include the tailpipe emissions from construction equipment and the embodied emissions of consumed materials. Climate change impacts are measured in quantities of GHGs emitted, and air quality impacts are measured in quantities of National Ambient Air Quality Standards (NAAQS) criteria pollutants emitted. This analysis allows USACE to compare impacts across the different flood risk management measures to better inform decision-making.

The GHGs in this analysis are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The air quality pollutants are the following criteria air pollutants (CAP): volatile organic compounds (VOC), carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), particulate matter 2.5 (PM2.5), and particulate matter 10 (PM10). Emissions from lead (Pb) are not a component of this analysis because emission factors (EFs) for this pollutant are not available from standard EF sources (e.g., United States Environmental Protection Agency [USEPA] Motor Vehicle Emission Simulator).

Within this analysis, a No Action Alternative and three flood risk management measures for Florida's Miami-Dade County were analyzed. The No Action Alternative includes evacuation of residents and impacts to structures if they do not receive any flood risk management measure. Measure 1 is the elevation of residential structures. The second and third types of measures relate to floodproofing nonresidential structures and CI assets. Measure 2 is the elevation of one HVAC system at a CI facility. Measure 3 entails deployment of temporary flood barriers around a CI asset. The deployment of temporary flood barriers serves as a proxy for dry floodproofing in this GHG analysis. The total GHGs and CAPs are then calculated for each measure based on aggregated emissions across all impacted structures.

Total GHG and CAP emissions are then calculated for the No Action Alternative and the four action alternatives presented in the Plan Formulation section of the Feasibility Report (Section 4.4). Climate change and air quality impacts are input into two tabs of USACE's Net Emission Analysis (NEAT) tool: "2. Construction Emissions" and "5. Embodied Carbon in Materials." For the purposes of the NEAT tool, construction activities under the action alternatives are assumed to be equally distributed over the construction period from 2027 to 2035. All EFs for the No Action Alternative are input into the NEAT tool in 2027. Operation and maintenance of the measures included as part of action alternatives are assumed not to generate appreciable emissions; in the NEAT tool module for operations and maintenance emissions are set to zero.

Note on Material Calculations for all Measures:

The NEAT tool's "5. Embodied Carbon in Materials" tab takes two inputs: cubic yards of cement and pounds of CO_2 per cubic yard of cement. Cement is the main carbon-intensive ingredient in concrete. The other ingredients—sand, stone, and water—have negligible or relatively small emissions compared to cement. Thus, for materials, the embodied carbon emissions associated with the concrete portions of materials in USACE's Micro-Computer Aided Cost Estimating System, Second Generation (MII) cost estimation software model outputs were evaluated as opposed to solely the emissions from the cement portions of the materials.

Note on Data from MII:

The source data for Measure 1 and Measure 2 came directly from the 2022 MII Cost Estimate for Nonstructural Residential Elevation Cost Models provided by USACE, Huntington District.

No Action:

Under the No Action Alternative, the proposed CSRM project would not be implemented. Damages would continue to occur as described in the Future Without Project (FWOP) Alternative. For the purposes of this analysis, GHG emissions are assumed to occur in the No Action Alternative through two mechanisms: reconstruction of total loss residential structures and evacuation of residents during storm events. This section presents computed GHG emissions based on the total number of benefiting single-family and multifamily residential buildings across all modeled areas for the study. The GHG emissions were not estimated for specific-frequency storm events or annualized over the period of analysis.

Emissions Associated with Total Loss of Residential Structures:

To calculate the emissions associated with reconstruction of total loss residential structures, literature research was performed to identify an estimate of the carbon dioxide equivalent (CO_2e) emissions per new home constructed in a warm climate (U.S. Department of Energy 2023). The number of single-family residential buildings that sustain an amount of damage that would require full reconstruction was obtained from the FWOP Generation 2 Coastal Risk Model (G2CRM) results from the economic analysis. A simplifying assumption was made that structures would be replaced if the present value of damages exceeds the depreciated replacement value of the structure. As seen in **Figure 7-3**, the quantity of full reconstruction homes was multiplied by the emissions rate of new home construction to generate the total GHG emissions across all residential buildings in the asset inventory across the study area.

$$CO_2e\ (g) = \ Full\ Reconstruction\ Homes\ (\#\ of\ homes) \times Emission\ Factor\ \left(\frac{g\ CO_2e}{home}\right)$$

Figure 7-3. Home Construction Emissions Equation

These emissions estimates do not incorporate GHG emissions associated with the repair of structures damaged by floodwaters but not considered total losses. Given this limitation, actual GHG emissions associated with the No Action Alternative are likely higher than presented in this analysis.

Emissions Associated with Evacuation of Residents:

To model the GHG emissions associated with evacuation of residents during storm events, GHG emissions were computed on a per vehicle basis. It was assumed that one car per single-family residential building is used to drive residents from Miami-Dade County to Fort Lauderdale during the evacuation. A simplifying assumption was made that the residents of 80 percent of residential structures would evacuate. The average driving distance from the Focus Areas to Fort Lauderdale was estimated to be 30 miles using an internet mapping platform. The vehicle was assumed to be a gasoline-powered passenger car. To calculate the emissions, the distance traveled was multiplied by an EF specific to the vehicle type (**Figure 7-4**).

$$CO_2\ (g) = \ Distance\ Traveled\ (miles) \times Emission\ Factor\ \left(\frac{g\ CO_2}{mile}\right)$$

Figure 7-4. On-Road Vehicle Emissions Equation

The calculated emissions of the single vehicle were then multiplied by the number of residential buildings with evacuees. These data were obtained from the G2CRM results from the economic analysis.

Measure 1: Building Elevation

For Measure 1, emissions from equipment and materials used in the construction process of elevating a residential structure were evaluated. A list of construction equipment and materials was generated using USACE's MII model, including the type of equipment, the run time hours of the equipment, the type of material, and the quantity of the material used. For each piece of equipment and type of material, an EF was selected to calculate the associated emissions. EFs were selected from databases or product specifications. For equipment or materials without a known EF, equipment and materials of similar specifications, designs, or purposes were used as proxies. Subject matter experts confirmed the relevance of the proxies selection.

The equipment run time hours were multiplied by the EF to determine the corresponding quantity of emissions. For equipment with horsepower ratings, an EF specific to the horsepower was used (**Figure 7-5**). For equipment without horsepower ratings, a general EF without a horsepower rating was used (**Figure 7-6**).

$$CO_2\ (g) = \ Operating\ Hours\ (hrs) \times \ Horsepower\ (hp)\ \times EF\ \left(\frac{g\ CO_2}{hp \cdot hr}\right)$$

Figure 7-5. Equipment Emissions Equation, Incorporating Horsepower

$$CO_2\ (g) = \ Operating\ Hours\ (hrs)\ \times EF\ \left(\frac{g\ CO_2}{hr}\right)$$

Figure 7-6. Equipment Emissions equation, Without Incorporating Horsepower

The material quantity was multiplied by the EF to determine the corresponding quantity of emissions (**Figure 7-7**).

$$CO_2e\ (g) = \ Quantity\ of\ material\ (kg)\ \times EF\ \left(\frac{g\ CO_2}{kg}\right)$$

Figure 7-7. Material Emissions Equation

GHG emissions were modeled for a range of typical residential buildings. The MII output included construction equipment and materials for a combination of structure areas with three different home areas in square feet (ft^2) and six different elevation heights in feet (ft). The home areas are 1,000, 2,000, and 3,000 ft^2. The elevation heights are two, four, six, eight, ten, and twelve ft. Emissions were calculated for each of these combinations of residential building square footages and elevations. Based on these data, a simple spreadsheet-based model was developed to interpolate between modeled square footage and height increments to estimate GHG emissions for the full range of residential buildings in the asset inventory (e.g., a 1,500 ft^2 house elevated by five ft).

Major Assumptions Made for Materials:

The materials modeled for emissions included a foundation wall comprised of blocks and grout-filled cells of varying square footage, a concrete grade beam of varying linear feet, and structural concrete of varying cubic yards. Various assumptions were made to convert the quantities of the structures into the quantities of concrete. For the foundation wall, 56 percent of the concrete block was assumed to be hollow and filled with masonry cement. Data from a technical product sheet were used to convert the volume of masonry cement into a mass of cement so the EF can be applied.

Measure 2: Heating, Ventilation, and Air Conditioning System Elevation:

Measure 2 is the 4 ft elevation of industrial HVAC systems. The calculation methodology for Measures 1 and 2 are the same, except for the following aspect.

For Measure 1, the MII output included construction equipment and materials for a combination of structure areas with different home areas and elevation heights. The MII model for Measure 2 accounts for only a standard size industrial HVAC system and a single height elevation of four ft; therefore, no regression equation was created. To model the emissions from elevating multiple HVAC systems, all by a height of four ft, the emission results of Measure 1 can be multiplied by the number of HVAC systems.

Table 7-1. Total Construction Equipment Greenhouse Gas Emissions in Grams (g) from a four-foot Elevation of an Industrial Heating, Ventilation, and Air Conditioning System

Emission Type	CO2 (g)	CH4 (g)	N2O (g)	VOC (g)	CO (g)	SOx (g)	NOx (g)	PM2.5 (g)	PM10 (g)
Quantity	393,410.92	40.59	36.87	162.51	2,582.29	5.41	2,648.56	108.48	111.90

Table 7-2. Total Construction Material Emissions from a four-foot Elevation of an Industrial Heating, Ventilation, and Air Conditioning System

	Concrete (yd3)	Concrete Emissions (lb CO2e/yd3 concrete)
Quantity	1.32	552.92

yd^3 = cubic yards; lb = pounds

Measure 3: Four-Foot Deployable Flood Barrier:

Measure 3 is the deployable flood barrier. For purposes of the GHG analysis, a typical flood barrier was considered. A commercially available product called "Heavy Duty Flood Barrier," manufactured by Geodesign Barriers (Appendix A-3), was considered for modeling purposes in this analysis, though specific barrier types, parameters, and manufacturers may be determined at a later phase of the project. The calculation of GHG emissions for the deployable flood barrier serves as a proxy for dry floodproofing because the method of installation (i.e., manual deployment) and materials are representative of other dry floodproofing methods for the purposes of this analysis. Manufactured for a variety of sizes, this modular flood barrier can protect against different flood heights. The product modeled for this measure is C48, which is rated for a maximum water column, or depth, of four ft. The emissions are based off a four ft long section. These section EFs can be multiplied by the number of sections linked together needed to form a long wall.

The emissions for this measure include only the embodied emissions of consumed materials. According to the product specification, this product is deployed manually, so no equipment emissions are included. In addition, this product is assumed to be stored in an area close to the area where the product is deployed, so emissions from transporting the product pieces to the site are considered negligible.

For some components of the product, the product specification document details the type of material (e.g., galvanized steel) and the quantity. For components that did not have a type or quantity of material specified, images in the product specification were used to make assumptions of these data.

For each material type, an EF was selected to calculate the associated emissions. EFs were selected from databases or product specifications. For materials without a known EF, materials with similar characteristics were used as proxies. Subject matter experts confirmed the relevance of the proxies. The material quantity was multiplied by the EF to determine the corresponding quantity of emissions (**Figure 7-7**). With no emissions from equipment and no cement components, the results from this measure were not input into the NEAT tool.

Table 7-3. Total Embodied Emissions from Product's Materials

	Emissions (lb CO2e/module)
4 ft long module for 4 ft water column	304.84

Greenhouse Gas Emissions and Net Emission Analysis Tool Inputs

Emission estimates were generated for each alternative based on the measure level emissions calculations described above. **Table 7-4** presents the total construction emissions by alternative and **Table 7-5** presents the total embodied carbon in materials that were input into the NEAT tool.

Table 7-4. Total Construction Emissions in Grams

Parameter	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Reactive Organic Gases also known as Volatile Organic Compounds (ROG/VOC)	15,432	4,875	16,133,758	16,138,633	8,077,172
CO	231,604	77,469	796,692,570	796,770,038	401,988,605
SO_x	92	162	71,647	71,809	34,432
NO_x	7,487	79,457	23,779,390	23,858,847	11,519,693
$PM_{2.5}$	157	3,255	1,188,140	1,191,394	584,231
PM_{10}	178	3,357	1,262,208	1,265,565	620,520
Pb	-	-	-	-	-
CO_2	58,145,921,753	1,583,133,609	12,603,912,032	14,187,045,640	7,923,671,560
CH_4	749	1,218	1,019,313	1,020,531	483,544
N_2O	262	1,106	909,147	910,254	427,812

Table 7-5. Embodied Carbon Emissions

Alternative	Concrete (yd3)	Concrete Emissions (lb CO2e/yd3 concrete)
Alternative 1	-	-
Alternative 2	39.63	552.92
Alternative 3	111,166.50	1,246.06

Alternative	Concrete (yd3)	Concrete Emissions (lb CO2e/yd3 concrete)
Alternative 4	111,206.13	1,246.06
Alternative 5	49,068.69	1,253.88

Social Cost of Greenhouse Gases

To estimate social costs in dollars for the GHG emissions associated with these measures, the total emissions across equipment and materials can be multiplied by the social cost values in dollars per unit mass. Social cost of carbon was calculated in the NEAT tool and is presented in **Table 7-6** by alternative. Appendix A-3 shows a more detailed breakdown of the total social costs by activity for each alternative and broken down by each GHG pollutant.

Table 7-6. Social Cost of Carbon in 2020 Dollars ($)

Alternative	Gross Total ($)
Alternative 1	3,430,623
Alternative 2	99,640
Alternative 3	5,020,417
Alternative 4	5,120,892
Alternative 5	2,375,866

7.10.2 Alternative 1

There would be no additional action to mitigate the effects from surge impacts associated with a coastal storm event. Minor, temporary, and localized air quality impacts may occur from ongoing construction projects and other contributing factors. The No Action Alternative considers GHG emissions resulting from evacuation and building reconstruction following a storm event. Based upon the GHG emissions analysis, total construction emissions are the highest for CO_2 for the No Action Alternative compared to the action alternatives (**Table 7-4**).

7.10.3 Alternative 2

There would be negligible, temporary, direct, adverse effects to air quality resources from construction emissions associated with modifications to existing critical facilities. The construction emissions would be associated with the elevation of critical exterior equipment, such as an industrial HVAC system. There are no anticipated construction emissions associated with dry floodproofing because equipment is not

necessary for installation and there are no cement components. Construction emissions associated with Alternative 2 would be spread across approximately two years.

7.10.4 Alternative 3

There would be minor, temporary, direct, adverse effects to air quality as the result of elevating residential buildings. There are no anticipated construction emissions associated with dry floodproofing nonresidential buildings because equipment is not necessary for installation and there are no cement components. Construction emissions associated with Alternative 3 would be spread across approximately eight years.

7.10.5 Alternative 4

There would be minor, temporary, direct, adverse effects to air quality as the result of floodproofing of CI and elevation of residential buildings. The temporary effects would all occur during construction activities. In comparison with the other action alternatives (Alternatives 2, 3, and 5), the total GHG emissions are highest for Alternative 4, which is a combination of Alternatives 2 and 3. The floodproofing of CI, and nonresidential buildings, and residential building elevations would not exacerbate changes to the climate. Temporary, negligible to minor increases in GHG emissions would result from the use of diesel-powered construction equipment. The implementation of these CSRM measures would reduce future damages from a coastal storm event, thereby potentially reducing future carbon emissions associated with disaster recovery and cleanup. GHG emissions associated with Alternative 4 would be spread across an approximate 13-year construction duration.

7.10.6 Alternative 5

The effects would be the same as described in Sections 7.10.5but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

7.11 Hazardous Materials and Waste

Figure 7-8 and **Figure 7-9** depict the locations of the Florida Department of Environmental Protection's (FDEP's) cleanup sites in relation to the proposed locations of CI and the nonstructural Focus Areas.

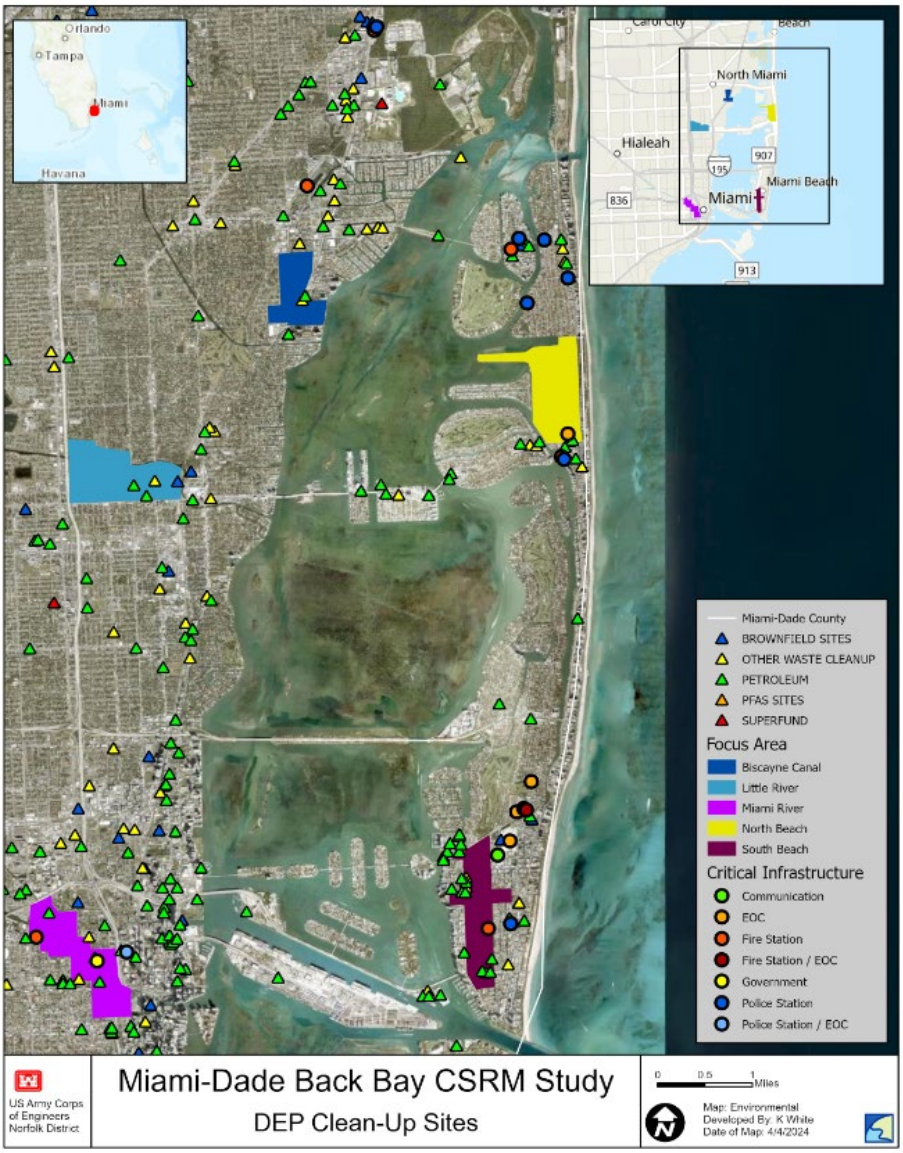


Figure 7-8. Florida Department of Environmental Protection Cleanup Sites in North Miami-Dade County

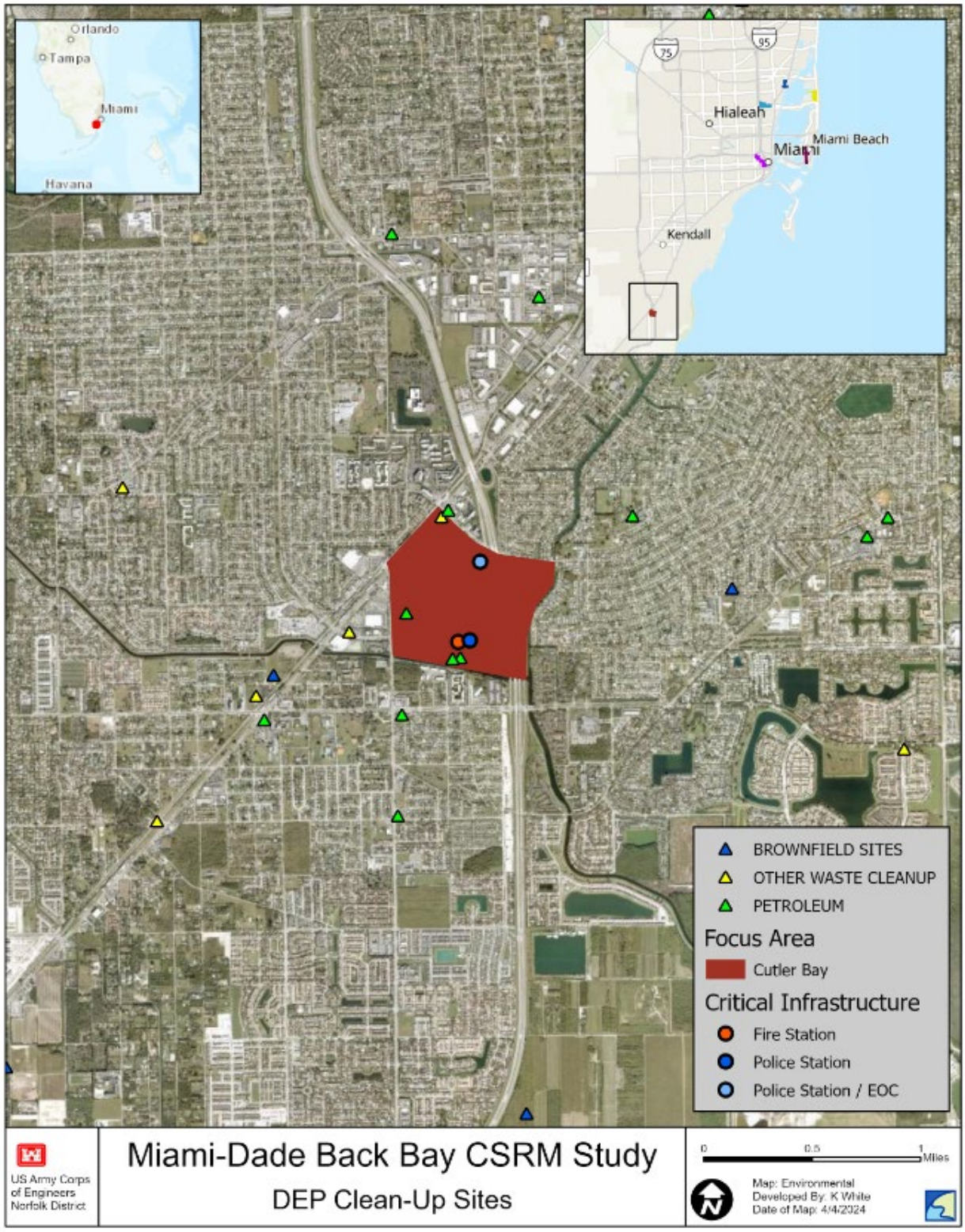


Figure 7-9. Department of Environmental Protection Cleanup Sites near Cutler Bay

Within the Focus Areas, there are several petroleum cleanup sites, identified as "other waste cleanup," and one brownfield site in the Little River Focus Area. The location of the brownfield site in the Little River Focus Area, known as Pelican Harbor Seabird Station, is currently vacant land proposed for the development of a wildlife rehabilitation facility (**Figure 7-8**). There are no Superfund sites near the CI or nonstructural Focus Areas.

7.11.1 Alternative 1

There would be no additional action to mitigate the effects from surge impacts associated with a coastal storm event; therefore, no impacts to Hazardous, Toxic, and Radioactive Waste (HTRW) would occur. Existing federal, state, and municipal cleanup programs would continue.

7.11.2 Alternative 2

There would be no direct or indirect effects to HTRW cleanup sites because of floodproofing CI. While some petroleum cleanup sites are identified within the Focus Areas on the map, these sites are either formerly developed sites that are currently vacant or sites that would be avoided as the project moves forward in the PED Phase.

7.11.3 Alternative 3

There would be no direct or indirect effects to HTRW cleanup sites from floodproofing commercial buildings or elevating homes. While some petroleum cleanup sites are identified within the Focus Areas on the map, these sites are either formerly developed sites that are currently vacant or sites that would be avoided as the project moves forward in the PED Phase.

Residential elevations may include existing buildings of varying ages; therefore, the potential exists for some buildings to contain lead-based paint (LBP), asbestos-containing material (ACM), or polychlorinated biphenyls (PCBs). As a result, a Phase 1 Environmental Site Assessment should be conducted for any affected building constructed before 1978. If any such contaminants are found, the construction contract must include procedures for the lawful demolition, removal, and disposal of such wastes. Therefore, there would be minor, temporary, direct, adverse effects associated with HTRW.

7.11.4 Alternative 4

There would be no direct or indirect effects to HTRW cleanup sites from floodproofing CI and commercial facilities or elevating homes. While some petroleum cleanup sites are identified within the Focus Areas on the map, these sites are either formerly developed sites that are currently vacant or sites that would be avoided as the project moves forward in the PED Phase.

Residential elevations may include existing buildings of varying ages; therefore, the potential exists for some buildings to contain LBP, ACM, or PCBs. As a result, a Phase 1 Environmental Site Assessment should be conducted for any affected building constructed before 1978. If any such contaminants are found, the

construction contract must include procedures for the lawful demolition, removal, and disposal of such wastes. Therefore, there would be minor, temporary, direct, adverse effects associated with HTRW.

7.11.5 Alternative 5

The effects would be the same as described in Sections 7.11.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

7.12 Noise

7.12.1 Alternative 1

There would be no additional action to mitigate the effects from surge impacts associated with a coastal storm event; therefore, no impacts to existing ambient conditions and noise would occur. Existing state and municipal noise ordinances would continue to be enforced.

7.12.2 Alternative 2

Negligible to minor, temporary, direct effects to the existing noise environment would occur during floodproofing of facilities or elevating external equipment associated with a facility and associated future maintenance, which would occur on an as-needed basis. The length of time to complete construction activities would vary depending on the modifications proposed at individual facilities.

7.12.3 Alternative 3

There would be minor, temporary, direct effects to the existing noise environment from floodproofing commercial facilities or elevating homes. Commercial facilities would be located in areas designated for commercial use; therefore, construction-related noise, consisting of construction vehicles and equipment, would have a minor effect in the immediate vicinity of the building.

There would be minor, temporary, direct effects to the existing noise environment in residential neighborhoods associated with the construction process to elevate a home. Residences in the immediate vicinity are most likely to experience direct effects from noise associated with construction equipment and vehicles. Although the exact distance between residences varies, a minimum distance between properties is anticipated to be 30 feet.

The following are typical levels of noise on-site:

- Backhoe (maximum noise level: 80.0 A-weighted decibels [dBA])
- Compactor (maximum noise level: 80.0 dBA)
- Dozer (maximum noise level: 85.0 dBA)
- Dump truck (maximum noise level: 84.0 dBA)
- Excavator (maximum noise level: 85.0 dBA)

- Front-end loader (maximum noise level: 80.0 dBA)

For construction-related noise, typical noise levels vary depending on the type of construction equipment required. For example, the typical noise level for backhoes and loaders approximately 50 feet from the source is 80 and 85 decibels, respectively (U.S. Department of Transportation 2017). The noise levels may exceed those typically encountered in residential and recreational areas. Vegetation and objects (including buildings) that are between the location and source of noise can abate sound. Although construction would result in temporary and localized noise increases during construction, these activities would be limited to daylight hours only, which typically will occur between 8:00 a.m. and 5:00 p.m. Any associated construction activities will comply with all local regulations regarding noise and vibration levels.

7.12.4 Alternative 4

There would be no noise-related effects beyond those described in Section 7.12.2 and 7.12.3. Construction activities would be limited to daylight hours only, typically between 8:00 a.m. and 5:00 p.m.

7.12.5 Alternative 5

The effects would be the same as described in Section 7.12.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

7.13 Utilities

7.13.1 Alternative 1

There would be no additional action to mitigate the effects from surge impacts associated with a coastal storm event. Existing utilities in low-lying areas would continue to be subject to potential storm surge flooding during a storm event. Impacts would be minor, adverse, and temporary to permanent because existing utilities impacted by storm surge may require repairs, upgrades, or potential relocations, as needed.

7.13.2 Alternative 2

There would be negligible to minor, temporary, adverse impacts to utilities during dry floodproofing of CI. Direct impacts to existing utilities may occur because of elevating external equipment, such as HVAC units. However, these impacts would be minor as a result of construction activities.

7.13.3 Alternative 3

There would be negligible to minor, temporary, adverse impacts to utilities during construction activities. Implementation of residential elevations and dry floodproofing of nonresidential buildings would require local investigations and coordination with utility companies for existing utilities such as water, sewage, and power lines.

7.13.4 Alternative 4

There would be negligible to minor, temporary, adverse impacts to utilities during construction. Utility site investigation would be required during the PED Phase to ensure appropriate avoidance and minimization measures are used. The elevation of exterior equipment at CI locations, where necessary, would have direct, temporary, adverse impacts to utilities during construction. Construction activities associated with residential elevations and dry floodproofing of nonresidential buildings also would directly impact utilities and require local utility investigations.

7.13.5 Alternative 5

The effects would be the same as described in Sections 7.13.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

7.13.6 Best Management Practices

To avoid and minimize impacts on utilities, the following BMPs would be used:

a. Utility investigations would be conducted during the PED Phase and coordination with utility companies would take place.
b. Construction activities would safeguard against any temporarily exposed or relocated utilities, as needed to ensure public safety.

7.14 Socioeconomics

7.14.1 Alternative 1

There would be no additional action to mitigate the effects from surge impacts associated with a coastal storm event. Therefore, no direct impacts to socioeconomics would occur. Indirect adverse effects would occur as a result of increasing threats to residents, properties, and the local economy related to storm surge events, which are anticipated to be exacerbated by climate change in the future.

7.14.2 Alternative 2

The dry floodproofing of CI facilities would result in permanent, beneficial effects to socioeconomics from resilience improvements to these facilities, which would resume normal functions more expeditiously following a coastal storm event, particularly for CI facilities that provide critical services to underserved communities. There also would be temporary, minor, beneficial effects to the local economy with locally sourced construction jobs for floodproofing CI facilities. Negligible to minor, temporary, adverse effects may occur to businesses and/or communities associated with noise and construction equipment in the immediate vicinity while construction is underway.

7.14.3 Alternative 3

There would be temporary, moderate, adverse impacts during construction associated with residential elevations. Temporary relocations would be required for residents during construction. Restricted use of residences during construction may occur. Because elevations are voluntary, property owners are not considered displaced persons, and no relocation reimbursements would be anticipated under the Uniform Relocation Assistance Act (URA), as described in the Real Estate Plan Appendix, Appendix A-4. Affected tenants would be relocated to comparable residences and provided relocation assistance aid in accordance with the URA. Relocation during construction may present temporary hardship to the elderly, handicapped, or socially vulnerable, for whom temporary relocation may be more burdensome and relocation options may be more limited. However, the assistance provided through the URA would assist tenants in offsetting the impacts associated with temporary displacement during construction. Temporary relocation could result in inconveniences associated with day-to-day activities such as increased commute time and distance to work, which could temporarily adversely affect income. During construction, temporary, minor, adverse effects to neighborhoods would occur from construction activity and noise associated with residential elevations. The elevation of residential buildings would be voluntary for property owners and would have a permanent, beneficial effect for property owners and tenants by reducing flooding damages and increasing resilience following a storm surge event. Temporary, minor, beneficial effects to the local economy would occur with locally sourced construction jobs.

7.14.4 Alternative 4

The effects would be the same as described in Section 7.14.2 and 7.14.3. The dry floodproofing of CI facilities would result in permanent, beneficial effects to socioeconomics from resilience improvements to these facilities, particularly for CI facilities that provide critical services to underserved communities. There would be temporary, minor, beneficial effects to the local economy from locally sourced construction jobs for floodproofing CI facilities. During construction, negligible to minor, temporary, adverse effects may occur to businesses and/or communities associated with construction equipment and noise in the immediate vicinity.

There would be temporary, moderate, adverse impacts during construction associated with residential elevations. Residents/tenants would be required to temporarily relocate during construction and restricted use of residences may occur. Temporary relocation may present hardships to the elderly, handicapped, or socially vulnerable, for whom temporary relocations may be more burdensome and relocation options may be more limited. Because elevations are voluntary, property owners are not considered displaced persons, and no relocation reimbursements would be anticipated under the URA, as described in Appendix A-4. Affected tenants, however, would be relocated to comparable residences and provided relocation assistance aid in accordance with the URA. However, the assistance provided through the URA would assist tenants in offsetting the impacts associated with temporary displacement. Temporary relocation could also result in inconveniences associated with day-to-day activities, which could temporarily adversely affect income. During construction, temporary, minor, adverse effects to neighborhoods would result from construction activity and noise associated with residential elevations.

The elevation of residential buildings would be voluntary for property owners and would have a permanent, beneficial effect for property owners and tenants by reducing flooding damages and increasing resilience following a storm surge event. Additionally, a temporary, minor, beneficial effect to the local economy would occur from locally sourced construction jobs for floodproofing of CI and nonresidential buildings and construction associated with residential elevations.

7.14.5 Alternative 5

The effects would be the same as described in Section 7.14.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

7.14.6 Best Management Practices

To avoid and minimize impacts to socioeconomics, the following BMPs would be used:

a. Regular communication and coordination with affected residents and neighborhoods
b. Consideration for construction phasing by neighborhood to minimize construction window and inconvenience for each neighborhood
c. Strict adherence to the URA including accommodations in accordance with law and regulation

7.15 Environmental Justice

7.15.1 Alternative 1

There would be no additional action to mitigate the effects from surge impacts associated with a coastal storm event; therefore, no direct impacts to underserved communities would occur. The potential for indirect adverse effects to underserved communities in low-lying areas may occur because of the increasing flooding threats from storm surge events that are anticipated to be exacerbated by climate change in the future. Underserved communities that are disproportionately located in low-lying, flood-prone areas may be disproportionately impacted under the No Action Alternative.

7.15.2 Alternative 2

The dry floodproofing of CI facilities would result in permanent, beneficial effects to underserved communities from resilience improvements to these facilities, particularly for CI facilities that provide critical services to underserved communities. During construction, negligible to minor, temporary, adverse effects may occur to businesses and/or communities associated with noise and construction equipment in the immediate vicinity. Temporary impacts during construction may disproportionally affect underserved communities in the Focus Areas; however, these impacts cannot be avoided to provide positive benefits to the communities. Potential impacts would be mitigated through adherence to BMPs, including those listed in Section 7.14.5, and construction activities being limited to daylight hours only, typically between 8:00 a.m. and 5:00 p.m.

7.15.3 Alternative 3

The nonstructural Focus Areas were identified based on the most vulnerable areas because of high-frequency flooding potential and social vulnerability (Section 1.1 provides further detail on the identification of Focus Areas). The elevation of residential buildings would be voluntary for property owners and would have a permanent, beneficial effect for property owners and tenants by reducing flooding damages and increasing resilience following a storm surge event.

However, there would be temporary, moderate, adverse impacts during construction associated with residential elevations. Residents/tenants would be required to temporarily relocate for several months during construction. Restricted use of residences may occur. Relocation during construction may present hardships to socially vulnerable individuals and families, and elderly individuals for whom temporary relocations may be more burdensome or challenging. Because elevation is voluntary, property owners are not considered displaced persons, and no relocation reimbursements would be anticipated under the URA. Affected tenants, however, would be relocated to comparable residences and provided relocation assistance in accordance with the URA (described in further detail in the Real Estate Appendix, Appendix A-4). Eligible tenants who are temporarily relocated are reimbursed for the cost of temporary alternate housing, meals, and incidentals (such as laundry services), and the fees for disconnection and connection of utilities at the temporary residence. Alternate housing may include hotels or apartments, depending upon availability. All temporary housing costs require advance approval by the nonfederal sponsor (NFS) after first obtaining written approval of USACE. General Services Administration (GSA) per diem rates are the basis of allowable hotel reimbursement. Temporary relocations could result in inconveniences associated with day-to-day activities, which could temporarily adversely affect income. During construction, temporary, minor, adverse effects to neighborhoods, which may include underserved populations, would result from construction activity and noise associated with residential elevations.

Elevating residences is a voluntary measure; therefore, property owners may choose not to participate. However, if the residents are renters, then they would be subject to the decisions of the property owners. Additionally, tenants would qualify for temporary relocation costs and associated reimbursement in accordance with the URA, which would help to mitigate the temporary adverse impacts associated with relocation. Once construction is complete, tenants would return to the elevated residence. After a residential elevation is complete, there would be permanent, beneficial effects because the building would be less susceptible to direct physical damages from a storm surge event. Temporary impacts during construction may disproportionally affect underserved communities in the Focus Areas; however, these impacts cannot be avoided to provide positive benefits to the communities. Potential impacts would be mitigated through adherence to BMPs, including those listed in Section 7.14.5, and construction activities being limited to daylight hours only, typically between 8:00 a.m. and 5:00 p.m.

7.15.4 Alternative 4

As described in Section 7.15.2, the dry floodproofing of CI facilities would result in permanent, beneficial effects to underserved communities from resilience improvements to these facilities, particularly for CI facilities that provide services to vulnerable communities. During construction, negligible to minor, temporary, adverse effects may occur to businesses and/or communities associated with construction

equipment and noise in the immediate vicinity. However, these temporary impacts would not disproportionally affect underserved communities.

The elevation of residential buildings would be voluntary for property owners and would have a permanent, beneficial effect for property owners and tenants by reducing flooding damages and increasing resilience following a storm surge event. However, there would also be temporary, moderate, adverse impacts during construction associated with residential elevations. Residents/tenants would be required to temporarily relocate for several months during construction. Restricted use of residences may occur. Relocation during construction may present hardships to socially vulnerable individuals and families and elderly individuals for whom temporary relocations may be more burdensome or challenging. Because elevation is voluntary, property owners are not considered displaced persons, and no relocation reimbursements would be anticipated under the URA. Affected tenants, however, would be compensated for relocation to comparable residences and provided relocation assistance in accordance with the URA (described in further detail in the Real Estate Appendix, Appendix A-4). Temporary relocations could also result in inconveniences associated with day-to-day activities, which could temporarily adversely affect income. During construction, temporary, minor, adverse effects to neighborhoods, which may include underserved populations, would result from construction activity and noise associated with residential elevations.

Elevating residences is a voluntary measure. Therefore, property owners may choose not to participate. However, if the residents are renters, then they would be subject to the decisions of the property owners. Tenants would qualify for temporary relocation costs and associated reimbursement in accordance with the URA, which would help to mitigate the temporary adverse impacts associated with relocation. Once construction is complete, tenants would return to the elevated residence. After a residential elevation is complete, there would be permanent, beneficial effects because the building would be less susceptible to direct physical damages from a storm surge event. Temporary impacts during construction may disproportionally affect underserved communities in the Focus Areas; however, these impacts cannot be avoided to provide positive benefits to the communities. Potential impacts would be mitigated through adherence to BMPs, including those listed in Section 7.14.5, and construction activities being limited to daylight hours only, typically between 8:00 a.m. and 5:00 p.m.

7.15.5 Alternative 5

The effects would be the same as described in Section 7.15.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

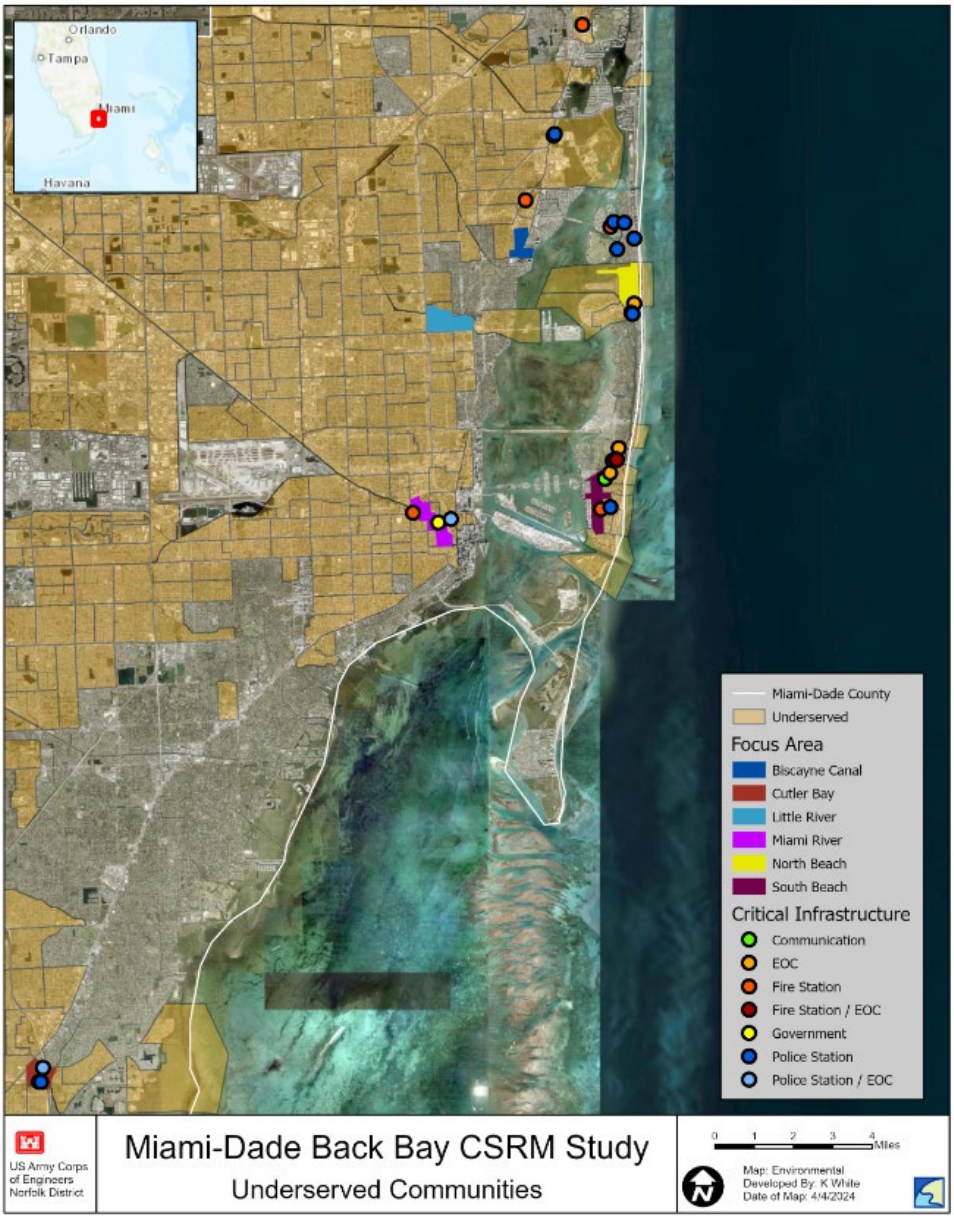


Figure 7-10. Underserved Communities in Miami-Dade County (CEQ 2022)

7.16 Recreation

7.16.1 Alternative 1

There would be no additional action to mitigate the effects from surge impacts associated with a coastal storm event. Therefore, no direct impacts to recreational resources would occur. Indirect adverse effects would occur as a result of increasing threats to recreational areas for use and enjoyment of residents and tourists from storm surge events that are anticipated to be exacerbated by climate change in the future.

7.16.2 Alternative 2

CI facilities are not areas where recreational activities would occur; there would be no direct adverse impacts to recreational resources from the dry floodproofing of CI.

7.16.3 Alternative 3

Elevations would apply to residences only. Therefore, there would be no direct effects to recreation. There would be negligible, temporary, indirect, adverse impacts to recreation during construction activities associated with residential elevations and floodproofing of nonresidential buildings. Residential elevations would occur in neighborhoods; therefore, temporary, minor, adverse impacts from noise may indirectly impact recreation activities such as walking or jogging in the area. Sidewalks adjacent to residences may be closed temporarily during construction activities.

7.16.4 Alternative 4

CI facilities are not areas where recreational activities occur. There would be no direct or indirect adverse impacts to recreational resources from the dry floodproofing of CI. Elevations would apply to residences only; therefore, there would be no direct effects to recreation. There would be negligible, temporary, indirect, adverse impacts to recreation during construction activities associated with these facilities. Residential elevations would occur in neighborhoods. Therefore, temporary, minor, adverse impacts from noise may indirectly impact recreation activities such as walking, jogging, or biking in the area. Sidewalks adjacent to the critical facility residences may be closed temporarily during construction activities.

7.16.5 Alternative 5

The effects would be the same as described in Section 7.16.4 but on a smaller scale, because of the fewer number of structures recommended for residential elevations and dry floodproofing of nonresidential structures.

7.17 Miami-Dade Back Bay Nature-Based Solutions Pilot Program

Following programmatic authorization of the NBS Pilot Program, subsequent implementation would have potential effects to the following resources. The detail provided in the following programmatic analysis is commensurate with the level of program detail currently known and provides a generalized overview of the anticipated resource impacts necessary to inform the decision to authorize the program. Future tiered NEPA documentation would evaluate in detail the site-specific impacts associated with program implementation to each of the resources as demonstration projects are identified for particular sites. Consultations pursuant to the Coastal Zone Management Act, Endangered Species Act, Magnuson–Stevens Fishery Conservation and Management Act, and National Historic Preservation Act (NHPA) would be completed in the future in accordance with federal statutes. Following the completion of the NEPA process, permits would be secured before construction. Following is a general comparison of the No Action Alternative (i.e., no authorization of the NBS Pilot Program) to the action alternative (i.e., Programmatic Authorization) for each resource area.

7.17.1 Wildlife Resources and Terrestrial Habitats

7.17.1.1 No Action Alternative

Wildlife and terrestrial habitats would persist in their current state and continue to be subject to development associated with urbanization. Common terrestrial forms of wildlife are generally acclimated to human-related impacts.

7.17.1.2 Programmatic Authorization

Impacts to wildlife and terrestrial habitats are anticipated to be primarily long-term and beneficial because of the potential habitat improvements and habitat availability. The beneficial effects would vary depending on the type of NBS pilot demonstration projects implemented through the program. Some temporary impacts, such as avoidance behaviors, or temporary disruptions to existing habitat may result during construction activities. Impacts to CBRS units would also be evaluated once site-specific demonstration projects are identified.

7.17.2 Wetlands, Mangroves, and Seagrasses

7.17.2.1 No Action Alternative

Wetlands, mangroves, and seagrasses would continue to persist in their current state. The No Action Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk.

7.17.2.2 Programmatic Authorization

Impacts to wetlands, mangroves, and seagrasses are anticipated to be primarily long-term and beneficial under the NBS Pilot Program. Based on stakeholder feedback (Section 5.3.2), there are potential opportunities to improve existing wetland, mangrove, and seagrass habitats with pilot demonstration projects designed for CSRM benefits. Potential temporary construction-related impacts to wetland, mangrove, or seagrass habitats may also occur. Avoidance and minimization measures would be included, and mitigation requirements would be incorporated into site-specific mitigation plans. As part of the site-specific pilot demonstration projects' environmental compliance requirements, USACE will conduct 404(b)(1) evaluations in accordance with Engineering Regulation (ER) 1105-2-100, Appendix C. Potential impacts to Biscayne Bay Aquatic Preserve may occur and would be evaluated once pilot demonstration projects are identified. Extensive coordination with FDEP will ensure impacts to the preserve are minimized and the projects are designed in a manner that is consistent with the protection of the preserve as required under FAC 18-18.

7.17.3 Special Status Species

7.17.3.1 No Action Alternative

Special status species and their associated habitats would continue to be subject to anthropogenic impacts associated with development in Miami-Dade County.

7.17.3.2 Programmatic Authorization

The NBS Pilot Program would consider special status species and their associated habitats in the identification of pilot demonstration project sites and during the project PED and Construction Phase. Avoidance and minimization measures would be used to minimize impacts to special status species resulting from implementation of the NBS Pilot Program. Given the protected resources occurring in Miami-Dade County and associated coastal habitats, extensive coordination will be conducted with NOAA Fisheries, USFWS, FDEP, and Florida Fish and Wildlife Conservation Commission. Consultations would be conducted in accordance with applicable federal statutes. In general, long-term impacts to special status species are anticipated to be beneficial through habitat improvements or habitat creation.

7.17.4 Geology, Topography, and Soils

7.17.4.1 No Action Alternative

Geologic and topographic conditions would continue to persist in their current state. Naturally occurring shorelines in Miami-Dade County may experience erosion as the result of storm surge with impacts dependent on storm strength, speed, and direction. Erosion, subsidence, and flooding events in Miami-Dade County would continue.

7.17.4.2 Programmatic Authorization

The demonstration projects implemented under the NBS Pilot Program would have short-term impacts to soils resulting from ground disturbance during construction activities. Long-term beneficial impacts may also result from reduced erosion in some areas; however, this anticipated beneficial impact will depend upon the demonstration projects selected in the future.

7.17.5 Bathymetry, Hydrology, and Tidal Processes

7.17.5.1 No Action Alternative

There would be no changes to the existing bathymetry of Biscayne Bay or tidal processes. Potential climate change impacts may continue to influence the length and severity of rainfall events, which may contribute to compound flooding when combined with the effects of a coastal storm.

7.17.5.2 Programmatic Authorization

The pilot demonstration projects implemented under the NBS Pilot Program would be designed primarily to address storm surge with additional co-benefits anticipated. Site-specific locations will be identified in the future once more information is available. However, some of the projects implemented under the NBS Pilot Program are anticipated to be constructed in the water; therefore, some localized impacts to bathymetry in nearshore environments may occur depending on the NBS type and may include short-term impacts related to construction. Future tiered NEPA documentation will evaluate further impacts.

7.17.6 Water Quality

7.17.6.1 No Action Alternative

There would be no direct or indirect effects to water quality that would continue to be influenced by various factors. Ongoing county and municipal programs for septic to sewer conversions would continue in parallel with local initiatives to improve water quality. Climate change effects and coastal storm events may indirectly and adversely impact water quality.

7.17.6.2 Programmatic Authorization

The NBS Pilot Program would implement various types of pilot demonstration projects, including some projects that would be constructed in the water. Temporary water quality impacts may occur during construction; however, BMPs would be used to minimize impacts. Environmental co-benefits anticipated from implementation of the demonstration projects may include long-term beneficial impacts to water quality. As part of the environmental compliance requirements, USACE will request a Section 401 water quality certification and Coastal Zone Management Act (CZMA) concurrence or defer to the PED Phase with policy-compliant letters of confirmation from the appropriate agencies in accordance with ER 1105-2-100, Appendix C.

7.17.7 Floodplains

7.17.7.1 No Action Alternative

With the No Action Alternative, residential, nonresidential, and CI buildings located in the project design floodplain would continue to be at risk of damage or destruction from storm surge flooding. Additional development within the floodplain would continue. Ongoing county and municipal programs would continue to address climate-related needs in vulnerable communities located in flood-prone areas. Planned municipal stormwater improvements would also alleviate some flooding issues.

7.17.7.2 Programmatic Authorization

Implementation of the NBS Pilot Program would include demonstration projects located in the project design floodplain; however, the pilot demonstration projects would not result in additional development

in the project design floodplain. Any impacts to the natural floodplain from the future implementation of the demonstration projects would be anticipated to be negligible and short-term.

7.17.8 Cultural Resources

7.17.8.1 No Action Alternative

Cultural resources located in low-lying areas of Miami-Dade County would continue to remain vulnerable to storm surge, and coastal storm events potentially may impact these areas. Historic buildings would continue to be at risk of damage or destruction from coastal storm flooding. Archaeological sites could sustain adverse effects from flooding, but damages to historic buildings could make them unusable and lead to their demolition. Flood damage to historic districts, sites, buildings, structures, or objects eligible for the NRHP could occur. Similarly, flood damage of historic landscapes could adversely impact the viewshed of other remaining intact historic properties.

7.17.8.2 Programmatic Authorization

As individual pilot demonstration projects are designed in the future, information will be available on areas where ground disturbance will occur, future archaeological surveys will be conducted as needed, and subsequent tier or tiers of NEPA documents will analyze these impacts. The implementation of individual NBS pilot projects may have the potential to affect historic properties and cultural resources in both terrestrial and submerged environments. Effects would be further evaluated following the identification of site-specific pilot projects and the completion of surveys. It is anticipated that the executed PA described in Section 7.8.2 would apply. Ongoing coordination will continue.

7.17.9 Aesthetics and Visual Resources

7.17.9.1 No Action Alternative

The No Action Alternative would involve no additional action to mitigate the effects from surge impacts associated with a coastal storm event. Additional development would continue and may result in localized changes to the visual landscape of certain areas of Miami-Dade County. The potential impacts to visual resources following a coastal storm event would depend upon the strength and intensity of the event and, consequently, coastal storm damages. Potential damages from a storm surge event may degrade aesthetic and visual resources.

7.17.9.2 Programmatic Authorization

Implementation of demonstration projects under the NBS Pilot Program would be anticipated to have short-term impacts to visual and aesthetic resources during construction, which may require various types of construction vehicles and equipment. Additionally, long-term beneficial impacts may also occur depending on the type and location of pilot demonstration projects constructed.

7.17.10 Air Quality

7.17.10.1 No Action Alternative

Localized air quality impacts would continue to occur from ongoing construction projects and other contributing factors in Miami-Dade County. GHG emissions would result from evacuation efforts and building renovations and reconstruction where damages have occurred following a storm event.

7.17.10.2 Programmatic Authorization

Short-term air quality impacts would occur during construction of pilot demonstration projects implemented under the NBS Pilot Program. GHG emissions analysis would be conducted as part of future NEPA documentation as more information becomes available on the types of demonstration projects to be constructed. Future NEPA documentation would also evaluate the potential carbon sequestration benefits associated with certain types of NBS such as mangroves and coastal wetlands, where applicable.

7.17.11 Hazardous Materials and Waste

7.17.11.1 No Action Alternative

There would be no direct or indirect impacts to HTRW sites from implementation of the No Action Alternative. Existing federal, state, and municipal cleanup programs would continue.

7.17.11.2 Programmatic Authorization

Under the NBS Pilot Program, HTRW cleanup sites would be avoided during the site selection process for NBS pilot demonstration projects. Therefore, no direct or indirect effects to HTRW cleanup sites would result from implementation of the NBS Pilot Program.

7.17.12 Noise

7.17.12.1 No Action Alternative

There would be no impacts to the existing ambient noise conditions with implementation of the No Action Alternative. Existing state and municipal noise ordinances would continue to be enforced.

7.17.12.2 Programmatic Authorization

At NBS pilot demonstration project sites, there would be minor, temporary, direct effects to the existing noise environment during construction. The exact locations of NBS pilot demonstration projects are unknown at this time; however, residential and recreation areas near construction would be most likely to experience direct effects from noise associated with construction equipment and vehicles. Section 7.12.3 provides typical noise levels associated with a construction site. Any construction activities associated with the NBS Pilot Program will comply with all local regulations regarding noise and vibration levels.

7.17.13 Utilities

7.17.13.1 No Action Alternative

Existing utilities in low-lying areas would continue to be subject to potential storm surge flooding during a storm event. Impacts would be minor, adverse, and temporary to permanent because existing utilities impacted by storm surge may require repairs, upgrades, or potential relocations, as needed.

7.17.13.2 Programmatic Authorization

There would be negligible to minor, temporary, adverse impacts to utilities during construction of individual NBS pilot demonstration projects. Utility site investigation would be required during the PED and Construction Phase to ensure appropriate avoidance and minimization measures are used. After construction is complete, NBS pilot demonstration projects may benefit utilities by providing additional protection from storm surge flooding.

7.17.14 Socioeconomics

7.17.14.1 No Action Alternative

There would be no direct impacts to socioeconomics from implementation of the No Action Alternative. However, indirect, adverse effects would occur as a result of increasing threats to residents, properties, and the local economy resulting from storm surge events, which are anticipated to be exacerbated by climate change in the future.

7.17.14.2 Programmatic Authorization

Implementation of the NBS Pilot Program will result in temporary, minor, beneficial effects to the local economy with locally sourced jobs and/or materials for the construction of NBS pilot demonstration projects. Once constructed, the NBS pilot demonstration projects may benefit residents, properties, and the local economy by providing increased CSRM and environmental co-benefits (carbon sequestration, reduction in nutrient runoff, etc.).

7.17.15 Environmental Justice

7.17.15.1 No Action Alternative

No direct impacts to underserved communities would occur from implementation of the No Action Alternative. The potential for indirect, adverse effects to underserved communities in low-lying areas may occur because of increasing flooding threats from storm surge events that are anticipated to be exacerbated by climate change in the future.

7.17.15.2 Programmatic Authorization

Implementation of the NBS Pilot Program would result in permanent, beneficial effects to underserved communities from resilience improvements to the natural landscape of Miami-Dade County. Individual NBS pilot demonstration projects may provide a variety of benefits to underserved communities, including increased CSRM and environmental co-benefits. During construction, negligible to minor, temporary, adverse effects may occur to businesses and/or communities close to noise and construction equipment. However, these temporary impacts are not anticipated to disproportionally affect underserved communities.

7.17.16 Recreation

7.17.16.1 No Action Alternative

No direct impacts to recreational resources would occur from implementation of the No Action Alternative. Indirect, adverse effects would occur as a result of increasing threats to recreational areas for use and enjoyment of residents and tourists from storm surge events that are anticipated to be exacerbated by climate change in the future.

7.17.16.2 Programmatic Authorization

Impacts to recreation are anticipated to be primarily long-term and beneficial. Beneficial effects would vary depending on the type of NBS pilot demonstration projects implemented; however, aquatic and nearshore habitat improvements would likely lead to increased opportunities for recreational birding, fishing, and snorkeling. Some minor, temporary, adverse impacts, such as temporary recreation area access limitations and noise during construction, may also result from implementation of the NBS Pilot Program, depending on the proposed locations of the NBS pilot demonstration projects.

7.18 Nonstructural Program

Following programmatic authorization of and authorization of future phases of the Nonstructural Program, subsequent implementation would have potential effects to the following resources. The detail provided in the following programmatic analysis is commensurate with the level of program detail currently known and provides a generalized overview of the anticipated resource impacts necessary to inform the decision to authorize the program. Future NEPA documentation would evaluate in detail the impacts associated with program implementation to each of the following resources. The Nonstructural Program would not include any components that would be expected to have in-water impacts. Consultations would be completed in the future in accordance with federal statutes. Following the completion of the NEPA process, permits would be secured before construction. A general comparison of the No Action Alternative (i.e., no authorization of the Nonstructural Program) to the action alternative (i.e., Programmatic Authorization) follows for each resource area.

7.18.1 Wildlife and Terrestrial Habitats

7.18.1.1 No Action Alternative

Wildlife and terrestrial habitats would persist in their current state and continue to be subject to development associated with urbanization. Common terrestrial forms of wildlife are generally acclimated to human-related impacts.

7.18.1.2 Programmatic Authorization

The Nonstructural Program would focus on existing structures situated in heavily urbanized areas of Miami-Dade County. Short-term impacts to wildlife and terrestrial habitats are anticipated because of construction activities. Potential indirect impacts would occur because of ground disturbance and temporary relocation of wildlife during construction activities. Direct impacts to terrestrial habitats may include tree removal to accommodate construction equipment. There would be no anticipated impacts to CBRS units.

7.18.2 Wetlands, Mangroves, and Seagrasses

7.18.2.1 No Action Alternative

Wetlands, mangroves, and seagrasses would continue to persist in their current state. The No Action Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk.

7.18.2.2 Programmatic Authorization

There would be no anticipated impacts to wetlands, mangroves, and seagrasses because the Nonstructural Program would focus on existing structures in heavily urbanized areas of Miami-Dade County.

7.18.3 Special Status Species

7.18.3.1 No Action Alternative

Special status species and their associated habitats would continue to be subject to anthropogenic impacts associated with development in Miami-Dade County.

7.18.3.2 Programmatic Authorization

The Nonstructural Program would focus on existing structures in heavily urbanized areas of Miami-Dade County. Avoidance and minimization measures would be used to minimize impacts to special status species by implementing the Nonstructural Program. Consultations would be conducted in the future in accordance with applicable federal statutes. The potential effects of implementing projects as part of the

Nonstructural Program on the Florida bonneted bat and other protected species will be evaluated once site-specific nonstructural projects are identified.

7.18.4 Geology, Topography, and Soils

7.18.4.1 No Action Alternative

Geologic and topographic conditions would continue to persist in their current state. Erosion, subsidence, and flooding events in Miami-Dade County would continue.

7.18.4.2 Programmatic Authorization

The Nonstructural Program would include modifications to existing structures. Short-term impacts during construction would include ground-disturbing activities surrounding the structures. Ground-disturbing activities may also be necessary to relocate utilities if required.

7.18.5 Bathymetry, Hydrology, and Tidal Processes

7.18.5.1 No Action Alternative

There would be no changes to the existing bathymetry of Biscayne Bay or tidal processes. Potential climate change impacts may continue to influence the length and severity of rainfall events, which may contribute to compound flooding when combined with the effects of a coastal storm.

7.18.5.2 Programmatic Authorization

The Nonstructural Program would focus on existing structures on the upland. There would be no direct or indirect effects to the bathymetry of Biscayne Bay, hydrology, and tidal processes.

7.18.6 Water Quality

7.18.6.1 No Action Alternative

There would be no direct or indirect effects to water quality which would continue to be influenced by various factors. Ongoing county and municipal programs for septic to sewer conversions would continue in parallel with local initiatives to improve water quality. Water quality impacts may be exacerbated by climate change effects and during a coastal storm event.

7.18.6.2 Programmatic Authorization

Modifications to existing structures located on land would not directly or indirectly affect water quality. Erosion and sediment control BMPs would be adhered to during construction. Ongoing county and municipal programs for septic to sewer conversions would continue in parallel with local initiatives to

improve water quality. Potential long-term, beneficial impacts would be associated with managing risk of flood damage to buildings and associated potential for floodwaters to transport debris or pollutants during a storm event.

7.18.7 Floodplains

7.18.7.1 No Action Alternative

Structures in the project design floodplain would continue to be at risk of damage or destruction from storm surge flooding. Additional development within the floodplain would continue. Ongoing county and municipal programs would continue to address climate-related needs in vulnerable communities located in flood-prone areas. Planned municipal stormwater improvements would also alleviate some flooding issues.

7.18.7.2 Programmatic Authorization

The Nonstructural Program would consider modification to existing structures located in the project design floodplain; however, the activities proposed would not result in additional development in the floodplain. Where a project site is located near a natural floodplain area, any adverse impacts from construction activities to the natural floodplain would be negligible and temporary, because construction methods would be used accordingly.

7.18.8 Cultural Resources

7.18.8.1 No Action Alternative

Cultural resources located in low-lying areas of Miami-Dade County would continue to remain vulnerable to storm surge, and coastal storm events potentially may impact these areas. Historic buildings would continue to be at risk of damage or destruction from coastal storm flooding. Archaeological sites could sustain adverse effects from flooding, but damages to historic buildings could make them unusable and lead to their demolition. Flood damage to historic districts, sites, buildings, structures, or objects eligible for the NRHP could occur in the absence of storm risk management measures as proposed that potentially impacts the viewshed of remaining historic properties. Similarly, flood damage of historic landscapes could adversely impact the viewshed of other remaining intact historic properties.

7.18.8.2 Programmatic Authorization

As the Nonstructural Program advances, information will be available on areas where ground disturbance will occur, and future archaeological surveys will be conducted as needed and subsequent tier or tiers of NEPA documents will analyze these impacts. The implementation of the Nonstructural Program may have the potential to affect historic properties and cultural resources in terrestrial environments. Effects would be further evaluated following the identification of structures considered for the Nonstructural Program and the completion of surveys. The conditions of the executed PA described in Section 7.8.2 would be applied. Ongoing coordination will continue.

7.18.9 Aesthetics and Visual Resources

7.18.9.1 No Action Alternative

Additional development would continue and may result in localized changes to the visual landscape of certain areas of Miami-Dade County. The potential impacts to visual resources following a coastal storm event would depend upon the strength and intensity of the event and, consequently, coastal storm damages. Potential damages from a storm surge event may degrade aesthetic and visual resources.

7.18.9.2 Programmatic Authorization

There would be minor, permanent, adverse, direct effects to visual resources resulting from implementation of the Nonstructural Program and the potential for modifications to existing buildings. Negligible to minor, permanent, beneficial effects may also result from managing the risk of storm-surge related flood damages and associated degradation of visual resources.

7.18.10 Air Quality

7.18.10.1 No Action Alternative

There would be no additional action to mitigate the effects from surge impacts associated with a coastal storm event. Localized air quality impacts may occur from ongoing construction projects and other contributing factors. GHG emissions would result from evacuation efforts and building reconstruction following a storm event.

7.18.10.2 Programmatic Authorization

Implementation of the Nonstructural Program would have short-term impacts on air quality and GHG emissions resulting from construction activities and embodied carbon emissions. GHG emissions analyses would be conducted as part of additional NEPA documentation in the future.

7.18.11 Hazardous Materials and Waste

7.18.11.1 No Action Alternative

There would be no direct or indirect impacts to HTRW sites from implementing the No Action Alternative. Existing federal, state, and municipal cleanup programs would continue.

7.18.11.2 Programmatic Authorization

There would be no direct or indirect effects to HTRW cleanup sites resulting from implementing the Nonstructural Program. The Nonstructural Program may include construction activities (building elevation, floodproofing, etc.) at existing buildings of varying ages; therefore, the potential exists for some buildings to contain LBP, ACM, or PCBs. As a result, a Phase 1, Environmental Site Assessment should be conducted

for any affected building constructed before 1978. If any such contaminants are found, the construction contract must include procedures for the lawful demolition, removal, and disposal of such wastes. Therefore, there would be minor, temporary, direct, adverse effects associated with HTRW.

7.18.12 Noise

7.18.12.1 No Action Alternative

There would be no impacts to the existing ambient conditions with implementation of the No Action Alternative. Enforcement of existing state and municipal noise ordinances would continue.

7.18.12.2 Programmatic Authorization

Negligible to minor, temporary, direct effects to the existing noise environment would occur during implementation of the Nonstructural Program at either CI facilities or multifamily residences. The length of time to complete construction activities would vary depending on proposed modifications at individual facilities. There would be minor, temporary, direct effects to the existing noise environment in residential neighborhoods associated with CSRM modifications to multifamily residences. Residences in the immediate vicinity are most likely to experience direct effects from noise associated with construction equipment and vehicles. Section 7.11.3 provides typical noise levels associated with a construction site.

Vegetation and objects (including buildings) that are between the location and source of noise can reduce sound. Although construction would result in temporary and localized noise increases during construction, these activities would be limited to daylight hours only, which typically will occur between 8:00 a.m. and 5:00 p.m. Any associated construction activities will comply with all local regulations regarding noise and vibration levels.

7.18.13 Utilities

7.18.13.1 No Action Alternative

Existing utilities in low-lying areas would continue to be subject to potential storm surge flooding during a storm event. Impacts would be minor, adverse, and temporary to permanent because existing utilities impacted by storm surge may require repairs, upgrades, or potential relocations, as needed.

7.18.13.2 Programmatic Authorization

There would be negligible to minor, temporary, adverse impacts to utilities during implementation of the Nonstructural Program. Utility site investigations would be required during the PED Phase to ensure appropriate avoidance and minimization measures are used. Construction activities also would directly impact utilities and require local utility investigations.

7.18.14 Socioeconomics

7.18.14.1 No Action Alternative

There would be no direct impacts to socioeconomics from implementation of the No Action Alternative. However, indirect, adverse effects would occur because of increasing threats to residents, properties, and the local economy resulting from storm surge events, which are anticipated to be exacerbated by climate change in the future.

7.18.14.2 Programmatic Authorization

Implementation of the Nonstructural Program for CI facilities would result in permanent, beneficial effects to socioeconomics from resilience improvements to these facilities, which would resume normal functions more expeditiously following a coastal storm event, particularly for facilities that provide critical services to underserved communities. There would also be temporary, minor, beneficial effects to the local economy with locally sourced construction jobs for floodproofing CI facilities. Negligible to minor, temporary, adverse effects may occur to businesses and/or communities associated with noise and construction equipment in the immediate vicinity while construction is underway.

There would be temporary, minor to moderate, adverse impacts to socioeconomics during construction associated with the Nonstructural Program for multifamily residences. Impacts will depend upon the appropriate CSRM measures proposed for multifamily residences, which will be developed and evaluated in the future. Temporary, minor, beneficial effects to the local economy would occur with locally sourced construction jobs.

7.18.15 Environmental Justice

7.18.15.1 No Action Alternative

No direct impacts to underserved communities would occur from implementing the No Action Alternative. The potential for indirect adverse effects to underserved communities in low-lying areas may occur because of increasing flooding threats from storm surge events that are anticipated to be exacerbated by climate change in the future.

7.18.15.2 Programmatic Authorization

Programmatic authorization of the Nonstructural Program would result in localized, permanent, beneficial effects to underserved communities from resilience improvements to CI and multifamily residences, and particularly for CI facilities that provide services to vulnerable communities. During construction, negligible to minor, temporary, adverse effects may occur to businesses and/or communities associated with construction equipment and noise in the immediate vicinity. However, these temporary impacts would not disproportionally affect underserved communities.

The Nonstructural Program may result in innovative nonstructural risk management measures for multifamily residential buildings. Participation in the Nonstructural Program would be voluntary for property owners and would have a long-term, beneficial effect for property owners and tenants by reducing flooding damages and increasing resilience following a storm surge event. During construction, temporary, minor, adverse effects to neighborhoods, which may include underserved populations, would result from construction activity and associated noise. After completion of construction, there would be long-term, beneficial effects because the building would be less susceptible to direct physical damages from storm surge events.

7.18.16 Recreation

7.18.17 No Action Alternative

No direct impacts to recreational resources would occur from implementation of the No Action Alternative. Indirect adverse effects would occur because of increasing threats to recreational areas for use and enjoyment of residents and tourists from storm surge events that are anticipated to be exacerbated by climate change in the future.

7.18.17.1 Programmatic Authorization

Implementation of the Nonstructural Program would only occur at CI facilities and/or multifamily residences. As such, construction activities would be confined to the structures specified in the Nonstructural Program and would not directly impact recreation. However, temporary, minor, adverse impacts from noise and sidewalk/road closures may indirectly impact recreation activities such as walking, jogging, or biking in the area.

7.19 Cumulative Effects

The implementation of CSRM measures proposed in the RP, to include dry floodproofing and residential elevations, would incrementally contribute toward improving community-wide resilience to coastal storms when considered alongside other federal, state, and municipal projects and initiatives. The projects considered as part of the cumulative effects analysis includes the list of USACE projects in Section 1.4.1.3 and relevant projects in the compiled list of NBS projects located in Appendix A-3. Other local projects considered include municipal stormwater improvement projects and other resilience efforts implemented as part of the Resilient305 Strategy. Programmatic authorization of the NBS Pilot Program and Nonstructural Program, and the future implementation of the programs, would also contribute to community-level resilience against coastal storms. The proposed long-term benefits, including managing coastal storm risk and reducing damages, would outweigh negligible to short-term environmental effects.

Implementation of the RP, NBS Pilot Program, and Nonstructural Program would result in negligible to minor, adverse cumulative effects to the following resources: air quality and special status species. However, the impacts would not be significant. Short-term air quality impacts, including GHG emissions, would result from construction emissions associated with the RP, the pilot demonstration projects implemented under the NBS Pilot Program, and the implementation of the Nonstructural Program. Short-

term impacts to air quality would result from the use of construction equipment and would not be anticipated to be significant. GHG emissions evaluations would be conducted for future projects and evaluated in future NEPA documentation for the NBS Pilot Program and Nonstructural Program. The construction of other ongoing federal, state, and municipal projects may also result in negligible cumulative impacts to air quality resulting from construction equipment emissions.

Potential impacts to special status species would also be considered and evaluated in future NEPA documentation for the NBS Pilot Program and the Nonstructural Program. Incremental cumulative impacts to special status species associated with the RP and the implementation of the two programs would be negligible to minor because of the efforts to avoid and minimize environmental impacts through adherence to BMPs. Although site-specific projects for the NBS Pilot Program have not been identified at this time, some of the pilot demonstration projects may include in-water construction. The NBS Pilot Program, which aims to increase USACE's understanding of the performance of NBS for CSRM, would have negligible to minor adverse effects during construction. Temporary, minor, adverse impacts may occur during construction to wetlands and aquatic resources. Site-specific mitigation plans will be developed in coordination with resource agencies to ensure the avoidance and minimization of impacts to these resources.

Temporary and/or permanent impacts to special status species resulting from the construction of other federal, state, and municipal projects may also occur; however, these impacts would be evaluated and minimized in accordance with mitigation requirements and BMPs. Reasonably foreseeable projects that may be evaluated further as part of the future comprehensive framework may also have cumulative adverse impacts to GHG emissions, special status species, wetlands, and aquatic resources as a result of construction. The cumulative effects associated with future potential projects would be evaluated as part of additional studies and would be documented in future NEPA documents.

Cumulative, long-term, beneficial effects to wetland and aquatic resources may also result from implementation of the NBS Pilot Program in consideration of other federal projects, such as Biscayne Bay Southeastern Everglades Ecosystem Restoration (BBSEER), and local environmental restoration initiatives. Cumulative beneficial effects to other resource areas including socioeconomics resulting from the RP, the proposed programs, and other federal, state, and municipal projects for resilience may occur to socioeconomic resources.

Implementation of the NBS Pilot Program would contribute to Miami-Dade County's multiple-lines-of-defense strategy for CSRM. However, after construction of the NBS pilot demonstration project(s), beneficial effects to the human and natural environments are anticipated. Cumulative beneficial, indirect effects of program implementation on local primary and secondary production, and food web dynamics, are reasonably foreseeable. These effects also have the potential to indirectly increase recreational opportunities within the study area including wildlife viewing and recreational fishing. Implementation of the NBS Pilot Program, along with other federal, state, and municipal efforts, would improve community-wide resilience to coastal storms while not substantially effecting individual resource areas.

Implementation of the Nonstructural Program, which includes coastal storm resilience adaptations to complex CI facilities and multifamily residences, would contribute toward Miami-Dade County's multiple-lines-of-defense strategy for CSRM. The Nonstructural Program would provide synergistic benefits to the

County for improved coastal storm resiliency, while also limiting potential adverse effects to existing structure footprints. Implementation of the Nonstructural Program would not result in substantial effects to individual resource areas, but would align with efforts (federal, state, municipal) aimed at improving community-wide resilience to coastal storms.

8 PLAN COMPARISION AND SELECTION

The purpose of plan comparison is to identify the most important effects across all plans (or action alternatives) in comparison to the No Action Alternative, and to compare the plans against the No Action Alternative and one another across those effects. Ideally, the comparison leads to identifying pros and cons of each plan for use by decision-makers for the selection of the Recommended Plan (RP).

8.1 Plan Comparison

This study includes five alternatives, which are described in depth in Section 4.4, Array of Alternatives. Following are brief descriptions of the alternatives:

- Alternative 1 is the No Action Alternative – if no federal project were recommended during the life cycle.
- Alternative 2 involves dry floodproofing critical infrastructure (CI) within the study area.
- Alternative 3 involves dry floodproofing nonresidential buildings and elevating residential buildings such as single-family homes and multifamily homes of four units or less.
- Alternative 4 is Alternatives 2 and 3 combined.
- Alternative 5 is the same as Alternative 4; however, it focuses on a subset of buildings with the highest coastal storm risk management needed.

Table 8-1 illustrates the number of buildings included and potential effects of each alternative related to annual damage, residual risk, and loss of life prevented. The percentages of residual risk remaining are based on the estimated 50-year period of analysis and Future Without Project (FWOP) Expected Damages of $4.72 billion which is based on all buildings within the Focus Area and not just those buildings as part of the Future with Project (FWP) for that alternative.

Table 8-1. Assessment of Alternative Effects over 50-Year Period of Analysis

Alternatives	Buildings Included for Risk Management	Expected Damages Prevented ($1,000s)	Residual Risk Remaining in Focus Area (%)	Direct Loss of Life Prevented
1. No Action / FWOP	CI:[1] 0 SFR:[2] 0 MFR:[3] 0 NONRES:[4] 0	$0	100%	0
2. CI Alternative	CI: 27 SFR: 0 MFR: 0 NONRES: 0	$252,000	95%	0
3. Nonstructural Alternative	CI: 0 SFR: 1,731 MFR: 326 NONRES: 403	$1,419,000	70%	437

Alternatives	Buildings Included for Risk Management	Expected Damages Prevented ($1,000s)	Residual Risk Remaining in Focus Area (%)	Direct Loss of Life Prevented
4. CI + Nonstructural Alternative	CI: 27 SFR: 1,731 MFR: 326 NONRES: 403	$1,671,000	65%	437
5. CI + Subset of Nonstructural Alternative	CI: 27 SFR: 460 MFR: 324 NONRES: 403	$1,510,000	68%	79

Note: October 2023 FY(24) price level, Period of Analysis: 50 years, Rounded, Interest Rate 2.75%
[1]**CI** – Critical Infrastructure
[2]**SFR** – Single-family residential building
[3]**MFR** – Multifamily residential buildings with four units or less
[4]**NONRES** – Nonresidential buildings, which include commercial, industrial, government, and education

As the No Action Alternative, Alternative 1 manages risk to no buildings; therefore, residual risk is the highest and no loss of life would be prevented for this alternative. Alternative 2 manages risk to 27 CI assets and decreases residual risk; however, it is a small number compared to the total number of buildings within the Focus Areas. While an argument can be made for indirect loss of life prevented by managing risk to CI, there is no direct loss of life prevented because people do not generally live in CI. Alternatives 3 and 4 show the most reduction in residual risk because these alternatives manage risk to the largest number of buildings. Alternative 5 presents less residual risk management and loss of life prevented because it includes 1,273 fewer residential buildings than Alternatives 3 or 4. Overall, Alternative 4 ranks the highest because it manages risk to the largest number of buildings, alleviating the most residual risk and preventing the most loss of life compared to the other alternatives. Appendix A-5, Section 4.3.1 Life Loss Analysis, provides more information regarding how life loss is estimated.

8.2 Identification of the National Economic Development Plan

The National Economic Development (NED) plan is the alternative that reasonably maximizes net NED benefits as required by Engineering Regulation (ER) 1105-2-100. **Table 8-2** describes the benefit-cost analysis, which includes annualized benefits and costs, project first cost, benefit-to-cost ratio (BCR), and net annual benefits of each alternative.

Table 8-2. Economic Calculations of Alternatives

Alternative	Total Average Annual Benefits	Total Average Annualized Cost	Project First Cost	Benefit-to-Cost Ratio (BCR)	Net Annual Benefits
Alternative 1. No Action / FWOP	$0	$0	$0	N/A	$0
Alternative 2. CI	$9,000	$5,000	$110,000	1.8	$4,000
Alternative 3. Nonstructural	$53,000	$116,000	$2,550,000	0.46	-$63,000
Alternative 4. CI + Nonstructural	$62,000	$121,000	$2,660,000	0.51	-$59,000
Alternative 5. CI + Subset of Nonstructural	$56,000	$74,000	$1,560,000	0.76	-$18,000

Note: October 2023 FY(24) price level, Period of Analysis: 50 years, $1000s Rounded, Interest Rate 2.75%

Alternative 2, the alternative that focuses on dry floodproofing CI within the study area, is the plan that reasonably maximizes net NED benefits since it is the only plan with positive net benefits. Therefore, Alternative 2 is the NED Plan.

8.3 Plan Selection

The study alternatives were compared to the study's three formulation objectives as described in Section 1.8. **Table 8-3** shows whether the alternative meets the study objectives within the Focus Areas determined for this study. A "No" in the table means it does not meet the objective. A "Yes – Low" means it slightly meets the objective. A "Yes – Medium" means it moderately meets the objective. A "Yes – High" means it considerably meets the objective.

Table 8-3. Array of Alternatives Evaluation to Study Objectives

Alternative Number	Alternative Name	Objectives		
		#1 Increase resiliency of CI	#2 Reduce economic damage to buildings	#3 Manage risk to life safety and human health
1	No Action / FWOP	No	No	No
2	CI Alternative	Yes – High	No	Yes – Low
3	Nonstructural Alternative	No	Yes – High	Yes – High
4	CI + Nonstructural Alternative	Yes – High	Yes – High	Yes – High
5	CI + Subset of Nonstructural Alternative	Yes – High	Yes – Medium	Yes – Medium

All alternatives that include risk management to CI meet Objectives 1 and 3 because dry floodproofing CI would increase the facilities' resiliency through improving its ability to continue operations during and after coastal storm events. All alternatives that include nonstructural risk management to residential and nonresidential buildings meet Objective 2, because elevating these buildings would reduce potential economic damage during a coastal storm. The No Action Alternative meets no study objectives. While Alternative 2 is the NED Plan, it does not meet the study objectives as effectively as Alternatives 4 and 5 because it only addresses risks to CI. Alternatives 4 and 5 meet all three study objectives, with Alternative 4 meeting Objectives 2 and 3 more effectively.

As described in Section 4.1, Planning Framework, there are four criteria according to ER 1105-2-103, Planning Policy for Conducting Civil Works Planning Studies, which include determining the completeness, effectiveness, efficiency, and acceptability of the alternatives. **Table 8-4** describes the evaluation of each alternative to each of the criteria. Completeness of the alternative is also dependent on the homeowner since nonstructural measures are voluntary.

Table 8-4. Array of Alternatives Evaluation to Four Planning Criteria

Alternative	Completeness	Effectiveness	Efficiency	Acceptability
Alternative 1. No Action / FWOP	Alternative is complete.	Does not alleviate the specified problems nor achieve the specified opportunities.	It is the least costly because there is no action, but it does not alleviate the specified problems nor achieve the specified opportunities.	It is viable and appropriate within existing laws.
Alternative 2. CI	Alternative is complete.	Partially alleviates identified problems and achieves opportunities.	It is the most cost-effective alternative, but it only partially alleviates problems and achieves opportunities.	It is viable and appropriate within existing laws.
Alternative 3. Nonstructural	Alternative is complete.	Partially alleviates identified problems and achieves opportunities.	Partially alleviates identified problems and achieves opportunities, but it is the second costliest alternative.	It is viable and appropriate within existing laws.
Alternative 4. CI + Nonstructural	Alternative is complete.	Most effectively alleviates identified problems and achieves opportunities.	Partially alleviates identified problems and achieves opportunities, but it is the costliest alternative.	The most acceptable plan. It is viable and appropriate within existing laws.
Alternative 5. CI + Subset of Nonstructural	Alternative is complete.	Partially alleviates identified problems and achieves opportunities.	Most efficient. Partially alleviates identified problems and achieves opportunities and is less costly than Alternative 4.	It is viable and appropriate within existing laws.

As described in Section 4.5.1, Four Evaluation Accounts, there are four accounts to facilitate and display the effects of alternative plans in the formulation of water resource projects while recognizing the importance of maximizing potential benefits relative to project costs. These accounts are NED, Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). Plan formulation involves comparing each of the alternatives against the four evaluation accounts that are shown in **Table 8-5**. Section 4.5.1.4, Other Social Effects Account, provides further information regarding the OSE metrics.

Table 8-5. Array of Alternatives Evaluation to Four Principles and Guidelines Accounts, Federal Discount Rate Fiscal Year 24 = 2.75 Percent, October 2023 Price Levels, 50-Year Period of Analysis

Alternative	NED ($1000s)	EQ	RED	OSE Score
Alternative 1. No Action / FWOP	N/A	No significant impacts to the environment	Value added: $0 FTE[4] jobs: 0	0
Alternative 2. CI Alternative	**AAB:**[1] $9,000 **AAC:**[2] $5,000 **NAB:**[3] $4,000 **BCR:** 2.1	No significant impacts to the environment	Value added: $114.5 million FTE jobs: 1,150	10
Alternative 3. Nonstructural Alternative	**AAB:** $53,000 **AAC:** $116,000 **NAB:** -$63,000 **BCR:** 0.46	No significant impacts to the environment	Value added: $2.5 billion FTE jobs: 24,200	17
Alternative 4. CI + Nonstructural Alternative	**AAB:** $62,000 **AAC:** $121,000 **NAB:** -$59,000 **BCR:** 0.51	No significant impacts to the environment	Value added: $2.7 billion FTE jobs: 25,300	33
Alternative 5. CI + Subset of Nonstructural Alternative	**AAB:** $56,000 **AAC:** $74,000 **NAB:** -$18,000 **BCR:** 0.76	No significant impacts to the environment	Value added: $1.6 billion FTE jobs: 15,200	22

[1]**AAB** – Average annualized benefits
[2]**AAC** – Average annualized costs
[3]**NAB** – Net annual benefits
[4]**FTE** – Full-time equivalent

Based on the evaluation of the array of alternatives, Alternative 4 was identified as the plan that maximizes comprehensive net public benefits and, therefore, was selected as the RP. Alternative 4, also known as the Maximum Risk Management Plan within the context of this refined study scope, is the alternative that maximizes both the OSE and RED accounts, maximizes human life loss prevented, and promotes the highest inclusion of vulnerable environmental justice communities. Alternative 2, CI only, is defined as the NED Plan because it reasonably maximizes net NED benefits. However, because Alternative 4 maximizes comprehensive net public benefits, and more effectively satisfies the study objectives to manage coastal storm risk and improve coastal resiliency for vulnerable environmental justice communities, the U.S. Army Corps of Engineers (USACE) in collaboration with Miami-Dade County, are pursuing a NED policy exception to support Alternative 4 as the RP, rather than the NED Plan. The Assistant Secretary of the Army for Civil Works approved the NED policy exception request to support Alternative 4 as the RP on June 24, 2024.

9 THE RECOMMENDED PLAN

9.1 Plan Accomplishments

The goal of this study is to provide Miami-Dade County with Coastal Storm Risk Management (CSRM) solutions in the Focus Areas that were identified based on areas of flooding at the highest frequencies affecting environmental justice communities. Alternative 4, or the Maximum Risk Management Plan within the Focus Areas, was selected as the Recommended Plan (RP). This plan includes elevating residential buildings, floodproofing nonresidential buildings, and floodproofing critical infrastructure (CI) throughout the study area. These measures are widely accepted, which would allow for the completion of this study within the time frame needed to complete a Chief's Report in 2024.

The measures within the Focus Areas accomplish the objective of increasing resiliency of Miami-Dade County to function effectively before, during, and after coastal storm events by decreasing the vulnerability of CI to flooding from storm surge with consideration for sea level change over 50 years. Even though floodproofing, which was the primary measure used for managing risk to CI, has its limitations for design levels – it would provide, at minimum, risk management for the higher-frequency storm events.

Similarly, nonstructural measures accomplish the goal of reducing economic damage to buildings within the Focus Areas. Nonstructural measures are voluntary, so the risk management is dependent on homeowner participation. Section 9.2 provides discussion of the components of the RP. Section 4.3.5 discusses separable elements. All measures in the RP are separable elements, meaning each measure can be constructed on its own regardless of other measures for CSRM.

9.2 Plan Components

An analysis was done to determine if a building would be eligible for elevation or floodproofing. The economics model, Generation 2 Coastal Risk Model (G2CRM), provides building and content damage for each building. The damage prevented is the benefit portion of net benefit and benefit-to-cost ratio (BCR) calculations. Appendix A-5, Economic Environment and Social Considerations, provides further information on these calculations and analysis. The RP includes 2,057 residential buildings, which includes single-family residential and multifamily residential homes, for elevation. **Table 9-1** shows the number of buildings in the RP broken down by Focus Area. There are two CI in the City of Aventura, which has been included under Biscayne Canal because that is the nearest Focus Area. Aventura did not have its own Focus Area, but it had a modeled area for economic modeling purposes since not all CI were located within the established Focus Areas. Appendix A-5, Section 2.1 Modeled Areas, explains this further.

Table 9-1. Nonstructural Measures per Focus Area in the Recommended Plan

Focus Area	# of Single-Family Residential Elevations	# of Multifamily Residential Elevations	# of Nonresidential Floodproofings	# of CI Floodproofings	Total
Biscayne Canal	260	28	23	4	315
Cutler Bay	69	0	38	3	110
Little River	805	27	87	0	919
Miami River	185	68	105	4	362
North Beach	257	185	47	8	497
South Beach	155	18	103	8	284
Total	1,731	326	403	27	2,487

Analysis for the floodproofing of nonresidential buildings was conducted in a similar manner to that of residential buildings. The difference is that the best management practice (BMP) for floodproofing is to floodproof up to only three feet from the ground since static forces from standing water would make any floodproofing shield or door buckle under pressure. Buildings that required more than three feet of floodproofing to reach the DWSE were still recommended for floodproofing to obtain some level of risk management to higher-frequency storms if doing so would generate benefits. The number of nonresidential buildings and CI recommended for floodproofing is 403 and 27, respectively.

Floodproofing does not address nuisance flooding depending on the location of the building nor is it meant as a standalone measure for sea level change. Floodproofing, as part of the RP, is to manage risk from coastal storm surge. Dry floodproofing was also only for nonresidential buildings, and those that were not in FEMA coastal high-hazard areas (Zone V), coastal A zones, or other high-risk flood areas where flash floods, high-velocity flows, or erosion occurs. These dry floodproofing limitations are consistent with the American Society of Civil Engineers (ASCE) 24-14, Flood Resistant Design and Construction: Requirements and Limitations for Dry Floodproofing.

9.2.1 Design Water Surface Elevation

Ground elevation data was taken from the South Atlantic Coastal Study's Digital Elevation Model (DEM) terrain which consisted of 3 meter grids (3-meter cell sizes). Environmental Systems Research Institute's (ESRI) ArcMAP software was used to identify the ground elevation data along the perimeter of each building's polygon. There can be errors in DEMs depending on when the data was captured, if there was any on-going construction within the vicinity, the size of the grid cells, where the building polygon landed, and so on. Ten percent of the buildings had elevation certificate data which included surveyed ground

elevations. A comparison of that data to the estimated ground elevation from the DEM showed an average range of error less than 0.1 feet; however, some buildings were off by up to 2 feet. Surveys of each building will be conducted in PED to determine more accurate ground elevation data especially at or near entrances to the building. The minimum, maximum, and average ground elevation for the buildings within each Focus Area is shown in the table below.

Table 9-2. Ground Elevation Data for Buildings in the RP

Modeled Areas	Minimum and Maximum Ground Elevation Ranges (ft. NAVD88)	Average Ground Elevation (ft. NAVD88)
Biscayne Canal	1.1 – 9.2	3.7
Cutler Bay	4.6 – 9.2	6.4
Little River	2.0 – 10.4	4.8
Miami River	0 – 14.7	4.5
North Beach	0.25 – 5.25	2.9
South Beach	0.19 – 5.4	2.7

The Design Water Surface Elevation (DWSE) is the risk management elevation level in feet NAVD88. For buildings recommended for elevation, the DWSE refers to the elevation of the first floor once the building is elevated. For buildings recommended for floodproofing, the DWSE refers to the top of the dry floodproofing measure. All construction is assumed to be completed by the year 2040 which means the 50 year period of analysis concludes at the end of the year 2089.

The USACE derived 0.5 percent annual exceedance probability (AEP) stillwater level from the year 2089 using FEMA's South Florida Storm Surge Study was used as a starting point for the DWSE. It includes astronomical tide, storm surge, wave overtopping, and USACE High Curve for sea level change. As discussed in Section 1.10 Study Scope, this study originally began in 2018 and three AEPs were analyzed – the 2 percent, 1 percent, and 0.5 percent (or 50-Yr, 100-Yr, and 200-Yr flood respectively). The optimized DWSE that resulted in the highest net NED benefits at that time was associated with the 0.5 percent AEP; therefore, that was used as a starting point for the 2024 study.

If a building fell within FEMA's special flood hazard areas, then additional significant wave height (SWH) was added to the DWSE. SWHs varied depending on whether it fell in FEMA's Zone AE (wave heights less than 3 feet) or Zone VE (Coastal High Hazard Area where wave action is 3 feet or more). The SWHs across the Focus Areas ranged from 0 feet to 5.1 feet, but the overall average was approximately 0.7 feet. Due to the added wave hazard in some areas, more stringent building practices will be required in Zone VE, such as elevating a home on pilings so that waves can pass beneath it, or a prohibition to building on fill, which can be easily washed away by waves. These practices are intended to improve the chance of a home safely weathering a flood event.

The bulk of the cost with elevating homes is typically associated with the initial elevating of the home which involves separating the house from its current foundation, placing steel beams under the house and lifting it using hydraulic jacks, placing the house on temporary cribbing to replace the foundation with piers or pilings, and disconnecting and reconnecting the plumbing, heating, cooling, and wiring. As discussed in the Cost Engineering Appendix under Summary of Cost Data Collected, the cost to elevate a home 8 feet in height was no different than elevating a home 10 feet in height.

To complete this study within an expedited schedule to accomplish a Chief's Report in 2024, the costs were developed assuming each house recommended for elevation would be elevated 12 feet above ground elevation. The DWSE using the 0.5 percent AEP including SLC and SWH was ranging from 8.7' to 15.4' NAVD88 with an average of approximately 11' NAVD88. Buildings are typically recommended to not be elevated beyond 12' above the ground due to structural limitations. Since the costs were developed using the high end of that limitation, the DWSE for elevating homes was updated to ground elevation plus 12'. Similarly, the DWSE for floodproofing buildings and CI was ground elevation plus four feet. The Recommended Plan is associated with the 0.5% AEP in the year 2089 (approximately 50 years after completion of project construction) after applying the USACE High sea level change scenario; however, due to varying ground and hydrologic elevation data throughout the focused study area and due to height limitations of floodproofing and elevation of buildings, the level of performance ranges from the two percent to the 0.1 percent AEP on a building-by-building basis. DWSEs will be further refined during PED once surveying of each building is completed. DWSEs in PED will be based on stillwater elevation, sea level change, any wave components that are needed which can result in buildings being elevated to different heights above the surveyed ground elevation data.

Table 9-3 provides a breakdown of the elevations and floodproofings for residential and nonresidential buildings by occupancy type.

Table 9-3. Number of Approximate Nonstructural Measures per Occupancy Type in the Recommended Plan

Occupancy Type	# of Elevations	# of Floodproofings
Single-Family Residential	1,731	N/A
Multifamily Residential	326	N/A
Commercial	N/A	260
Educational		13
Governmental		119
Industrial		11

Occupancy Type	# of Elevations	# of Floodproofings
Religious / Community		0
Hotel / Motel		0
Institutional		0
Total Nonstructural	2,057	403

The following figures are examples of such measures.

Figure 9-1. Elevated Home with Drive-Under Garage, New Orleans, Louisiana

Figure 9-2. Removable Flood Barriers of an Office, Bothell, Washington

Figure 9-3 shows the count of CI assets recommended for floodproofing in the RP.

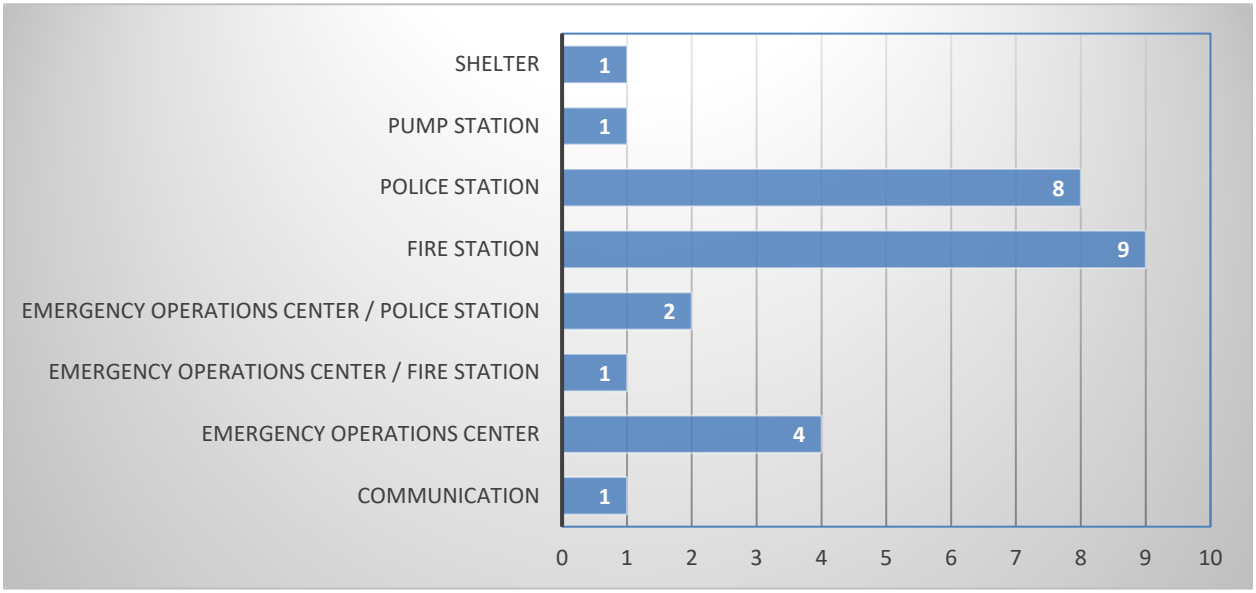


Figure 9-3. Critical Infrastructure Count in the Recommended Plan

The RP includes a total of 27 CI assets within and near the Focus Areas. There were some buildings that were joint CI buildings such as emergency operations centers (EOC) and fire or police stations. **Table 9-4** shows the full breakdown.

Table 9-4. Descriptions of the Critical Infrastructure within the Recommended Plan

CI	Description	Municipality
County Fire Stations	Miami-Dade Fire Rescue (MDFR) Firehouse 34	Cutler Bay
	MDFR Firehouse 8	Aventura
	MDFR Station 22	North Miami
	MDFR Firehouse 76	Bay Harbor Islands
	MDFR Firehouse 20	North Miami
Municipal Fire Station	Fire Station No. 1	Miami Beach
	Fire Station Headquarters	Miami Beach
	Miami Beach Fire Department – Station 4	Miami Beach
	Miami Fire Rescue Department	Miami
County Police Station	Miami-Dade Police Department Intracoastal District Station	Aventura
	Miami-Dade Police Department South District Station	Cutler Bay
Municipal Police Stations	Indian Creek Village Police	Indian Creek
	Surfside Police Department – Surfside Towers	Surfside
	Bay Harbor Islands Police Station	Bay Harbor Islands
	Bal Harbour Village Police	Bal Harbour
	Miami Beach Police Department	Miami Beach
	Miami Beach Police Substation	Miami

CI	Description	Municipality
EOC	Scott Rakow Youth Center	Miami Beach
	North Shore Community Center	Miami Beach
	Miami Beach Senior High School	Miami Beach
	Miami Beach Convention Center	Miami Beach
EOC / Police Station	Municipal Police Station – Cutler Bay Town Hall	Cutler Bay
	EOC / City of Miami Police Department	Miami
EOC / Fire Station	EOC / Miami Beach Fire Rescue Station #2	Miami Beach
Pump Station	WASD Pump Station 1 (4th Street)	Miami
Shelter	Private Data – Cannot Disclose	-
Communication	Miami Beach City Hall	Miami Beach

9.3 Cost Estimate

The project first cost of the RP at October 2023 price levels is approximately $2,660,000,000. This is the cost used for all economic analyses for the study. The total project cost (or fully funded cost) of the project, with escalation through the midpoint of construction, is approximately $3,353,000,000. The midpoint of construction is reflected as separate midpoints for the various components of the RP and are as follows: CI floodproofing construction midpoint of third-quarter Fiscal Year 2028, nonresidential floodproofing midpoint of fourth-quarter Fiscal Year 2030, and residential elevations midpoint of second-quarter Fiscal Year 2033. That is the cost used for requesting funds from Congress and will be cost-shared between the federal government and the nonfederal sponsor (NFS) at 65 percent and 35 percent, respectively. Section 9.7 provides more information related to cost sharing. **Table 9-5** shows the economic summary of the RP, including a breakdown of costs. The costs include a contingency of 52 percent. More information on the contingency is available in Section 3.4, Contingency, of the Cost Engineering Appendix.

Additionally, the costs presented in **Table 9-5** are based on a Class 4 cost estimate as detailed in the Cost Engineering Appendix. A Class 4 cost estimate is a reflection of early conceptual technical information (five to ten percent design), which is still lacking technical information and scope clarity in some areas, resulting

in major estimate assumptions in technical information and quantities, heavy reliance on cost engineering judgment, cost book, parametric, historical, and specific crew-based costs. While certain construction elements can be estimated in detail, there is still a great deal of uncertainty relative to major construction components. Although Class 4 estimates may be more accurate than Class 5 estimates, they are based on very limited technical information. Class 4 estimates typically have a contingency range of 30 percent to 100 percent.

Table 9-5. Economic Summary of the Recommended Plan (October 2023 Price Levels and 2.75 Percent Discount Rate)

Project First Costs	
Construction	$1,592,000,000
Preconstruction, Engineering, and Design (PED)	$500,000,000
Construction Management (CM)	$245,000,000
Real Estate	$165,000,000
Cultural Resource Mitigation	$160,000,000
Project First Cost	**$2,660,000,000**
Average Annual Costs	$117,000,000
Annualized Interest During Construction (IDC)	$300,000
Annualized Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R)	$3,800,000
Total Average Annual Costs (AAC)	**$121,100,000**
Average Annual Benefits (AAB)	$62,000,000
Annualized Net Benefits	-$59,100,000
BCR	**0.51**

The cultural resource mitigation cost is 10 percent of the construction cost. It was derived from using the assumption that it would cost approximately $40,000 per building for mitigating any cultural resources. That cost includes developing a Historic Preservation Treatment Plan for each adversely affected historic property.

9.4 Lands, Easements, Rights-of-Way, Relocations, and Disposal

NFSs are required to provide all lands, easements, rights-of-way, relocations, and disposal areas (LERRDs) for cost-shared project implementation in accordance with the Project Partnership Agreement (PPA). The elevation and floodproofing measures would be offered to owners of buildings that have been determined to be eligible and have voluntarily consented to grant a right of entry for construction, staging, and storage. Owners of residential and nonresidential buildings must sign a participation agreement and grant a perpetual restrictive easement or a restrictive covenant that will run with the land. The easement or restrictive covenant will be acquired only over the portion of the property occupied by the building and not over the entirety of the property. The NFS would be required to provide temporary relocation assistance benefits to tenants occupying eligible buildings in accordance with the Uniform Relocation Act (URA). Total LERRDs are estimated to be $118,000,000 ($165,000,000 with cost contingency) for the RP. Appendix A-4, Real Estate Plan, provides further discussion of the potential real estate requirements.

Elevations of residential homes are voluntary. Although project costs and benefits are typically calculated assuming that 100 percent of the buildings included in the RP will choose to participate, the actual level of participation could vary.

9.5 Operations, Maintenance, Repair, Replacement, and Rehabilitation

Once construction of the water resources project is complete, the operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) phase begins, during which ongoing activities are conducted to support the function of the project. OMRR&R is the responsibility of the NFS. OMRR&R costs, which will be confined to periodic curb-side assessments by the NFS and the potential annual testing and inspecting of placing the dry floodproofing methods in place, are described below.

Elevation OMRR&R

OMRR&R for elevation consists of primarily administrative activities and monitoring the project to ensure buildings that participated are not violating any restrictions. Some tasks used to develop OMRR&R costs for elevation are described below:

- Every five years, the NFS will electronically or through mass mailings reach out to project participants providing notice that the building on the property was elevated by USACE and notice of the easement encumbering the property and the restrictions thereon.
- Every five years, the NFS will conduct physical inspections from the street of, at minimum, 10 percent of the buildings that have participated in the project. For those buildings which are situated on large acreage parcels where the building is not visible from the street, the NFS may notify the owner of the inspection and obtain concurrence to enter the property.
    - The inspections will determine among other things, that no part of the structure located below the level of the lowest habitable finished floor has been converted to living area for human habitation or occupancy, or otherwise altered in any manner which would impede the movement of waters beneath the structure.
- When available, the NFS will also make efficient use of monitoring that is already being conducted by local cities or counties, Federal Emergency Management Agency, or state agencies.

- The NFS will utilize GIS or a sharable database to track surveys and violations. They may also use existing tracking tools or those from local, state, or Federal agencies if they exist. The NFS will provide updates to USACE every five years after surveys have been completed.
- If a potential violation of the terms of the easement is discovered, the NFS will coordinate with the local government, as appropriate. Resolution may be deferred to a local government if there are sufficient mechanisms for enforcement and resolution; however, the NFS will still issue a notice of violation and will inform the property owner that the issue must be resolved with the local government or legal action may be taken to recover the funds expended by the Federal Government.

It was assumed two personnel would conduct the surveys, keep records of results, and identify and report any violations over a period of one week. This would occur once every 5 years which would result in 10 surveys over the 50 year life cycle.

Floodproofing OMRR&R

OMRR&R for floodproofing would consist of performing annual inspections of the building to ensure the floodproofing measure would function correctly over the 50 year lifecycle. Testing, inspecting, and maintaining of the floodproofing methods would take place annually. All equipment related to floodproofing (ie: flood logs on openings) is assumed to be kept on-site which is the best management practice. For nonresidential buildings, it is assumed two personnel would perform the inspection and testing over a period of two hours. For CI, it is assumed three personnel would perform the inspection and testing over a period of three hours since CI can be more complex and there is a need for more staff to be trained and kept up-to-date on procedures. Due to uncertainties surrounding the warranty information of the floodproofing products and the frequency of repairing and/or replacing items involved in dry floodproofing, replacement costs were assumed at every five years due to damage from storms. Five percent of the project first construction cost of floodproofing was used to account for such damage to items like the mounts, flood logs, or gaskets related to storm or debris so they can be repaired or replaced.

OMRR&R Costs

FY24 Davis-Bacon labor rates were used for 'Building Construction' within Miami-Dade County and were escalated for each year up to 2089. The OMRR&R costs were estimated at $221 million over 50 years which is based on 100 percent participation of all buildings in the Recommended Plan. That results in an annualized OMRR&R costs of $3.8 million. OMRR&R costs are not included in the total project cost summary but are used to calculate the total investment cost shown as total average annual costs throughout the report. The NFS is responsible for the cost of the OMRR&R.

9.6 Risk and Uncertainty

All CSRM projects comprise different risk management alternatives represented by the tradeoffs among engineering performance, project cost, economic and environmental resilience, other social effects, and life loss consequences. These alternatives generate differences in damage reduced, residual risk, local and federal project costs, impacts to the environment, other social effects, and life loss. The project delivery team (PDT) selected the RP considering all these tradeoffs to identify a plan that manages risk and

considers other conditions appropriately. Throughout the study and project implementation, the PDT will communicate with the NFS, local residents, and stakeholders so they understand these tradeoffs and can fully participate in the study and implementation of the project.

9.6.1 Sea Level Change

With any CSRM project, the long-term efficiency of the formulated plan and proposed measures, and their ability to manage the risk and vulnerability to coastal storms, is dependent on the accuracy of sea level change models and their ability to project water levels 50 to 100 years in the future. There is a degree of uncertainty involved with extrapolating sea level change data and how deviations in the expected sea level can potentially change the effects of coastal forces, i.e., winds, tidal forces, and wave heights, because of the change in water depths. To mitigate this uncertainty within the 50-year economic period of analysis, the USACE Low Curve was used from 1992 to 2024 and the USACE High Curve was used from 2024 to 2089, which resulted in a sea level change increase of 4.54 feet.

The economic model (G2CRM) was run using the USACE High Sea Level Change Curve rate. Engineering Regulation (ER) 1100-2-8162 requires the consideration of alternatives to be formulated and evaluated against three sea level change scenarios—typically the Low, Intermediate, and High USACE Sea Level Change Curves. To conduct a sensitivity analysis on sea level change, the USACE Low and Intermediate Sea Level Change Curve rates were also evaluated. **Table 9-6** displays the economic uncertainty for economic results for all three USACE SLC curves on the DWSE.

Table 9-6. Sea Level Change Economic Uncertainty ($1000s)

USACE SLC Curve	Average Annual Benefits	Average Annual Costs	Project First Cost	BCR	Net Benefits
High	$62,000	$121,100	$2,660,000	0.51	-$59,000
Intermediate	$30,000	$121,100	$2,660,000	0.25	-$91,000
Low	$23,000	$121,100	$2,660,000	0.19	-$98,000

Note: October 2023 FY(24) price level, Period of Analysis: 50 years, Interest Rate 2.75%

The USACE high curve resulted in the most net benefits. The USACE High curve also aligns with the Miami-Dade County's climate compact that they signed which recommends the USACE or NOAA High curve depending on the project life and scale. Should future SLC proceed more slowly than assumed in planning, both economic and comprehensive net public benefits of this plan will likely be lower than assumed.

Roadways and buildings were not modeled or evaluated for high tides and / or SLC alone. Flooding to roadways and utilities due to storm surge was also not evaluated. There are areas in the Focus Area that are currently shown as flooded in the High SLC scenario alone over the next few decades. Without this evaluation, the long-term risk is acknowledged that the floodproofing and elevation of buildings as part of

the RP may be in areas where the future will be in a flooded state or evacuation will be difficult due to limited or no access to roadways under a High SLC scenario.

9.6.2 Residual Risk

Residual risk is the risk that remains after a CSRM measure is implemented. No measure, except for acquisition/demolition, can eliminate all risk to a building. Residual risks remain in the RP that the team cannot eliminate because of constraints or other factors. This study was limited to the Focus Areas identified because of scope and budget; therefore, areas outside of the Focus Areas in Miami-Dade County remains at risk to coastal storms. This study does not directly address nuisance flooding either; therefore, residual risks from other types of flooding may remain such as rainfall flooding, tidal flooding, and flooding seen from sea level change in the future. Further studies will include additional recommendations for implementation, and/or actions from the NFS will be needed to address the full extent of existing CSRM and flooding problems in Miami-Dade County.

As shown in Table 8-1 under Section 8.1, Plan Comparison, the residual damage risk remaining for the RP is approximately 65%. The reason it is on the higher end is because of there are approximately 2,400 buildings in the Focus Area that were not included for analysis in this 2024 report. Those are buildings that will be prioritized in future study efforts. More information on those buildings is provided in Table 4-3 under Section 4.4, Arrays of Alternative. Residual damage risk remaining to those buildings that are part of the RP is approximately 23% which means 77% of the damage is managed with the RP. The 23% of residual risk is most likely attributed to the DWSE limitations of floodproofing which is maxed out at four feet above ground elevation for this 2024 study.

Residual life loss risk remaining for the RP is approximately 13% which means 87% of the risk to lives is potentially reduced with the RP. This is assuming 100% participation rate, and that the population data and evacuation rates estimated are close to reality. Risks described regarding those items are described in 9.6.5 Participation Rate and 9.6.6 Life Loss Related to Evacuation Rates.

9.6.3 Engineering Risk

There is uncertainty associated with the engineering and design of the study. Because the elevation of residential buildings and floodproofing of nonresidential buildings require building-by-building information and analysis, this engineering risk will remain until each building included in this plan has been evaluated during the PED Phase to ensure they are appropriate for elevating or floodproofing.

Inspection of buildings during PED: Pre-design level assessment and evaluation of each building currently included in the RP, which will occur during the PED Phase, may lead to changes to the plan. For example, unique building characteristics may alter the nonstructural floodproofing measures that will be used. The assessment and evaluation of each building may also identify buildings, which are currently included in the plan, that cannot be elevated or floodproofed, so they will have to be removed from the program.

The Pawcatuck River CSRM Study provides an excellent example of engineering risk associated with a nonstructural RP. This study is a similar CSRM study effort USACE is leading to investigate solutions to

reduce the impacts of coastal storms from Point Judith to the Connecticut border. There are several lessons learned from the Pawcatuck River CSRM Study that can be applied, including:

- Floodproofing some buildings, particularly commercial buildings, was found to be more difficult than perceived during the feasibility phase. This was primarily because of the type and age of the building's construction, physical location of the building, compliance with the Americans with Disabilities Act (ADA), and the locations of the heating, ventilation, and air conditioning (HVAC) and other building systems.
- Many buildings contain outdated HVAC and other building systems that need to be upgraded before the building can be elevated or floodproofed.
- Some buildings that were identified during feasibility had been elevated or floodproofed before the design phase and removed from the program.
- Older building construction required structural improvements before elevation.
- Unique building footprints, multiple deck systems, fieldstone or brick chimneys, attached garages or additions, and extensive landscaping features made elevating or floodproofing more difficult and more expensive.

Risk and uncertainty associated with a nonstructural plan remains during the feasibility phase simply because of the currently unknown details of each building included in the plan. The uncertainty will be eliminated once these buildings are individually assessed before retrofitting.

Local Building Code Analysis for Elevating Buildings: Local building codes play a role in whether a residential building can be elevated or not. If the local codes are not understood, there is a risk of including buildings in the RP that cannot be managed.

Maximum Height for Elevating Buildings: In the event of elevating buildings, the International Building Code (IBC) and International Existing Building Code (IEBC) stipulates that if wind load (or seismic load) increases by 10 percent or more, then an analysis must be conducted to ensure the existing building can resist the prescribed loads. During the PED Phase of the Pawcatuck River CSRM Project, the Structural Engineering Section of the USACE New England District concluded that designs requiring buildings to be elevated higher than 12 feet would result in an increase of wind load greater than 10 percent. For single-family homes, however, USACE is not bound by the IBC or the IEBC. Instead, USACE follows the International Residential Code (IRC), which does not have similar provisions. Although not specifically stipulated by the IRC, good engineering practice requires USACE to consider these load increases, to avoid developing designs that would be less "safe" than the original.

9.6.4 Applicable Measures Not Analyzed

Section 4.3.6, Screening of Measures, discussed the measures that were screened out for the 2024 Study. This section describes a few applicable measures that were not analyzed.

Acquisition, relocation, and/or managed retreat (evacuation)

Acquisitions, relocations, and/or managed retreat was not considered for the 2024 study. There is a possibility that there are buildings recommended for elevation that would be more cost effective using

one of those three methods; however, per Planning Bulletin 2019-03, Further Clarification of Existing Policy for USACE Participation in Nonstructural Flood Coastal Storm Risk Management, December 13, 2018, elevation is a voluntary measure whereas acquisition, relocation, and managed retreat is a mandatory measure. While acquisition does remove all coastal storm risk to a building which would result in the highest of National Economic Development benefits, the focus areas developed are at risk to high frequency storm surge events and need solutions that are quicker to implement. There is uncertainty around the additional processes and costs related to acquisition if the homeowner was not a willing seller requiring eminent domain to be exercised as a last resort. The time to develop the cost for acquisition is a lengthy process which can require proper appraisals of each building, title work, condemnation packaging, processing, court proceedings, relocation services, moving fees, differential payments if the new equivalent home is more costly, negotiations and acquisition of property, right of way agents, eminent domain specialists, etc. With so many unknowns, it is uncertain if it would have been a more cost effective solution. The Focus Areas also consist of all environmental justice communities, and forcing residents to move could disrupt social cohesion. With additional time for thorough analysis, these measures can work very well in some areas, but they require extensive coordination with and support from stakeholders, municipalities, the nonfederal sponsor, and residents.

There are risks of not evaluating acquisition as a measure. As mentioned in Section 9.6.1, Sea Level Change, some areas in the Focus Area are shown as flood in High SLC scenarios. There are also areas that have high groundwater levels. Acquisition, relocation, and/or managed retreat could be a more reasonable measure in such areas to address long-term risks associated with roadways, utilities, or even buildings that are in a persistently flooded state under a high SLC future condition.

Structural Measures

Structural measures were not considered for the 2024 study. They are measures that have been shifted for potential analyses in future efforts. Structural measures, like ringwalls or floodwalls, were not analyzed for individual buildings or a group of buildings that are recommended for elevation or floodproofing to determine if it would have been more cost effective solution. The focus areas developed are at risk to high frequency storm surge events which means the storms are more frequent but potentially less damaging since they produce less storm surge water levels. Large structural measures, such as storm surge barriers as described in the Atlantic Coastline Alternative in Section 1.10, would most likely remain open majority of the time and close only during low frequency storms (higher storm surge water levels). For that reason, recommending buildings for elevation and floodproofing in high frequency storm areas will not reduce the benefits of any larger structural measure that could be recommended in future efforts.

Ringwalls or floodwalls were also not analyzed for Critical Infrastructure where dry floodproofing was the recommended measure. Ringwalls are typically I-walls meaning they are limited to 6' in height where floodwalls could be T-walls that can go higher than 6'. They are usually far more expensive than dry floodproofing due to additional engineering and real estate costs. Dry floodproofing methods like flood logs are typically at a maximum of 3 to 4 feet, but it can be higher if the building is reinforced. Structural measures for CI are more feasible when there are multiple CI within a parcel which was not the case in the RP's CI. By not analyzing and comparing structural measures for CI included in the RP, it is possible that higher risk management design levels could have been achieved but for a much higher cost.

9.6.5 Participation Rate

The RP assumes 100% participation rate for all elevations and floodproofings which are voluntary measures. While it is anticipated that the participation rate will be lower than 100%, an assumption of appropriate participation rates was not made since there is limited data in the Miami-Dade County area on past or on-going home elevations and floodproofings. The Office of Management and Budget's Approved Planning and Operations Public Surveys clearance process takes a minimum of 6 months and may take as long as a year; therefore, outreach efforts were not conducted during feasibility and will have to be performed during the PED phase. By assuming a 100% participation rate, there's a risk that benefits are over estimated but then so are the costs. There is also a risk that if the participation rate ends up not being 100% that it will disrupt the social cohesion of neighborhoods where some homes are elevated, and some are not. Reluctancy of not wanting to participate could be attributed to:

- Not being familiar with the full process of elevating or floodproofing. Outreach and education efforts will be conducted during PED phase.
- Not being able to or not wanting to cover the costs of bringing the building up to code. These items are described more in depth in Appendix A-7, Nonstructural Implementation Plan, Section 2.3.2 Eligible and Ineligible Elevation Costs.
- Not wanting to stay in other accommodations while their home is being elevated. Currently, only renters get benefits for temporary relocation under the Uniform Relocation Act so owners would have to pay out of pocket.
- Some may choose not to participate at first but may change their mind after seeing homes elevated in their neighborhood.

9.6.6 Life Loss Related to Evacuation Rates

Life loss is heavily dependent on who remains and who evacuates during a storm event. Assumptions were made regarding population over and under 65 who would be present during the day and at night. The 2012 Statewide Regional Evacuation Study Program – Volume 1-11 Technical Data Report South Florida Region Appendix IIIB was used to make assumptions on potential evacuation rates. There is uncertainty surrounding the exact population of each building as well as the number of people who would evacuate. Improving those results with better data could result in different life loss numbers; however, it is difficult to determine accurate evacuation rates even with behavioral studies since it can change person to person year to year. There might be a misconception that those whose homes would be elevated would no longer need to evacuate. The purpose of elevating a home is to safeguard the building and its contents. Anyone, whether homeowner or renter, whose home is elevated would still be highly recommended to evacuate during a storm event. This would be stressed during the PED Phase when outreach would occur. For that reason, assumptions were not made in the economic model to reduce the amount of evacuation if a building were to be elevated in the future with project condition. Further information regarding estimated evacuation rates and population data used are in Section 2.3 Evacuation Planning Zones of Appendix A-5. While not calculated for this study, an indirect flood fatality can also occur before, during or after a major flood event. The flood disaster changes the characteristics (e.g. transportation infrastructure) of a geographic area and creates unsafe conditions that lead to death. Common mortalities include stress-induced medical conditions (e.g. heart attack); power related fatalities (e.g. carbon monoxide poisoning;

asphyxiation); exposure to extreme temperatures (hyperthermia or hypothermia); infections from contact with water; and lack of medical treatment for chronic conditions or minor but treatable conditions.

9.7 Cost Sharing

"Project First Cost" is the constant dollar cost of the RP at current price levels and is the cost used in authorizing the document for a project. The "Total Project Cost" is the constant dollar fully funded cost with escalation to the estimated midpoint of construction. Total Project Cost is the cost estimate used in PPAs for implementation of design and construction of a project. Total project cost is the cost estimate provided to an NFS for their use in financial planning because it provides information regarding the overall nonfederal cost sharing obligation. For this project, the RP first cost was calculated to be $2,660,000,000, while the RP total project cost (fully funded) was determined to be $3,353,000,000.

In accordance with the cost share provisions in Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended (33 United States Code [U.S.C.] 2213), the project PED and Construction Phase is cost-shared 65 percent federal and 35 percent nonfederal. The nonfederal costs include credit for the value of LERRDs. Total LERRDs are estimated to be $165,000,000, as shown in **Table 9-7. Table 9-7** and **Table 9-8** provide the cost share apportionments for the project first costs and total project costs, respectively. For the total project cost, midpoint of construction is FY2028Q3 for Critical Infrastructure, FY2030Q4 for nonresidential floodproofing, and FY2033Q2 for residential elevations. The Cost Engineering Appendix shows the detailed cost estimates.

Table 9-7. Project First Cost (Constant Dollar Basis) Apportionment (October 2023 Price Levels)

Project First Cost (Constant Dollar Basis)	**$2,660,000,000**
Federal Share (65%)	$1,729,000,000
Nonfederal Share (35%)	$931,000,000
Less: LERRDs Credit	$165,000,000
Nonfederal Cash Contribution	$766,000,000

Table 9-8. Total Project Cost (Fully Funded) Apportionment

Total Project Cost (Fully Funded)	**$3,353,000,000**
Federal Share (65%)	$2,179,000,000
Nonfederal Share (35%)	$ 1,174,000,000

9.8 Design and Construction

When a study is completed and the project is authorized, the project moves into the PED Phase, during which design plans and specifications for construction are completed. For PED to be initiated, USACE must sign a design agreement with an NFS to cost share PED, which can begin prior to project authorization. This project would require a budgetary new start for construction, in addition to congressional

authorization. PED is cost-shared 65 percent federal and 35 percent nonfederal. Once the design is complete, the project must receive funds from Congress for construction. Construction is cost-shared 65 percent federal and 35 percent nonfederal and will require a PPA between USACE and the NFS.

The RP comprises features that manage coastal storm risk to vulnerable coastal and environmental justice communities. USACE and the NFS acknowledge that assumptions made regarding the timing and duration of the PED and construction phases are based on the available data and existing information, and could be subject to future variation because of the following:

- Limited level of design in the study phase
- Expected changes in land and real estate development in the project area
- Flood risk management measures completed by others and USACE in the project area
- Level of voluntary participation in the residential home elevations by homeowners (assumed 100 percent in feasibility for purposes of estimating costs and construction timelines)
- Timing of congressional authorization and appropriation of funds
- NFS funds availability
- Timing of executed PPA

The USACE Chief of Engineers must approve the recommended project before design and construction may be initiated. Then the Chief's Report and approved Integrated Feasibility Report/ Environmental Assessment (IFR/EA) are provided to the Assistant Secretary of the Army for Civil Works (ASA[CW]) and Office of Management and Budget (OMB) for review, before transmittal to Congress for authorization. The project requires congressional authorization to receive federal construction funding. In some cases, funding for design may be available before congressional authorization. Project implementation is currently anticipated to begin in 2027 and to be completed by 2040. **Table 9-9** provides the current estimated schedule for the project based on that assumption.

Table 9-9. Estimated Design and Construction Schedule

Action	Estimated Start Date
Final IFR/EA to Higher Authority for Approval	June 2024
Signed Chief's Report and Chief's Report Submitted to ASA(CW)	September 2024
ASA(CW) Chief's Report Approval / Submittal to OMB	January 2025
Execute Design Agreement with NFS[1]	May 2026
Start Plans and Specifications (PED Phase)[1]	May 2026
Award Construction Contract with Notice to Proceed[1]	September 2027
Construction Completion[1]	May 2040

[1]Pending additional congressional authorization and appropriation.

It is unlikely that funding for construction would be available all at once because of the large size and cost of the RP. The PDT and Miami-Dade County developed a strategy for construction sequencing of the RP, as shown in **Table 9-10.** This allows earlier preparation if construction funds were made available as well as proper communication of construction priority to stakeholders.

Table 9-10. Approximate Construction Sequencing Strategy of the Recommended Plan

Measure	Duration (Years)	Fiscal Year Start	Fiscal Year End	Priority
CI Floodproofing	2	2027	2029	1
Residential Elevations	13	2027	2040	2
Nonresidential Floodproofing	6	2027	2033	3

The construction period of 13 years from 2027 to 2040, as shown in **Table 9-10**, is based on assuming 100 percent participation for the voluntary residential elevations. Because this measure is voluntary, it is likely that not every homeowner will elect to participate, meaning the actual construction duration may vary.

9.9 Environmental Commitments

To ensure avoidance and minimization of potential impacts, the standard Jacksonville District BMPs for migratory and shorebirds (1 through 7) and BMPs for the Florida bonneted bat (8 through 14) will be adhered to during construction as follows:

1. All construction personnel must be advised that migratory birds are protected by the Florida Endangered and Threatened Species Act of 1977, Title XXVIII, the Migratory Bird Treaty Act of 1918, and the Endangered Species Act of 1973, as amended. The contractor may be held responsible for harming or harassing the birds, their eggs, or their nests.
2. Construction activities will be under surveillance, management, and control to prevent impacts to migratory birds and their nests.
3. A qualified bird monitor will be present and monitor the construction area from April 1 through August 31, unless there is an exception granted by a USACE biologist.
4. A USACE biologist must approve the bird monitor, who must possess qualifications that include, but are not limited to, identifying bird species, nesting behavior, eggs and nests, and habitat requirements. The monitor must also be familiar with state requirements and reporting procedures.
5. The bird monitor must record any nesting activity in accordance with reporting requirements. Should nesting begin within the construction area, a temporary 200- to 300-foot buffer, as specified by the monitor and the USACE biologist, must be created and marked with signs to avoid entry.
6. Strict erosion and sediment control measures should be used during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer

Manual, Latest Update July 2013 (or most current version), as well as the conditions of any permits issued for the project.

7. Native vegetative seed mixes must be planted on disturbed land after construction is complete.
8. To minimize impacts to the Florida bonneted bat, BMPs 8 through 14 would also be adhered to. Potential roost trees or structures need to be removed, and cavities need to be checked for bats within 30 days prior to removal of trees, snags, or structures. When possible, remove structure outside of breeding season (e.g., January 1 through April 15). If evidence of use by any bat species is observed, discontinue removal efforts in that area and coordinate with the United States Fish and Wildlife Service (USFWS) on how to proceed.
9. When using heavy equipment, establish a 250-foot (76-meter) buffer around known or suspected roosts to limit disturbance to roosting bats.
10. Avoid engineering designs that encourage bats from using roofs, buildings, or structures. For example, minimize and seal any gaps, cracks, holes in roofing, siding, soffits during construction.
11. Retain mature trees and snags that could provide roosting habitat. These may include live trees of various sizes and dead or dying trees with cavities, hollows, crevices, and loose bark.
12. Protect known Florida bonneted bat roost trees, snags or structures, and trees or snags that have been historically used by Florida bonneted bats for roosting, even if not currently occupied, by retaining a 250-foot (76-meter) disturbance buffer around the roost tree, snag, or structure to ensure that roost sites remain suitable for use in the future.
13. Maintain natural light conditions. Avoid and minimize the use of artificial lighting and avoid permanent night-time lighting. Where lighting is necessary to meet minimum life safety requirements it must be designed to meet each of these recommendations:
    a. Utilize fully-shielded fixtures to restrict the amount of upward-directed light. Light sources must be downward directed and shielded so that the luminaire emits no more than 10% of its vertical output above 80 degrees from nadir. Examples of appropriate fixtures can be found in FWC Sea Turtle Lighting Guidelines.
    b. Use the “Backlight, Uplight, Glare” (BUG) system developed by the Illuminating Engineering Society to avoid glare, excessive lighting and light trespass. The “uplight” rating should be zero, and “backlight” and “glare” ratings should be as close to zero as possible. Fixtures on edges of developed areas should have zero backlight ratings.
    c. Avoid broad spectrum and excessive short wavelength artificial light below 560 nanometers. Lights with less than 3000 Kelvin (K) color temperature must be used, while color temperatures of 2700 K or less are ideal. Lights with the lowest lumens possible should be used.
    d. Utilize shielding, louvers and baffles, dimming and other appropriate lighting controls to direct and minimize lighting when not in use.
    e. Lighting must not illuminate any retained or restored vegetated areas.

f. Prevent indoor artificial lighting reaching the outdoor environment. Use fixed window screens, blinds or tinting on fixed windows and skylights to contain artificial light inside buildings.

14. If Florida bonneted bats have taken residence within a structure, contact USFWS and Florida Fish and Wildlife Conservation Commission before attempting removal or when conducting maintenance activities on the structure.
15. Construction activities would take place during daylight hours only, which typically will occur between 8:00 a.m. and 5:00 p.m.

Cultural resource commitments as stipulated by the executed 2021 Programmatic Agreement (PA) will be implemented once an individual undertaking has been authorized and funded for the Preconstruction, Engineering, and Design Phase. The USACE Jacksonville District (SAJ) archaeologist assigned to the project will evaluate which review process outlined in the PA would be followed for a particular undertaking. The Jacksonville District archaeologist will define the area of potential effects in consultation with PA signatories and concurring parties. Then the effort to identify historic properties would be planned and implemented. Any identified cultural resources would be evaluated for their eligibility to the National Register of Historic Places. The survey results would be reported, and PA signatories and concurring parties would have an opportunity to review and concur or review and comment. If historic properties are identified, the SAJ archaeologist would implement measures stipulated in the PA to make a finding of effect. An avoidance analysis would be completed in consultation with PA parties to develop the finding of effect. For any adversely affected historic property, a treatment plan would be completed and implemented prior to construction being authorized to proceed in that location. Development of a research design, reporting documentation, and curation of recovered artifacts would be completed in accordance with the PA. The PA includes a discovery plan for cultural resources found during construction.

9.10 Environmental Operating Principles

First introduced in 2002 and later reissued in 2012, the USACE Environmental Operating Principles (EOPs) (ER 200-1-5) were developed to ensure that the USACE missions include totally integrated sustainable environmental practices (USACE 2021). The EOPs provided corporate direction to ensure the workforce recognized USACE's role in, and responsibility for, sustainable use, stewardship, and restoration of natural resources across the nation.

Since being introduced, the EOPs have instilled environmental stewardship across business practices, from recycling and reduced energy use at USACE and customer facilities to a fuller consideration of the environmental impacts of USACE's actions and meaningful collaboration within the larger environmental community. The EOPs relate to the human environment and apply to all aspects of business and operations, including military programs, Civil Works, research and development, and across USACE. The EOPs require a recognition and acceptance of individual responsibility from senior leaders to the newest team members. Recommitting to these principles and environmental stewardship will lead to more efficient and effective solutions and will enable USACE to further leverage resources through collaboration. This is essential for successful integrated resources management, restoration of the environment, and sustainable and energy efficient approaches to all USACE mission areas. It is also an essential component

of USACE's risk management approach in decision-making, allowing the organization to offset uncertainty by building flexibility into the management and construction of infrastructure.

USACE's EOPs were considered in the planning process of this study. In particular, the planning process and selection of the RP leveraged scientific, economic, and social knowledge to assess the effects of USACE actions; met USACE's responsibility and accountability under applicable law for activities that may impact human and natural environments; worked collaboratively with individuals, groups, and agencies interested in USACE's activities; and used an open and transparent process. The RP provided a mutually supported economic and environmentally sustainable solution as part of a broader and more comprehensive phased approach to manage coastal storm risk within the project area.

9.11 Views of the Nonfederal Sponsor

Miami-Dade County supports the final Miami-Dade Back Bay CSRM Study IFR/EA and its recommendations for a comprehensive framework, a nonstructural-focused RP to improve life safety, and programs to advance future Nature-Based Solutions (NBS) pilot projects and nonstructural projects. Miami-Dade County is grateful to USACE and was particularly pleased that USACE allowed Miami-Dade County staff and consultants to play such an active role in the PDT and maintain regular and close coordination across all levels of vertical team leadership within the USACE enterprise to accelerate work, communicate expectations, and adapt to changing needs and concerns. Miami-Dade County is committed to providing continued opportunities for robust feedback from the public, resource agencies, and other practitioners in the climate and urban resilience fields. County priorities for further consideration include the following:

Integration across USACE studies, regional efforts, and local initiatives: Integration will be crucial for successful implementation of authorized projects and programs. The County is highly supportive of ongoing efforts of the USACE Jacksonville District to integrate various studies in the area, including, but not limited to, Central and Southern Florida (C&SF) System Section 216 Flood Resiliency Study, Comprehensive Everglades Restoration Plan (CERP), Biscayne Bay Southeastern Everglades Ecosystem Restoration (BBSEER), Key Biscayne CSRM Study, and PortMiami Navigation Project. The County desires to see further development of the integration efforts (e.g., definition of joint priorities, roles, structure, etc.) to include flood risk management and related resilience work of the South Florida Water Management District, Miami-Dade County, and 34 municipalities. Through local organizing mechanisms such as the County's Sea Level Rise Strategy and Adaptation Action Area (AAA) planning, this will help ensure other neighborhood-level investments—such as septic to sewer conversions, drainage, and transportation improvements—can be designed and implemented in a complementary and cost-effective fashion.

Continuation of USACE vertical team leadership and County coordination: This enables the County to ensure its voice and priorities help guide decisions influencing future planning and implementation. The County believes there is great value in maintaining the vertical team leadership coordination within USACE, which has led to nimble, timely, and effective decision-making contributing to the successful delivery of this unique report for 2024 WRDA authorization.

Development of 2026 and/or 2028 Chief's Report(s): This action exemplifies adaptive management as described as part of the Comprehensive Framework by evaluating what projects can be independently recommended in the short-term while being future ready. The County supports leveraging all potential

opportunities to advance feasible projects that provide multiple levels of CSRM benefits along with other comprehensive benefits through the development of additional and fully independent feasibility reports that implement the larger multiple-lines-of-defense vision.

Development of a transition strategy or "bridge" for sustained funding: The County strongly believes in the need to continue the Miami-Dade Back Bay CSRM Feasibility Study beyond the use of the current feasibility funds available through the Bipartisan Budget Act of 2018 appropriation and granted as part of the ASA(CW) letter from August 3, 2022. The County strongly believes that a pathway similar to that of the Key Biscayne CSRM Study, identified as a need in the 2022 Final IFR/EA of the Main Segment Miami-Dade County CSRM, must be pursued. To support the full implementation of the Comprehensive Framework and to assess the feasibility of a range of potential measures that create multiple lines of defense, the County supports the need for a New Phase Investment Determination.

Centering and prioritization of environmental justice: Focusing on environmental justice throughout study efforts will ensure an equitable and community-driven plan. The County appreciates efforts led by USACE in making environmental justice a priority in all its projects, and it has a strong desire to build on the community-based engagement to continue listening, learning, and centering the preferences and concerns of the most marginalized or traditionally under-represented groups. The County encourages further collaboration with municipalities, community-based organizations, and other stakeholder groups to ensure environmental justice remains a key driver of decision-making.

CI in the RP: The County and all the incorporated and unincorporated communities within it rely on CI to be resilient to storms and flood inundation to ensure their proper function and delivery of emergency or critical services before, during, and after severe storm events. The County strongly supports the advancement of this initial recommendation of CI assets for CSRM measures. The County is also interested in expanding the scope of potential CI assets in subsequent feasibility studies to consider a broader list of other key community lifeline and support facilities, infrastructure systems, and hubs or centers identified by municipalities and other stakeholders, especially those at risk of compound flooding and/or those that serve environmental justice or otherwise socially vulnerable neighborhoods. The County is also prepared to facilitate coordination to ensure that relevant critical asset inventories and flood and sea level change vulnerability assessment results produced by the County and municipalities for the Florida Department of Environmental Protection's Resilient Florida program are leveraged and made complementary to this study effort.

Nonstructural in the RP: Adapting both residential and nonresidential buildings in place have many advantages to managing coastal flood risks. The County supports advancing the nonstructural measures recommended for the initial Focus Areas identified in this report for authorization leading to detailed PED and Construction. The County is prepared to cooperate with any relevant real estate mechanisms as needed and will be developing a robust approach, in coordination with municipalities, for educating and engaging property and business owners, renters, and related neighborhood stakeholder groups. In compliance with the URA, the County also strongly believes in providing adequate temporary relocation assistance for property owners and renters during future implementation phases, including, but not limited to, financial resources, comprehensive guidance, and education.

Nonstructural Program: The County is supportive of the requested authorization of a Nonstructural Program, which is independent from the nonstructural recommendation as part of the RP or additional future nonstructural formulation in the Comprehensive Study Framework, to explore ways USACE can address coastal storm risks to other building types, such as multifamily residential buildings and a broader array of CI assets that supports community resilience. The County is particularly interested in gathering additional community stakeholder input to identify potential assets that serve as CI throughout the County, with emphasis on those serving environmental justice neighborhoods before, during, and after coastal storm events.

NBS Pilot Program: The County knows that NBS are a cornerstone set of management measures to address coastal storm risks while also providing numerous comprehensive benefits, and these solutions remain critical to the Miami-Dade Back Bay CSRM Feasibility Study's success. In addition to incredible support from the USACE Engineering With Nature (EWN) team and Engineering Research and Development Center (ERDC), the County strongly believes an inclusive and collaborative effort among local stakeholders is also key. The County is particularly interested in exploring additional ways to leverage and engage the immense knowledge, expertise, and resources found within local government, higher education institutions, nongovernmental organizations, and others to advance the best ideas to plan, design, and implement NBS. Through a more collaborative effort, opportunities to test, implement, and monitor NBS can be identified and advanced in coordination with other ecosystem restoration and compensatory mitigation efforts.

Addressing compound flooding impacts: Miami-Dade County has and will continue to advocate for integrated planning and design of projects. The County and its partners are cognizant of Section 8106 of the 2022 WRDA as a potential pathway and, during the development of this final report, envisioned its future application as part of a further feasibility study.

Modeling of Atlantic Coastline Alternative concept: This is an important effort that will help inform a potential future feasibility study of a system of storm surge gate structures near the barrier islands that may significantly manage coastal storm risks. Miami-Dade County supports the ongoing USACE ERDC investigation and more detailed hydraulic, hydrology, and water quality modeling to understand how the broader structural concept may affect how water flows before, during, and after a storm event. Miami-Dade County highly encourages continued coordination with the South Florida Water Management District, the County Division of Environmental Resources Management, municipal staff, and other relevant stakeholder groups to ensure the results can be most useful for this study and other regional flood risk and water quality planning efforts.

10 ENVIRONMENTAL COMPLIANCE FOR THE RECOMMENDED PLAN

10.1 Environmental Compliance for the Recommended Plan

Table 10-1. Summary of Relevant Federal Laws and Regulations

Title of Law	United States Code (U.S.C.)	Compliance Status
American Bald and Golden Eagle Protection Act of 1962, as amended	16 U.S.C. 668	Full compliance. No bald eagle nests are located within a mile of nonstructural areas or critical infrastructure facilities.
Clean Air Act of 1970, as amended	42 U.S.C. 7401 et seq.	Miami-Dade County is within the Southeast Florida Intrastate Air Quality Control Region established by 40 Code of Federal Regulations (CFR) § 81.49 and is currently in attainment for all criteria pollutants. Full compliance.
Clean Water Act (CWA) of 1972, as amended	33 U.S.C. 1251 et seq.	There is no in-water work. A CWA (Section 401) Water Quality Certificate is not required. No CWA Section 404 authorization is required.
Coastal Barrier Resources Act and Coastal Barrier Improvement Act of 1990	Public Law 97-348 and 101-591	There are no Coastal Barrier Resource System (CBRS) units located near critical infrastructure or nonstructural Focus Areas.
Coastal Zone Management Act of 1972, as amended	16 U.S.C. 1451 et seq.	Full compliance. Federal consistency concurrence was received from the Florida Department of Environmental Protection (FDEP) on June 24, 2024.
Endangered Species Act of 1973	16 U.S.C. 1531 et seq.	Full compliance. Informal consultation with United States Fish and Wildlife Service (USFWS) was completed on June 14, 2024. No consultation with National Marine Fisheries Service (NMFS) is required with no impacts to trust resources under NMFS jurisdiction.
Fish and Wildlife Coordination Act of 1958, as amended	16 U.S.C. 661 et seq.	Full compliance. USFWS documentation was provided June 4, 2021. No Fish and Wildlife Coordination Act (FWCA) coordination is required with NMFS. There are no

Title of Law	United States Code (U.S.C.)	Compliance Status
		in-water impacts and no impacts to trust resources under NMFS jurisdiction.
Marine Mammal Protection Act of 1972, as amended	16 U.S.C. 1361 et seq.	There is no in-water work and no impacts to marine mammals. Consultation is not required.
Magnuson–Stevens Fishery Conservation and Management Act	16 U.S.C. 1801 et seq.	There is no in-water work. An Essential Fish Habitat (EFH) Assessment is not required.
Migratory Bird Treaty Act of 1928, as amended	16 U.S.C. 703 et seq.	Full compliance. The United States Army Corps of Engineers (USACE) Jacksonville District Best Management Practices for Migratory Birds would be adhered to during construction.
National Environmental Policy Act of 1969, as amended	42 U.S.C. 4321 et seq.	Preparation and circulation of the Draft Integrated Feasibility Report/ Environmental Assessment (IFR/EA) partially fulfills requirements of the National Environmental Policy Act (NEPA). Full compliance was achieved with signed Finding of No Significant Impact (FONSI).
National Historic Preservation Act of 1966, as amended	54 U.S.C. § 300101 et seq.	Full compliance. Programmatic Agreement was executed on April 9, 2021.
Resource Conservation and Recovery Act of 1976	42 U.S.C. 6901 et seq.	Full compliance. Testing, quantification, and notification for any hazardous materials will occur during the Preconstruction, Engineering, and Design (PED) Phase.

Table 10-2. Summary of Relevant Executive Orders

Title of Executive Order	Executive Order Number	Compliance Status
Floodplain Management	11988	Full compliance anticipated. The draft and final IFR/EA will be publicly available documents. The draft Finding of No Practicable Alternative in included in Appendix A-6. The final IFR/EA will include the final determination.
Protection of Wetlands	11990	No wetland impacts.
Federal Actions to Address Environmental Justice and Minority and Low-income Populations	12898	Full compliance. No disproportionate impacts to underserved communities are anticipated.
Protection of Children from Environmental Health Risks and Safety Risks	13045	Full compliance. No disproportionate impacts to children are anticipated.
Consultation and Coordination with Indian Tribal Governments	13175	Full compliance.
Responsibilities of Federal Agencies to Protect Migratory Birds	13186	Full compliance.
Advancing Racial Equity and Support Through the Federal Government	13985	Full compliance.
Tackling the Climate Crisis at Home and Abroad	14008	Full compliance.
Revitalizing our Nation's Commitment to Environmental Justice for All	14096	Full compliance.

10.2 Public Involvement

10.2.1 Scoping

Stakeholder involvement has been a critical component of the study and the development of a countywide vision for managing coastal storms. Stakeholders include any member of the public that may affect, are affected by, or have a general interest in the study. They are people or groups who see themselves as having rights and interests at stake, either directly or indirectly. During the initial stages of the study, a National Environmental Policy Act (NEPA) scoping meeting was held December 5, 2018, to receive scoping comments from the public. An open house public meeting was subsequently held September 10, 2019, and virtual NEPA public meetings were held on June 9 and 11, 2020, following release of the initial draft report. Virtual office hours were also held on June 18 and 19, 2020. During the initial stages of the study after the draft report was released to the public for review and comment in June 2020, substantial public and stakeholder concerns were received. Concerns focused primarily on the proposed structural measures and the environmental impacts associated with the in-water structures, as well as concerns with the floodwalls proposed on land bisecting communities. Additional concerns focused more generally on the need for more natural and nature-based solutions for managing coastal storm risk, including recommendations for the use of hybrid reef structures, mangroves, and breakwater structures.

Following the restart of the study in August 2022, the frequency of public involvement efforts expanded to generate increased awareness and interest from the public on the study. The United States Army Corps of Engineers (USACE) Norfolk District (NAO) and Miami-Dade County hosted a virtual public information meeting on October 12, 2022, following a restart of the study. During this meeting, public input was requested. **Table 10-3** identifies public meetings and stakeholder engagement opportunities from August 2022 to the present. Although members of the public may have attended all the meetings listed in **Table 10-3**, public information meetings on the study hosted by NAO and Miami-Dade County for the general public are highlighted. Communication tools to inform the public regarding upcoming meetings include Miami-Dade County Office of Resilience's email newsletter, announcements on the study's webpage, NAO's stakeholder distribution list, and social media posts on Facebook and Instagram. Translators were available to translate in Spanish and Haitian Creole for the duration of the virtual public information meetings held on June 26, 2023, August 23, 2023, March 21, 2024, and both meetings held in May 2024.

Table 10-3. Stakeholder and Public Engagement Opportunities Since August 2022

Meeting Type	Date	Type	Primary Attendees
City of Miami Briefing	October 6, 2022	Virtual	Locality
Public Information Meeting	October 12, 2022	Virtual	Public
Information Meeting	October 20, 2022	Virtual	Cutler Bay City Council
Watershed Management Board	October 25, 2022	Virtual	Board Members
Miami Shores Town Council	November 1, 2022	Virtual	Council Members
Planning Charrette #1	November 14–18, 2022	In Person	Stakeholders
Open House Public Meeting	November 14, 2022	In Person	Public
Information Meeting	January 17, 2023	Virtual	Advocacy Groups
Public Information Meeting	February 23, 2023	Virtual	Public
Planning Charrette #2	March 1–3, 2023	In Person	Stakeholders
Public Information Meeting	June 26, 2023	Virtual	Public
Public Information Meeting	August 23, 2023	Virtual	Public
Public Information Meeting	August 29, 2023	Virtual	Public
Public Information Meeting	March 21, 2024	Virtual	Public
Public Information Meeting	May 2, 2024	In Person	Public
Public Information Meeting	May 7, 2024	Virtual	Public

10.2.2 Agency Coordination

USACE and Miami-Dade County have also expanded interagency coordination efforts since August 2022. A virtual interagency meeting was held on September 15, 2022, and within the first 90 days following study restart. The purpose of the meeting was to provide critical study updates and present the path forward for the first 12 months of the study. The meeting was well attended with 58 individuals present, including USACE and Miami-Dade County staff. Interagency meetings have since been held approximately bimonthly to provide consistent updates on the study. **Table 10-4** documents interagency meeting dates held since August 2022. As cooperating agencies, National Marine Fisheries Service (NMFS), United States Environmental Protection Agency (USEPA), and Florida Department of Transportation (FDOT) have consistently participated in the interagency meetings alongside other participating agencies. Fish and Wildlife Coordination Act (FWCA) requirements were completed as documented in the USFWS letter dated June 4, 2021, which addressed floodproofing of critical infrastructure throughout Miami-Dade County and nonstructural measures and remains applicable to the scope of the study for this report.

Table 10-4. Planning Charrettes and Interagency Meetings Since August 2022

Meeting Type	Date	Type	Primary Attendees
Interagency Meeting	September 15, 2022	Virtual	Resource agencies, localities, tribes
Interagency Meeting	October 20, 2022	Virtual	Resource agencies, localities, tribes
Planning Charrette #1	November 14–18, 2022	In Person	Stakeholders, including agencies
Interagency Meeting	December 8, 2022	Virtual	Resource agencies, localities, tribes
Interagency Meeting	January 26, 2023	Virtual	Resource agencies, localities, tribes
Planning Charrette #2	March 1–3, 2023	In Person	Stakeholders, including agencies
Interagency Meeting	March 16, 2023	Virtual	Resource agencies, localities, tribes
Interagency Meeting	May 18, 2023	Virtual	Resource agencies, localities, tribes
Interagency Meeting	August 31, 2023	Virtual	Resource agencies, localities, tribes
Interagency Meeting	November 2, 2023	Virtual	Resource agencies, localities, tribes
Interagency Meeting	November 2, 2023	Virtual	Resource agencies, localities, tribes
Interagency Meeting	December 9, 2023	Virtual	Resource agencies, localities, tribes
Interagency Meeting	February 8, 2023	Virtual	Resource agencies, localities, tribes
Interagency Meeting	May 7, 2024	Virtual	Resource agencies, localities, tribes

10.2.3 Tribal Consultation

Scoping with tribes was initiated in the original three-year study by letter on November 20, 2018, inviting the Miccosukee Indian Tribe, the Seminole Tribe of Florida, and the Seminole Nation of Oklahoma to participate in NEPA scoping and to attend the public scoping meeting for the study; no responses were received. In October 2019, coordination letters for Programmatic Agreement (PA) development were sent to tribal governments. In 2020, it was decided to apply the existing PA used by USACE Jacksonville District for Operations, Navigation, and Shore Protection Programs and in coordination with the Florida State Historic Preservation Officer, the Bureau of Ocean Energy Management, and the Advisory Council on Historic Preservation. The PA was executed in April 2021, but no tribes elected to sign the PA as concurring parties. Tribes have continued to be included as consulting parties in the Section 106 process for the project. Notice of the availability of the initial Draft Miami-Dade County Integrated Feasibility Report/ Environmental Impact Statement (IFR/EIS) was sent to the tribes on June 5, 2020. Coordination letters for the PA were sent to tribal governments in August 2020 and January and April 2021. Tribes were also invited to interagency and public meetings as well as charrettes listed in **Table 10-5**. The USACE also updated the tribes on the status of the project and estimated report release by letter in April 2024. Appendix A-3 includes documentation of tribal consultation and the PA.

Table 10-5. Tribal Coordination

Letter/Email Type	Date	Tribe
NEPA Scoping	November 20, 2018	Miccosukee Indian Tribe, Seminole Tribe of Florida, The Seminole Nation of Oklahoma
Draft PA	October 2, 2019	Miccosukee Indian Tribe, Muscogee Nation, Seminole Tribe of Florida, The Seminole Nation of Oklahoma, Thlopthlocco Tribal Town
Draft IFR/EIS Release	June 5, 2020	Miccosukee Indian Tribe, Seminole Tribe of Florida, The Seminole Nation of Oklahoma, Thlopthlocco Tribal Town
Draft PA	August 27, 2020	Miccosukee Indian Tribe, Muscogee Nation, Seminole Tribe of Florida, The Seminole Nation of Oklahoma, Thlopthlocco Tribal Town
PA Switch to USACE Jacksonville District	January 29, 2021	Seminole Tribe of Florida, The Seminole Nation of Oklahoma
Draft PA Notice	April 20, 2021	Seminole Tribe of Florida, The Seminole Nation of Oklahoma
Interagency, Public Meeting, and Charrette Notices	Prior to all meetings listed in Table 10-5	Miccosukee Indian Tribe, Seminole Tribe of Florida, The Seminole Nation of Oklahoma
Project Updates	October 7, 2022	Miccosukee Indian Tribe, Seminole Tribe of Florida, The Seminole Nation of Oklahoma
Project Updates	April 2024	Miccosukee Indian Tribe, Seminole Tribe of Florida, The Seminole Nation of Oklahoma

10.2.4 Public Comments Received

Following the restart of the study in August 2022, a public crowdsourcing reporter tool was created online to provide an electronic platform for all stakeholders, including the general public, to submit comments on the study. The tool was announced during the virtual public meeting held on October 12, 2022. Comments were geo-referenced to a specific location identified by each individual commenter. General comment themes include the following considerations: SFWMD's canal structures as opportunities for use as flood barriers, the need for septic to sewer conversions, the use of temporary barriers to protect vulnerable coastal areas, open space and park areas to serve as stormwater retention areas, the use of

natural and nature-based features to reduce storm surge, and meaningful and intentional community engagement. Appendix A-6 includes a copy of all informal comments received from October 2022 to March 2024. Additionally, Appendix A-6 contains the formal comments received during the NEPA public comment period for the Draft IFR/EA that closed on May 31, 2024, along with agency responses.

10.2.5 Future Public Engagement

Public engagement will continue to remain a priority in the future. As the study continues, public engagement opportunities will be expanded to include outreach to underserved communities within the focus areas included in this Final Report. The USACE and Miami-Dade County have initiated conversations on future community engagement efforts that would be anticipated to occur within the broader context of other resilience efforts, local initiatives, and other USACE projects. The USACE and Miami-Dade County intend to host engagement opportunities for communities within the focus areas following project authorization in WRDA 2024. Additionally, these engagements will serve as the first steps towards implementing a community outreach program to keep residents in underserved communities informed of the process associated with implementation of nonstructural measures, including home elevations. These engagement opportunities will also seek meaningful feedback from community members and residents that will inform the study as it moves forward with additional analyses beyond WRDA 2024. Additionally, public comments received on the Draft Report recommended a nonstructural program working group be established comprised of members from diverse backgrounds to ensure the effectiveness and equity of the project's implementation. The USACE and Miami-Dade County will further consider this request and explore the potential opportunity to establish a nonstructural program working group in the future.

11 DISTRICT ENGINEER RECOMMENDATIONS

I recommend that the coastal storm risk management (CSRM) project, as described in this report for the Miami-Dade Back Bay CSRM Feasibility Study, be authorized in accordance with the reporting officers' Recommended Plan, with such modifications as in the discretion of the Chief of Engineers may be advisable. Consistent with the United States Army Corps of Engineers (USACE) Headquarters study guidance dated December 5, 2023, and included in Appendix A-8, the recommendations included in this report are complete recommendations but serve as an interim response to the study authority. This means that further feasibility analyses supporting additional and separable risk management solutions, using the existing study authority and remaining/approved study funding via the Bipartisan Budget Act of 2018, will continue after signature of this Chief's Report. Per the study guidance, these analyses will contribute to development of a Comprehensive Study Framework, described in further detail in Section 2 of this report, and future Chief's Reports for potential Water Resources Development Act (WRDA) authorizations in 2026 and/or 2028. Any Chief's Reports that are developed beyond the current Chief's Report for WRDA 2024 will comply with the National Environmental Policy Act (NEPA) and recommend actions with independent utility from those recommended in this report.

Recommended Plan:

- Elevation of 2,057 Residential Buildings;
- Floodproofing of 403 Nonresidential Buildings; and
- Floodproofing of 27 Critical Infrastructure Facilities.

I also recommend, because of the complexity and challenges outlined in the Integrated Feasibility Report and Environmental Assessment (IFR/EA), the authorization of two programs as described in Sections 5 and 6 of this report.

Authorization of Programs

- Nature-Based Solutions Pilot Program with requested total programmatic cost limit of $200 million
- Nonstructural Program with requested programmatic study cost of $6 million

In making the following recommendations, I have considered all significant aspects in the overall public interest, including environmental, social, and economic effects, engineering feasibility, and compatibility of the project with the policies, desires, and capabilities of Miami-Dade County and other nonfederal interests. Federal implementation of the project for CSRM includes, but is not limited to, the following required items of local cooperation to be undertaken by the nonfederal sponsor in accordance with applicable federal laws, regulations, and policies:

a. Provide 35 percent of construction costs, as further specified below:

   1. Provide, during design, 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

   2. Provide all real property interests, including placement area improvements, and perform all relocations determined by the federal government to be required for the project;

3. Provide, during construction, any additional contribution necessary to make its total contribution equal to at least 35 percent of construction costs;

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the level of coastal storm risk management the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Inform affected interests, at least yearly, of the extent of risk management afforded by the project; participate in and comply with applicable federal floodplain management and flood insurance programs; prepare a floodplain management plan for the project to be implemented not later than one year after completion of construction of the project; and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with the project;

d. Operate, maintain, repair, rehabilitate, and replace the project or functional portion thereof at no cost to the federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal laws and regulations and any specific directions prescribed by the federal government;

e. Give the federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the nonfederal sponsor owns or controls for access to the project to inspect the project, and, if necessary, to undertake work necessary to the proper functioning of the project for its authorized purpose;

f. Hold and save the federal government free from all damages arising from design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project, except for damages due to the fault or negligence of the federal government or its contractors;

g. Perform, or ensure performance of, any investigations for Hazardous, Toxic, and Radioactive Wastes (HTRW) that are determined necessary to identify the existence and extent of any HTRW regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 United States Code (U.S.C.) 9601 et seq or any other applicable law, that may exist in, on, or under real property interests that the federal government determines to be necessary for construction, operation, and maintenance of the project;

h. Agree, as between the federal government and the nonfederal sponsor, to be solely responsible for the performance and costs of cleanup and response of any HTRW regulated under applicable law that are located in, on, or under real property interests required for construction, operation, and maintenance of the project, including the costs of any studies and investigations necessary to determine an appropriate response to the contamination, without reimbursement or credit by the federal government;

i. Agree, as between the federal government and the nonfederal sponsor, that the nonfederal sponsor shall be considered the owner and operator of the project for the purpose of liability pursuant to CERCLA or other applicable law, and to the maximum extent practicable shall carry out its responsibilities in a manner that will not cause HTRW liability to arise under applicable law; and

j. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4630 and 4655), and the Uniform Regulations contained in 49 Code of Federal Regulations (CFR) Part 24, in acquiring real

property interests necessary for construction, operation, and maintenance of the project, including those necessary for relocations, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the executive branch. Consequently, the recommendations may be modified before they are transmitted to higher authority as proposals for authorization and implementation funding. However, prior to transmittal to higher authority, the sponsor, the states, interested federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Date: _____ _____

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12 LIST OF REPORT PREPARERS

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Faraz Ahmed, CFM	Plan Formulation	ME, Civil Engineering	10
Michelle Hamor	Plan Formulation	BS, Civil Engineering	31
Nicole Miller	Plan Formulation	MS, Urban and Regional Planning	4
Idris Dobbs	Economics	BS, Economics	15
Zach Martin	Environmental Analysis	MS, Zoology	16
Susan Miller, RPA	Cultural Resources	MA, Anthropology	43
Jenny Palacio	Economics	MS, Mathematics and Statistics	3
Abbegail Preddy	Project Manager	BS, Biological Systems Engineering	6
Miranda Ryan	Environmental Analysis	BS, Biology	8
Norman Thomas	Real Estate	Associate Broker License Virginia	4
Courtney Colwell	Real Estate	MS, Coastal Environmental Management	14
Kevin White	GIS Mapping	BS, Geography	5
Robin Williams, PE	Hydraulics and Hydrology Engineering	BS, Civil Engineering	32
Justine Woodward	Environmental Analysis	MS, Marine Science	11
Tim Gysan, PMP, PE	Project Integration	MS, Environmental Engineering	24
John Everett	Counsel	Juris Doctor	16
Hannah Fox	Counsel	Juris Doctor	1
CDM Smith (USACE Consultant)			
Miami-Dade County			
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Christian Kamrath	Project Planning	MS, City and Regional Planning	9
Martina Potlach	Nature-Based Solutions	MS, Landscape Architecture	3
Moffat & Nichol (Miami-Dade County Consultant)			
Lynette Cardoch	Input for Project Planning	PhD, Oceanography and Coastal Sciences	30
Jeff Morris	Input for Project Planning	MA, Environmental and Natural Resources Economics	33

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