COVER SHEET
Florida Keys Coastal Storm Risk Management Study
Draft Integrated Feasibility Report and
Environmental Impact Statement
Monroe County, Florida

LEAD AGENCY:
Department of the Army
U.S. Army Corps of Engineers, Norfolk District

COOPERATING AGENCIES:
U.S. Environmental Protection Agency, Region 4; Florida Keys National Marine Sanctuary; National Oceanic and Atmospheric Administration Protected Resources Division, Florida Department of Transportation

ABSTRACT:
The U.S. Army Corps of Engineers (USACE), Norfolk District and Monroe County propose to implement structural and non-structural measures to manage coastal storm risk in the Florida Keys, Florida. Without a plan to promote resiliency and reduce the risks of coastal storm damage, the County will continue to be vulnerable to coastal storm damage. The USACE has prepared a Draft Environmental Impact Statement (EIS) to evaluate potential impacts of the proposed action in accordance with the requirements of the National Environmental Policy Act of 1969, as amended, implementing regulations of the NEPA, 40 Code of Federal Regulations 1500-1508, and other applicable state and federal laws and USACE policies. Four alternatives, including a Structural Only Alternative, a Nonstructural Only Alternative, a Combination Alternative, and the No Action/Future Without Project Alternative, were fully evaluated to determine the potential environmental, cultural, and socioeconomic impacts resulting from the proposed action. Resource areas evaluated in the EIS include: land use and land cover, socioeconomics, transportation, water resources, wetlands, floodplains, special status species, wildlife, terrestrial habitat and vegetation, geology and soils, air quality, noise, recreation, utilities, aesthetics and visual resources, and cultural resources. Potential impacts are described in the EIS.

All comments concerning this EIS are required to be submitted by 10 August 2020.

For further information and to submit comments, please contact the U.S. Army Corps of Engineers, Norfolk District:

U.S. Army Corps of Engineers, Norfolk District
803 Front Street
Norfolk, Virginia 23510
Attention: Kathy Perdue
(757) 201-7218
FloridakeysCSRM@usace.army.mil.

Florida Keys Coastal Storm Risk Management Feasibility Study

Monroe County, Florida

Draft Integrated Feasibility Report and Environmental Impact Statement

June, 2020

US Army Corps of Engineers ®
Norfolk District

EXECUTIVE SUMMARY

This draft integrated feasibility report and environmental impact statement documents the findings of the Florida Keys Coastal Storm Risk Management Study to date.

The Florida Keys are an important asset to the economic development of the United States because the islands are a major tourism destination that also hold unique environmental resources including the third largest coral reef in the world and 17 national and state parks. There is Federal interest in addressing the Keys' high levels of risk and vulnerability to coastal storms which are expected to be compounded by the combined effects of sea level change and climate change. The vulnerability of the Florida Keys to coastal storms was most recently exemplified by the significant damage sustained by Hurricane Irma in 2017.

States and territories with more than one flood-related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017 qualified for supplemental investigation funds for the initiation and completion of authorized flood and storm damage reduction studies appropriated by Public Law 115-123. High-priority studies were provided supplemental funding in 33 states and three territories which met the criteria due to impacts from Hurricanes Harvey, Irma, and Maria. Florida is one of the 33 states and the Florida Keys Coastal Storm Risk Management Study is one of 14 CSRM studies being conducted with supplemental funds in the State of Florida.

The purpose of the Florida Keys CSRM Study is to evaluate coastal storm risk and recommend a project for implementation that would reduce that risk throughout the study area. The study authority limits the study analysis to the effects of coastal storms that impact the Florida Keys. This includes storm surge with consideration for wave attack, erosion, and sea level change in the estimates of inundation and how it is expected to damage infrastructure. This study did not formulate plans to address the impacts of general sea level rise that is often referred to as "sunny day flooding" or precipitation. Direct effects of wind associated with coastal storms were also not considered in the development of alternatives. Due to the limitations of the study, this project is not an all-encompassing solution that would address all of the coastal storm risk in the Keys, but it is one important component of the larger effort by the non-federal sponsor, Monroe County, as well as municipalities, local organizations, and state and federal government agencies that are all working to reduce risk and improve resiliency in the Florida Keys. This study seeks to not only reduce coastal storm risk, but also build on resilience by implementing strategic approaches that are compatible with the work of others.

The tentatively selected plan (TSP) recommended herein includes the following measures to reduce coastal storm risk and damage throughout the Florida Keys:

- Shoreline stabilization in six different locations along U.S. Route 1 (Overseas Highway) that were identified as having risk of damage due to erosion and/or wave energy during a storm event. These six rock revetment structures range in height from five to seven feet and were designed to reduce damage to a total of approximately 5,500 feet of

roadway by stabilizing the shoreline and reducing the risk of washout.

- Dry floodproofing 47 critical infrastructure buildings that were identified at risk to damage from coastal storms. Dry floodproofing will reduce the damage caused by storm surge during storm events so that emergency and critical services can resume more quickly after a storm event.
- Nonstructural measures to reduce coastal storm damage to approximately 7,400 residential and 3,800 nonresidential structures at risk throughout the Keys. Nonstructural measures are applied to a structure to reduce damage from flooding, which in the Keys would be caused by storm surge. The nonstructural measures recommended in the TSP include elevation and acquisition of residential structures and dry floodproofing of nonresidential structures.

For the structures recommended for elevation and floodproofing in the TSP, property owners may decide to participate in the project (or not) because the implementation of those nonstructural measures is completely voluntary. However, current USACE policy (Planning Bulletin 2019-03) requires the use of eminent domain to be retained, if necessary, for acquisition, relocation, and evacuation if such nonstructural features are included in the recommended plan. Monroe County has made it clear to USACE that they would not support the recommendation of any plan that includes mandatory acquisition. The county would like for participation in acquisition to be made voluntary as it is for floodproofing and elevation, so they have submitted a request to USACE for a waiver to the current policy that requires mandatory acquisition through the use of eminent domain. If their request for a waiver from the policy that requires the use of eminent domain for acquisition is denied, then Monroe County has stated that they would opt to move forward with a locally preferred plan (LPP) that does not include acquisition. Therefore, at the end of this study, the recommended plan will not include mandatory acquisition. The acquisition will remain in the plan if a policy waiver is granted to allow for voluntary participation in acquisition and if a waiver is not granted, a LPP that does not include acquisition will be requested by Monroe County.

The National Economic Development (NED) benefits generated by the TSP are expected to exceed the estimated project costs. The relationship between benefits and costs is expressed as a benefit cost ratio (BCR) as shown in Table 1. The TSP first cost and total project cost are estimated to be $5.5 billion and $6.5 billion respectively. Project First Cost is the constant dollar cost of the TSP at current price levels and is the cost used in the authorizing document for a project. Total Project Cost is the constant dollar fully funded with escalation to the estimated midpoint of construction. Total Project Cost is the cost estimate used in Project Partnership Agreements for implementation of design and construction of a project. Total Project Cost is the cost estimate provided to the non-federal sponsor for their use in financial planning as it provides information regarding the overall non-Federal cost sharing obligation. The non-federal costs include the value of lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs). Total LERRDs are estimated to be $183,407,000. The Project First Cost and Total Project Cost are shown below in Table 2 and Table 3 respectively.

Table 1. Project Benefits and Costs

Annual Benefits (1,000's)	Project First Costs (1,000's)	Annual O&M Costs (1,000's)	Total Average Annual Costs (1,000's)	Annual Net Benefits (1,000's)	BCR
$364,084	$5,537,351	$301	$217,703	$146,381	1.7

Table 2. First Cost Apportionment Table

	Federal (65%)	Non-Federal (35%)	Total
Initial Project Cost	$3,599,287,800	$1,938,072,850	$5,537,351,000
LERRD Credit	$0	$161,793,000	$161,793,000
Cash Contribution	$3,599,287,800	$1,776,279,850	$5,375,558,000

Table 3. Total Project Cost Apportionment Table

	Federal (65%)	Non-Federal (35%)	Total
Initial Project Cost	$4,213,847,300	$2,268,994,700	$6,482,842,000
LERRD Credit	$0	$183,407,000	$183,407,000
Cash Contribution	$4,213,847,300	$2,085,587,700	$6,299,435,000

Environmental Impacts and Mitgation

A public scoping meeting and several follow up public meetings were held throughout the study process. Cooperating agencies were invited to participate in the development of this draft Environmental Impact Statement (EIS); and consulting parties were invited to participate in the development of a Programmatic Agreement to address historic resources. Interagency coordination of the EIS occurred throughout the study process, and is still ongoing.

There will be direct and indirect, temporary and permanent adverse effects on land use and socioeconomics that are moderate to significant. These effects include both adverse and beneficial effects, depending on perspective, for approximately 300 residences affected by acquisition, demolition, and relocation. Some residents may not desire to relocate, and acquisition also could disrupt communities. There are approximately 7,100 elevations of residences. Both acquisition and elevation could present a potentially significant temporary and permanent hardship for the low income families, minorities, disabled and the elderly. However, the Proposed Action would also allow those affected by repetitive damage the benefit of relocating to comparable areas less subject to flood damage associated with coastal storms. There would be significant beneficial effects for those receiving elevations or floodproofing. Significant and beneficial temporary and permanent effects due to protection of structures in the flood plain are expected. The Study Area includes areas subject to the Coastal Barrier Resources Act (CBRA), which is regulated by the U.S. Fish and Wildlife Service (USFWS), and establishes unit areas and specifies for those areas certain restrictions on federal involvement in the development and/or improvements to buildings. However, no structural or nonstructural measures will be within the restricted map units per CBRA. The Proposed Action also will

adhere to Executive Order 11988, which requires the federal government to avoid long and short term adverse effects on flood plains.

Permanent direct and indirect moderately beneficial transportation, safety, and socioeconomic effects would result from the protection of vulnerable sections of U.S. Route 1 from erosional damage due to coastal storms. Minor temporary impacts for these would occur during construction. There would be permanent, moderate benefits because flood warning systems, land use planning, and emergency planning would help residents evacuate more effectively, orderly, and safely, reducing direct impacts on the traveling public.

There would be significant permanent adverse effects to any National Register of Historic Places (NRHP) eligible buildings that are subject to buyout/demolition and/or elevation; these impacts would be primarily in the NRHP listed Key West Historic District. The most severe adverse effects would be from buyout/demolition. At the proposed revetment locations, there are potential indirect and direct, temporary and permanent adverse effects on two recorded sites; however National Register of Historic Places eligibility has not yet been determined for either site. Coordination pursuant to the National Historic Preservation Act (NHPA) is ongoing with the Florida State Preservation Officer (SHPO), Seminole Tribe of Florida, Miccosukee Tribe, the Seminole Nation of Oklahoma, and the Monroe County Historic Preservation Commission. A Draft Programmatic Agreement has been prepared to address adverse effects and mitigation and is included in Appendix E, Cultural Resources.

Moderate to potentially significant permanent temporary and adverse effects on threatened and endangered species are anticipated, due to modifications of up to 0.5 acre of American crocodile critical habitat, approximately 0.5 acre of Cape Sable thoroughwort critical habitat, and approximately 0.25 acre of loggerhead sea turtle critical habitat, including turtle nesting areas. A Biological Assessment has been prepared and is included in the Environmental Appendix. Pursuant to Section 7 of the Endangered Species Act (ESA), the U.S. Army Corps of Engineers (USACE) initiated formal consultation with the USFWS on April 30, 2020, to address adverse effects and reasonable and prudent measures with respect to these species. Coordination pursuant to the Fish and Wildlife Coordination Act (FWCA) is also ongoing.

Permanent and temporary moderate adverse effects on land use, recreation, beaches, and upland nearshore vegetation would result from the proposed revetment approximately 1,500 linear feet along a narrow section of Long Key beach, in Long Key State Park shoreline, near its campground facility. Impacts on vegetated dune areas will be mitigated with a planting plan suitable to park management. In addition, there would be temporary, direct and indirect, adverse effects on the use of sections of the Overseas Trail, the public pier at Fiesta Key, Long Key State Park campground roadway, and Indian Key Fill beach access area, during an approximately four to five month construction window. However, there would be permanent beneficial effects due to erosion protection.

There are no known hazardous materials locations with the proposed revetment areas. However Phase 1 Environmental Site Assessments would be needed for the demolition or

elevation of any affected structure constructed prior to 1978, with respect to asbestos-containing materials (ACM), lead-based paint (LBP), and polychlorinated biphenyls (PCBs). If any such contaminants are found, lawful demolition, removal, and disposal of such wastes would be followed.

There would be direct, permanent adverse impacts on approximately 10,250 square feet of sea purslane and sea oxeye-dominated herbaceous wetlands at West Summerland Key. Approximately 100-200 square feet of scrub/shrub wetlands are present at the proposed revetment site as well; however it is anticipated that they would be avoided. Permanent wetland impacts would be mitigated, and thus would be minor. There would be direct and indirect, minor effects on hydrology, hydraulics, and bathymetry, wildlife, soils, and aesthetics. There will be minor to negligible impacts on geology and soils. Strict erosion and sediment control measures would be employed during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version).
There would be no or negligible direct or indirect effect on marine mammals, essential fish habitat (EFH) or fisheries, benthics, submerged aquatic vegetation (SAV), water quality or navigation, because there will be no impacts on subaqueous bottom. This project would have negligible temporary effects on air quality during construction due to emissions, and negligible permanent effects are anticipated. However, if in-water natural and nature based features (NNBFs) are found to feasible as part of the Proposed Action, then this finding will be modified.

Minor temporary impacts during construction for transportation, land use, noise, aesthetics, wildlife, recreation, and utilities. Construction equipment will be visible at almost all locations, and would create temporary noise and disturbance to wildlife and the public during construction. However, overall, the permanent effects on land use, recreation, transportation, safety, noise, and utilities are expected to be minimally adverse to mostly beneficial, because these resources would be enhanced through coastal storm risk management.

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ACRONYMS

ACM – Asbestos Containing Materials

ADCIRC – Advanced Circulation Model

ADM – Agency Decision Milestone

ASA(CW) – Assistant Secretary of the Army for Civil Works

BCE – Before the Common Era (replaces B.C.)

BCR – Benefit-to-cost ratio

BFE – Base Flood Elevation

CAA – Clean Air Act

CBRA – Coastal Barrier Resources Act

CBRA – Coastal Barrier Resources System

CCCL – Coastal Construction Control Line

CE – Common Era (replaces A.D.)

CERCLA – Comprehensive Environmental Response, Compensation and Liability Information System

CRS – Community Rating System

CSRM – Coastal Storm Risk Management

CWA – Clean Water Act

CZMA – Coastal Zone Management Act

DEM – Digital Elevation Model

DERM – Division of Environmental Resource Management

DO – Dissolved Oxygen

DPR – Florida Department of Environmental Protection, Division of Parks and Recreation

EIS – Environmental Impact Statement

EFH – Essential Fish Habitat

EO – Executive Order

EQ – Environmental Quality

ER – Engineering Regulation

ESA – Endangered Species Act

ESI – Environmental Sensitivity Index

FAAS – Focus Area Action Strategies

FAC – Florida Administrative Code

FCSA – Feasibility Cost Sharing Agreement

FDEP – Florida Department of Environmental Protection

FDOT – Federal Department of Transportation

FEMA – Federal Emergency Management Agency

FIRM – Flood Insurance Rate Map

FIS – Flood Insurance Study

FKAA – Florida Keys Aqueduct Authority

FKEC – Florida Keys Electric Cooperative

FLKNMS – Florida Keys National Marine Sanctuary

FLMP – Florida Coastal Management Program

FMPA – Florida Municipal Power Agency

FONSI – Finding of No Significant Impact

FPL – Florida Power and Light

FWCAR – Fish and Wildlife Coordination Act Report

G2CRM – Generation II Coastal Risk Model

GIS – Geographic Information System

H & H – Hydrology and Hydraulics

HAPC – Habitat Areas of Particular Concern

JD – Jurisdictional Determination

KEYS – Keys Energy Services

LBP – Lead Based Paint

LERRD – Lands, Easements, Rights-of-Way, Relocations, and Disposal

LIDAR – Light Detection and Ranging

LPP – Locally Preferred Plan

MA – Model Area

MBTA – Migratory Bird Treaty Act

MHI – Median Household Income

MHW – Mean High Water

MSFCMA – Magnuson-Stevens Fishery Conservation and Management Act

MSL – Mean Sea Level

NAAQS – National Ambient Air Quality Standards

NACCS – North Atlantic Coast Comprehensive Study

NAD – North Atlantic Division

NAVD88 – North American Vertical Datum of 1988

NCA – Noise Control Act

NED – National Economic Development

NEPA – National Environmental Policy Act

NFIP – National Flood Insurance Program

NFS – Non-Federal Sponsor

NHPA – National Historic Preservation Act

NMFS – National Marine Fisheries Service

NNBF – Natural and Nature-Based Features

NOAA – National Oceanographic and Atmospheric Administration

NPDES – National Pollutant Discharge Elimination System

NPL – National Priorities List

NRHP – National Register of Historic Places

NWI – National Wetlands Inventory Project

OFW – Outstanding Florida Waters

OPA – Otherwise Protected Area

OSE – Other Social Effects

OSHA – Occupational Safety and Health Administration

PCB – Polychlorinated Biphenyls

PDRS – Post-Disaster Recovery Strategy

PDT – Project Delivery Team

PED – Preconstruction Engineering and Design

RCRA – Resource Conservation and Recovery Act

RED – Regional Economic Development

RER - Regulatory and Economic Resources

ROGO – Rate of Growth Ordinance

ROI – Region of Influence

RSLR – Relative Sea Level Rise

RSM – Regional Sediment Management

SACS – South Atlantic Coastal Study

SAD – South Atlantic Division

SAFMC – South Atlantic Fisheries Management Council

SAV – Submerged Aquatic Vegetation

SFWMD – South Florida Water Management District

SHPO – State Historic Preservation Office

SIP – State Implementation Plan

SLC – Sea Level Change

SLR – Sea Level Rise

TMDL – Total Maximum Daily Load

TSP – Tentatively Selected Plan

TSS – Total Suspended Solids

URA – Uniform Relocation Assistance and Real Property Acquisition Act (1970)

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

WASD – Water and Sewer Department

WMA – Wildlife Management Area

WQPP – Water Quality Protection Program

WRDA – Water Resources Development Act

WSEL – Water Surface Elevation

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

The Florida Keys are an important asset to the economic development of the United States because the islands are a major tourism destination that also hold unique environmental resources including the third largest coral reef in the world and 17 national and state parks. There is Federal interest in addressing the Keys' high levels of risk and vulnerability to coastal storms which is expected to be compounded by the combined effects of sea level change and climate change. The vulnerability of the Florida Keys to coastal storms was most recently exemplified by the significant damage sustained by Hurricane Irma in 2017.

States and territories with more than one flood-related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017 qualified for supplemental investigation funds for the initiation and completion of authorized flood and storm damage reduction studies appropriated by Public Law 115-123. High-priority studies of projects were provided supplemental funding in thirty-three states and three territories which met the criteria due to impacts from Hurricanes Harvey, Irma, and Maria. Florida is one of the 33 states and the Florida Keys Coastal Storm Risk Management Study is one of 14 CSRM studies being conducted with supplemental funds in the State of Florida.

1.2 STUDY AREA

The study area includes all land and water resources reasonably deemed to be within the vicinity of the Florida Keys, a 123 mile long chain of islands extending into the Gulf of Mexico from the southern tip of mainland Florida, provided they are located entirely within the jurisdictional boundary of Monroe County, FL. A map of the study area is shown in Figure 1-1.

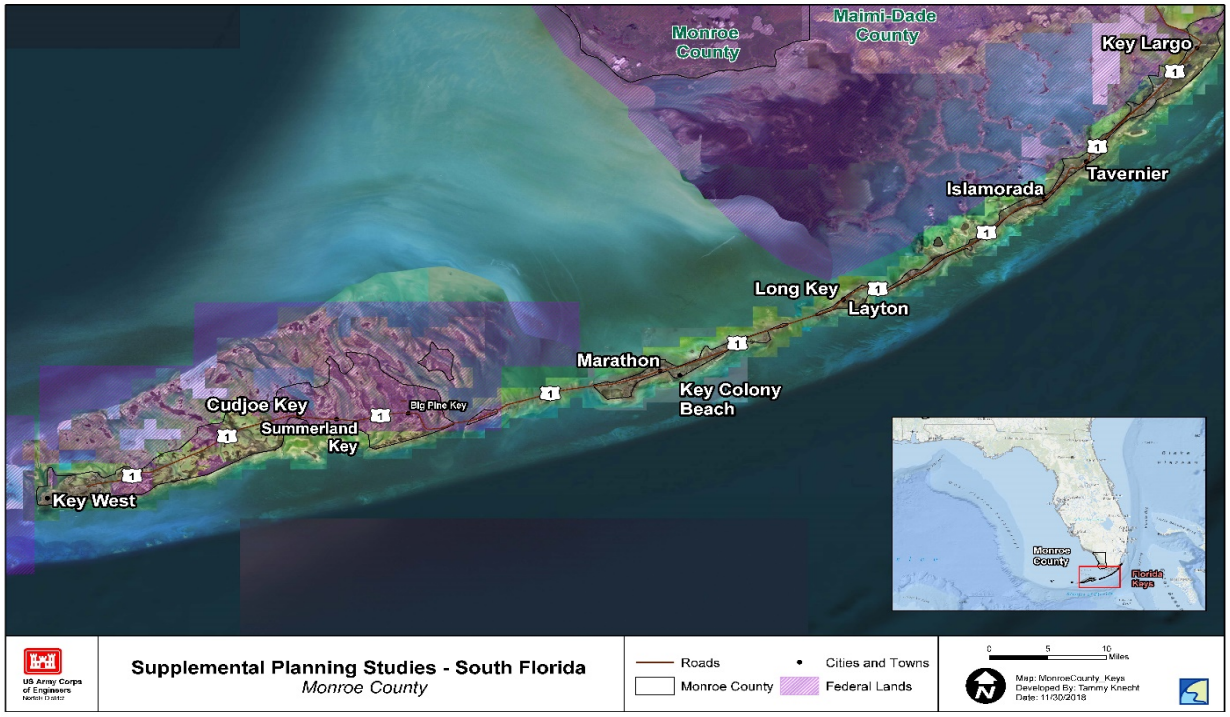

Figure 1-1: Study Area

1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

This study is needed to address the coastal storm risk that is inherent to the low lying chain of islands located in an area that regularly experiences significant coastal storm events such as hurricanes. As shown in Figure 1-2, the majority of the study area is within the 100 year floodplain as defined on the current flood insurance rate map (FIRM) The most severe hurricane to hit the Keys since the 1960's was Hurricane Irma, which made landfall as a category four storm. Irma destroyed or badly damaged more than 4,000 homes and 1,800 boats and left almost all homes and businesses without power, water, sewer, and phone service.

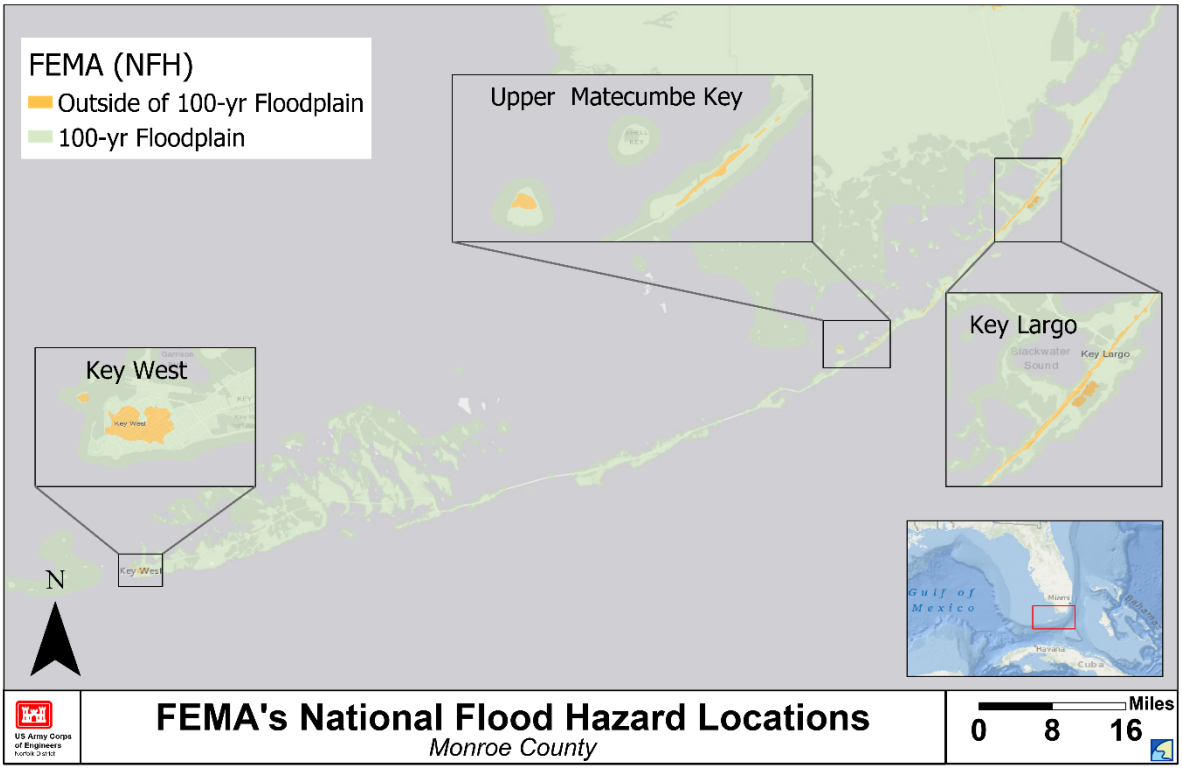

Figure 1-2: 100 Year Floodplain

1.4 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 particular reference to areas where severe damages have occurred from hurricanes.

Per the Assistant Secretary of the Army for Civil Works (ASA(CW)) memorandum dated 9 August 2018, Subject: Policy Guidance on Implementation of Supplemental Appropriations in the Bipartisan Budget Act of 2018, for feasibility studies (including General Reevaluation Studies), a new feasibility cost sharing agreement (FCSA) or an amendment to the existing FCSA is required to address use of Supplemental Investigations funds at 100 percent Federal expense. Additionally, this guidance states that studies funded by Public Law 115-123 will be undertaken in accordance with existing Civil Works policies and guidance and incorporate SMART Planning principles.

1.5 RISK INFORMED DECISION FRAMEWORK

This study is being completed using the USACE SMART Planning principles for civil works feasibility studies to ensure that the study results in a recommendation that is Specific, Measurable, Attainable, Risk informed, and Timely (SMART). USACE has adopted a risk informed planning initiative in support of the SMART Planning principle that requires study teams to balance the level of uncertainty and risk regarding level of detail of the study with the

understanding that the level of detail required to make planning decisions increases over the course of the study. The USACE planning process has always been iterative, with teams repeating certain steps of the planning process as needed throughout the study. However, under risk informed planning, the need for multiple iterations of the entire planning process is emphasized, with the intent that the quality and quantity of information and analysis should increase with each iteration of the complete planning process. As the quantity and quality of the data used in the study analyses increases, the amount of uncertainty surrounding planning decisions should decrease with each iteration. Throughout the planning process, which is pictured in Figure 1-3, study teams are constantly identifying risk and uncertainty and then deciding which ones must be reduced or eliminated in order to make good planning decisions that will result in the selection of a plan with an acceptable level of risk and uncertainty.

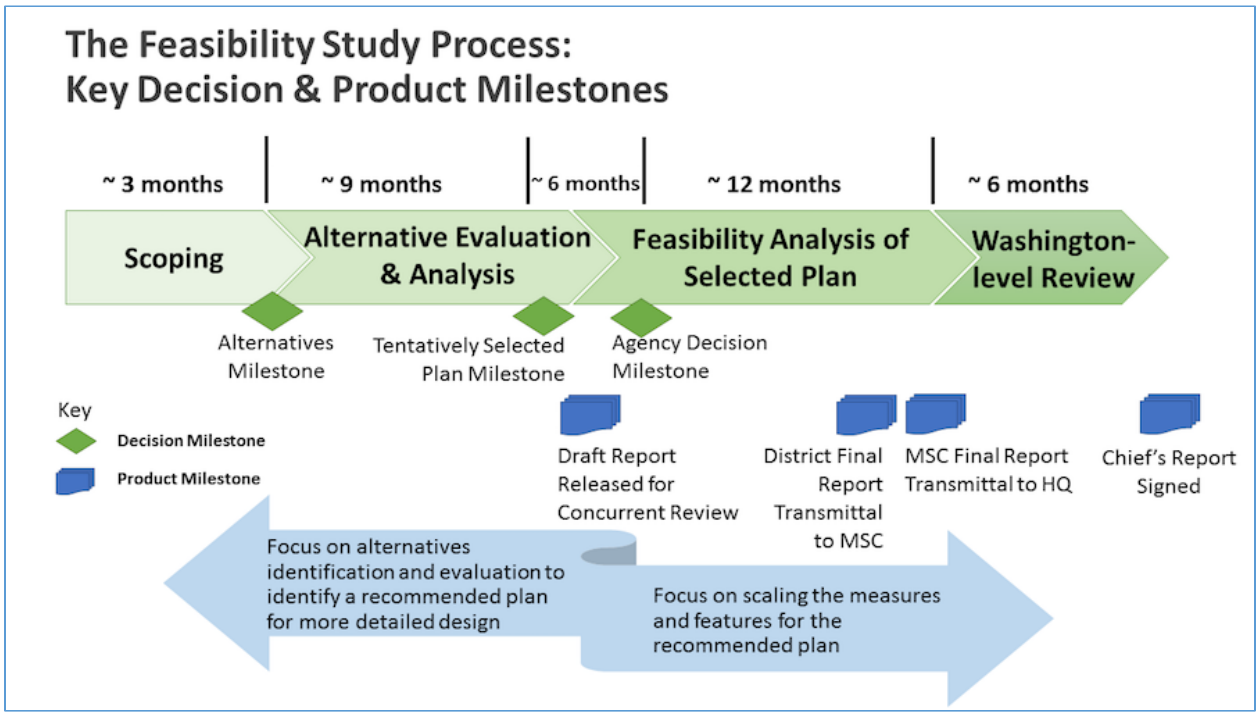

Figure 1-3: SMART Planning Process

Once the study is complete and the plan recommended to Congress in the Chief's Report has been authorized into law, additional and more detailed analysis will be completed prior to implementation of the project during the Preconstruction Engineering and Design (PED) phase. During PED, the approximately 35 percent design developed during the study phase will be refined so that plans and specifications can be completed for project implementation. Table 10-3 in this report shows the draft implementation schedule.

1.6 STORM DAMAGE HISTORY

During the past 100 years, the county has been impacted by 6 major tropical events. The tidal surges associated with these storm events inundated structures and caused coastal erosion. Table 1-1 below shows the water levels in Monroe County from historic storms.

Table 1-1: Historical Storm Events.

	Storm Event Name	Date	Peak Water Surface Elevations NAVD 88 (in feet)	Rainfall (in inches) measured from Key West International Airport
1	Unnamed Hurricane	September 20-22, 1948	1.27	8.03
2	Hurricane Betsy	September 8, 1965	1.87	3.90
3	Hurricane Andrew	August 23-24, 1992	1.27	0.60
4	Hurricane Irene	October 14-15,1999	1.01	8.59
5	Hurricane Wilma	October 23-24, 2005	5.43	2.02
6	Hurricane Irma	September 9-11,2017	2.19	5.70

Hurricane Irene

Hurricane Irene made landfall in the lower Keys as a Category 1 Hurricane (74-95mph). Wind gusts were reported on Big Pine Key at 100miles per hour (mph). The storm was called a “major rainmaker” by the National Hurricane Center.

Hurricane Wilma

Hurricane Wilma is the second strongest storm recorded in the Atlantic Ocean basin. Wilma was a Category 3 hurricane (111-130mph) when it passed by Key West. This event created the largest water surface elevation ever recorded by the Vaca Key gauge.

Hurricane Irma

Hurricane Irma made landfall as a Category 4 hurricane at Cudjoe Key with maximum sustained winds at 130mph. Wind gusts were reported at Big Pine Key at 160 mph. The event produced the second largest water surface elevation on record for the Vaca Key gauge.

1.7 PRIOR USACE STUDIES, REPORTS, AND EXISTING PROJECTS

1.7.1 Prior Studies and Reports

There are some notable USACE studies and reports pertaining to coastal storm risk in the study area that have been completed to date:

- Beach Erosion Control Report on Cooperative Study of Key West, FLA, dated 23 October 1957
- Key West, FL., Beach Erosion Control Study Chief’s Report, dated 27 June 1958
- Special Flood Hazard Information Report, Monroe County Keys, Florida, dated June 1972

- Plan of Study, Monroe County, Florida, Beach Erosion Control and Hurricane Protection Study, dated June 1976 (revised October 1977)
- Feasibility Report for Beach Erosion Control with Accompanying Environmental Impact Statement for Monroe County, Florida, dated February 1982 (revised April 1983)
- Monroe County, Florida Shore Protection Project General Design Memorandum with Environmental Assessment, dated October 1993
- Monroe County, Florida Shore Protection Project General Design Memorandum with Environmental Assessment, dated October 1999
- Florida Keys Carrying Capacity Study Socioeconomic Module Development for the Carrying Capacity/Impact Assessment Model, dated October 2002

In addition to the completed studies listed, the USACE South Atlantic Division is currently conducting the South Atlantic Coastal Study (SACS) which will conduct regional analyses of coastal risk and identify initial measures/costs that can address vulnerabilities with emphasis on regional sediment management (RSM) as an actionable strategy to sustainably maintain or enhance current levels of coastal storm risk reduction across 65,000 miles of tidally influenced coastline in the South Atlantic Division area of responsibility affected by sea level rise (SLR) where hurricane and storm damages are occurring, or are forecasted to occur. The goals of the SACS include:

1. Provide a common operating picture of coastal risk to provide decision-makers at all levels with a comprehensive and consistent regional assessment of coastal risk.
2. Identify high risk locations and focus current and future resources on the most vulnerable areas.
3. Identify and assess risk reduction actions that would reduce risk to vulnerable coastal populations.
4. Promote and support resilient coastal communities to ensure a sustainable coastal landscape system, considering future sea level rise scenarios and climate change, and provide information to stakeholders to optimize existing efforts to reduce risk.
5. Promote sustainable projects and programs by developing and providing consistent foundational elements to support coastal studies and projects and regionally managing projects through RSM and other opportunities.
6. Leverage supplemental actions so that multiple supplemental studies and construction efforts will inform and be informed by the SACS.

The SACS will ultimately result in the completion of Focus Area Action Strategies (FAAS) for areas where coastal storm risk is highest. These FAAS will use SACS products in combination with other resources to develop actionable risk reduction strategies with stakeholders and serve as examples of how vulnerabilities in other high risk locations can be addressed. A FAAS will be developed for the Florida Keys as part of the SACS. The Florida Keys CSRM feasibility study PDT has been coordinating closely with the SACS team to ensure that the two efforts are compatible.

1.7.2 Existing Projects

Key West Harbor is a Federal navigation project that provides approximately 23 miles of channel from the main ship channel and anchorage to Garrison Bight and Key West Bight. Garrison Bight forms part of the project for improving Key West Harbor and consists of approximately 3.75 miles of channel, a breakwater along the north side of the bight, and a 12 foot deep turning basin in the bight.

The Intracoastal Waterway, Miami to Key West, Florida provides a channel 7 feet deep and 35 feet wide from Miami to Cross Bank and a channel 7 feet deep by 90 feet wide from Miami to Key West. Finally, there are multiple Federal, state, local, and non-governmental environmental entities that have completed various ecosystem restoration projects within the study area and vicinity, such as coral reef and mangrove restoration.

1.8 PERTINANT STUDIES, PROJECTS, AND INITIATIVES COMPLETED BY THE NON-FEDERAL SPONSOR AND OTHERS

The non-federal sponsor, Monroe County, and other state and federal agencies, non-governmental groups, and other stakeholders all recognize that the Florida Keys are vulnerable to coastal storms and other problems that affect coastal communities, namely sea level change. Monroe county and others have been collectively working on various resilience studies and projects that aim to reduce the impacts that coastal storms will have on the Florida Keys now and in the future and also address the overall resiliency of the Islands so that they can continue to thrive.

1.8.1 Pertinent Work completed by the Non-Federal Sponsor

Monroe County has been working to identify and reduce coastal storm risk in the Florida Keys and has completed various studies on topics including sea level change, adaptation and mitigation methodologies, and comprehensive planning. The County has also engaged in efforts to improve their class rating in the FEMA Community Rating System and projects to improve county infrastructure to be more resilient to sea level rise.

Studies and Reports

Several studies pertaining to coastal storm risk in the study area have been completed recently by Monroe County:

- GreenKeys (completed 2015). This was a two year study that resulted in Monroe County's plan for addressing climate change and sea level rise that is considered to be a blueprint for increased sustainability and resilience in the Keys. The GreenKeys study generated sea level rise scenarios and a vulnerability analysis for roads, county buildings, habitat, and infrastructure.
- Roads Elevation Pilot Project Report (2016). The County conducted this technical analysis based on a data driven method to identify the appropriate design response to potential sea level rise effects on roadways for two communities, Twin Lakes and Big Pine Key, and ultimately recommended road elevation in both locations.
- Watershed Management Plan (2019). This was completed to meet the requirements to achieve a FEMA Community Rating System Class 4 status. The plan focuses on the assessment of storm water drainage systems that are vulnerable to climate change.
- 2030 Comprehensive Plan of Monroe County, Florida (enacted October 2019). This plan was recently revised to add Peril of Flood requirements for Coastal Element and incorporate climate, energy, and sea level rise strategies throughout the plan.

- A Repetitive Loss Analysis to identify mitigation strategies for homes at risk for repetitive flood loss (2019)
- A Countywide Roads Vulnerability Assessment/Elevation and Adaption Plan is currently underway for 300 miles of county roads (2019-current)

Projects and Initiatives

Monroe County has also initiated or completed the following projects and engaged in the following initiatives:

- Completed a greenhouse gas emission inventory and convened the Monroe County Green Building Task Force (2008)
- Joined the Southeast Florida Regional Climate Compact as a founding member (2009)
- Convened a Climate Change Advisory Committee and drafter the county's first Climate Action Plan (2011)
- Created the County's Office of Sustainability, including the position of County Sustainability Director (2012)
- Completed and formally adopted the GreenKeys Sustainability Action Plan, and in-depth five year work plan to guide the County's response to sea level rise (2016)
- Achieved Class 5 in the FEMA Community Rating System, a move from the previous Class 10 rating (2016)
- Added policies to Comprehensive Plan to place disincentives on development in high-risk areas (2017)
- Adopted an Interim Design Criteria Resolution for Road Elevations that factor in SLR and future flood risk (2017)
- Incorporated SLR projections into new County facility construction (2018)
- Completed the Countywide Mobile LIDAR elevation data (2019)
- Completed design work for the Roads Elevation Pilot Projects (2019)
- Completed requirements to achieve Class 4 rating in FEMA Community Rating System (2020)
- Currently in pursuit of $150M in Community Development Block Grant Mitigation (CDBG-MIT) funding to implement the Monroe County Flood Mitigation and Sea Level Rise Resiliency Program, a regional, multi-year program to address critical infrastructure vulnerabilities, build resiliency, reduce risk, and protect people and property (2020-current)

1.8.2 Pertinent Work completed by Florida Department of Transportation

U.S. ROUTE 1 is a critical transportation route and also the only evaluation route that leads northward to connect the Keys with mainland Florida. The Florida Department of Transportation (FDOT) is responsible for the maintenance and repair of U.S. Route 1 because it is a state roadway. FDOT maintains U.S. Route 1 and has made repairs required to return the roadway to the previous condition, but generally, has not and does not expect to receive the funding required to make significant improvements to the over 100 mile stretch of roadway known as the Overseas Highway that would reduce storm damage and/or the effects of sea level rise.

Studies and Reports

FDOT has recently completed the following relevant studies and reports:

- Study of Roadway Base Clearance for State Roads in Monroe County, Phase I-GIS Screening Report, November 2018. This report assessed the vulnerability of the road to sea level rise and did not recommend any projects but may be used to identify sites for projects in the future.
- Scoping Report, FM 443893-1, SR 5/US 1/Overseas Highway from MM 73.75 to MM 77.5 (Lower Matecumbe Key), (90050000 MP 14.063-14.072, 90060000 MP 0.000-3.741), Monroe County, FL, July 2019. This report recommends that the segment of U.S. ROUTE 1 at Sea Oats beach be elevated 1.7 feet and includes a schedule that estimates a contract letting date of January 26, 2022 for this work to be initiated.

Planned Projects

FDOT is currently making some targeted improvements in areas that were damaged by Hurricane Irma, most notably, revetment along some segments of roadway to reduce wave energy and erosion in areas exhibiting higher risk to damage by coastal storms. The PDT coordinated closely with FDOT to accurately capture where their projects will be completed and ensure that the revetment completed by FDOT prior to the base year for the economic analysis in this study have been included in the future without project conditions for this study.

The Scoping Report dated July 2019 recommended that the segment of U.S. ROUTE 1 at Sea Oats Beach, a stretch of roadway that is well known in the Keys to be vulnerable to the effects of coastal storms and sea level rise, should be elevated 1.7 feet. The estimated contract letting date is scheduled to take place prior to the base year for the economic analysis in this study, so this project has been included in the future without project conditions for this study.

The plan formulation appendix to this report, Appendix A, includes more detail on how projects completed by FDOT were considered in the analysis of measures to reduce coastal storm risk to U.S. ROUTE 1.

1.8.3 Pertinent Work Completed by Other Stakeholders

There are many other stakeholders in the Florida Keys that have completed studies and projects that were reviewed by the PDT to discern the problems, opportunities, and future without project condition for this study. Important stakeholders include the five municipalities in the Keys; the City of Key West, City of Marathon, City of Key Colony Beach, City of Layton, and Village of Islamorada. There are also multiple state parks and state and federal environmental resource agencies. In addition to the various opportunities for agency and public coordination, the PDT also held numerous additional meetings with stakeholders as needed, especially in areas where the study recommendations could affect the area or operations of that stakeholder.

1.9 PUBLIC AND AGENCY COORDINATION

1.9.1 Interagency Coordination

Interagency coordination began with a kick-off planning charette on November 14, 2018. Over 30 federal, state, and local government officials, resource agencies, academics, and nonprofit organization members participated, with the goal of focusing the Florida Keys Coastal Storm Risk Management Study objectives and identifying solutions that would address flood risk in the Keys. During the workshop, workgroups were formed and conferred on these topics.

In addition, the following were invited to be cooperating agencies: U.S. Environmental Protection Agency (USEPA); U.S. Coast Guard; U.S. Navy; Federal Emergency Management Agency (FEMA); Florida Keys National Marine Sanctuary (FKNMS); National Oceanic and Atmospheric Administration's National Marine Fisheries Service Protected Resources Division (NOAA PRD) and National Marine Fisheries (NMFS); U.S. Fish and Wildlife Service (USFWS); National Park Service (NPS); Federal Highway Administration (FHWA); Florida Department of Transportation (FDOT); and Florida Department of Environmental Protection (FDEP). The following accepted the invitation: USEPA, FKNMS, NOAA PRD, and FDOT. FEMA is a participating agency.

Interagency meetings were held on January 7, 2019, February 12, 2019, and March 21, 2019, and November 20, 2020. After further consideration of potential impacts, a Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) was published in the Federal Register on November 8, 2019. Scoping letters were again sent to the interagency team. A follow-up interagency/cooperating agency meeting was held on November 20, 2019. Participants in the various meetings included: Monroe County, USEPA, FKNMS, NOAA PRD, NOAA NMFS, USACE Jacksonville and Norfolk Districts, FDOT, FDEP, and Florida Fish and Wildlife Conservation Commission (FWCC) participated. An Interagency site visit was held to view the locations of the structural measures on December 11-12, 2019. Participants included team members or representatives from FKNMS, NOAA PRD, NOAA NMFS, USACE Jacksonville and Norfolk Districts, FDOT, FDEP (State Parks), and the City of Islamorada. To-date, comment letters have been received from FKNMS, NOAA PRD, NOAA NMFS, USEPA, FWCC.

Coordination under the U.S. Fish and Wildlife Coordination Act (FWCA) with the U.S. Fish and Wildlife Service (USFWS) is ongoing. Coordination under Section 7 of the Endangered Species Act is ongoing and a Biological Assessment has been prepared and is provided in the Environmental Appendix, Appendix D.

Coordination under the NMFS under the Magnuson-Stevens Fishery Conservation and Management Act has been conducted. An Essential Fish Habitat Assessment was initially prepared; however it was not needed, because after the Proposed Action was subsequently modified, the footprint is no longer in subaqueous areas. Coordination as required per Section 106 the National Historic Preservation Act is ongoing and a draft Programmatic Agreement has been prepared and is also provided in the Environmental Appendix, Appendix D. Further coordination will occur between the release of this draft and final report.

The study team has coordinated with FDOT throughout the entire study, but increased the frequency of information sharing and level of collaboration following the September 2019 public meetings in Key Largo and Key West for the months leading up to identification of the TSP and TSP milestone meeting in January 2020. During this time, FDOT shared a list of all the projects that will be completed along U.S. ROUTE 1 as a result of damage that occurred during Hurricane Irma and all of the detailed plans and designs that they had available for those projects to the PDT and these were reviewed by engineering team members. Once the PDT had refined the shoreline stabilization areas to be included in the TSP, a webinar was held with various FDOT staff and the PDT so that the proposed revetments could be discussed in detail and any remaining redundancies identified. During this webinar, there were also detailed discussions regarding the designs and construction schedules for the FDOT projects planned along U.S. Route 1. The PDT will continue to coordinate closely with FDOT for the remainder of the study.

A personal meeting was held in October 2018 with the Tribal Historic Preservation Officer (THPO) for the Seminole Tribe of Florida during which the basic scope and objective of the project was presented. Notices for the scoping meetings, along with brief project descriptions, were sent in November 2018 to the Deputy State Historic Preservation Officer (SHPO), THPOs for the Seminole Tribe of Florida and Miccosukee Tribe, the Chief of the Seminole Nation of Oklahoma, and the Monroe County Historic Preservation Commission. In October 2019 a draft of a programmatic agreement was sent to the SHPO. In January 2020 a form answering detailed questions about the project was completed and sent to the Advisory Council on Historic Preservation (ACHP) to inform their decision on participation in the development of the programmatic agreement.

1.9.2 Public Involvement

On December 3-4, 2018, the USACE held National Environmental Policy Act (NEPA) Open-House-Style Public Scoping meetings in the Cities of Islamorada and Key West. USACE staff were on-hand with storyboards to show the areas of the city to be addressed, to describe the potential measures, to answer questions, and to obtain public comments. Approximately 31 people attended, and eight public comments were submitted during and after the meeting.

On September 11-12, 2019, the USACE held Open House Style Public Meetings in Key Largo and Key West to update the public on the measures and the alternatives. The meeting was an open-house style forum including updated storyboards and a brief introduction to the study and status update by the Norfolk District at the midpoint of the meeting. Approximately 40 people and the media attended these meetings, and a total of 23 public comments were received. The public was again given the opportunity to comment after the NOI was published on November 8, 2019.

Prior to the September 2019 public meetings, a web-based GIS tool called Crowd Source Reporter was developed for the study to facilitate the communication of the proposed alternatives to the public and as an additional platform for the public and stakeholders to make comments with an option to reference them to a certain location on the map. All public comments and USACE responses from both of these meetings are included Environmental Appendix.

As mentioned earlier, on November 8, 2019, an NOI was published in the Federal Register to notify the public of our decision to prepare an EIS. A newspaper announcement was also run in The Citizen newspaper. The Crowd Source Reporter tool was reopened for public comments. No additional public comments were received.

CHAPTER 2 AFFECTED ENVIRONMENT*

2.1 LAND USE

Land use comprises the natural conditions and/or human-modified activities occurring at a particular location. Human-modified land use categories include residential, commercial, industrial, transportation, communications and utilities, agricultural, institutional, recreational, and other developed use areas. Figures 2-1 through 2-4 show land use in the Keys. State laws, management plans, and zoning regulations determine the type and extent of land use allowable in specific areas and often intend to protect specially designed or environmentally sensitive areas. Zoning requirements are regulations developed by the locality to control potential future development. Comprehensive plans evaluate long term demographic trends to identify how the region of analysis should be developed. Where zoning focuses on immediate trends in development, comprehensive plans are generally less regulatory in nature and often serve as guidance when current planning department is evaluating applications for development.

The Region of Influence (ROI) for land use consists of all areas directly and indirectly affected by the proposed structural and nonstructural measures, from Palo Alto Key (north Key Largo) extending southwest to Key West, Florida, including shoreline and adjacent wetlands.

Monroe County has a 2030 Comprehensive Plan adopted on April 30, 2016, as well as a Rate of Growth Ordinance (ROGO), which governs growth and is explained further in this section. The aquatic environment surrounding the Keys falls within the boundaries of the Florida Keys National Marine Sanctuary (FKNMS), which is under the jurisdiction of the National Oceanic and Atmospheric Administration (NOAA 2019a).

2.1.1 Existing Conditions

Land Use in the Keys is similar throughout the Upper and Middle Keys (Figures 2-1 to 2-4). It is predominantly low and middle intensity development dispersed along population centers on US Route 1. Key Largo, Tavernier, Islamorada, and Marathon are large population centers. The developed landscape intensifies with more middle intensity development near Marathon. In the Lower Keys, Boca Chica Key and in particular, Key West, are large population centers, with an urban landscape of low, medium and high density development.

Population density of Monroe County, at 74.3 people per square mile (28.6/km2), is moderately lower than the U.S. as a whole, and substantially lower than the rest of Florida. However, in the Florida Keys portion of Monroe County, population density is 591 per square mile (227.3/km2) (US Census Bureau, 2020).

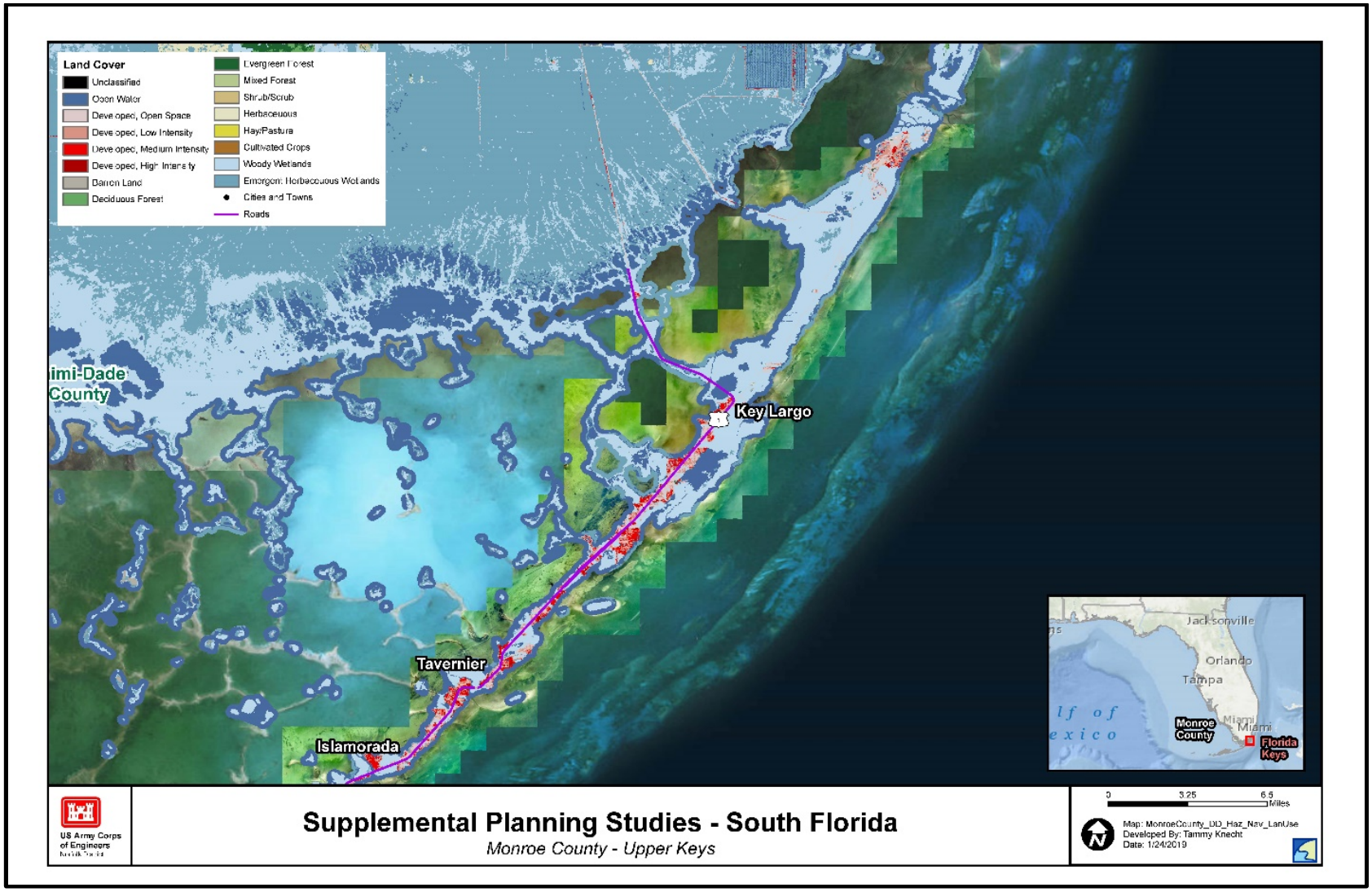

Figure 2-1: Land Use, Northern Keys

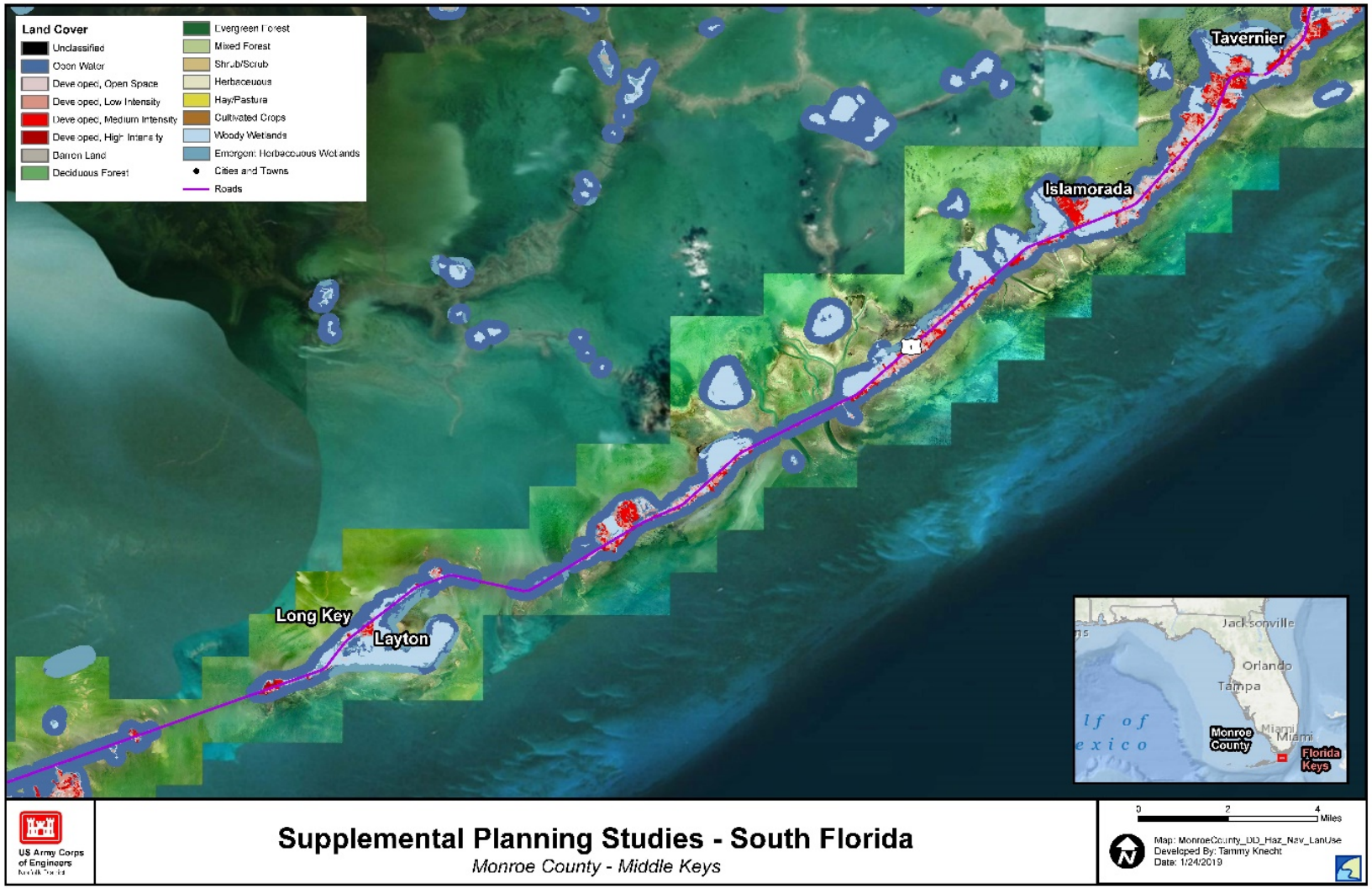

Figure 2-2: Land Use, Middle Keys

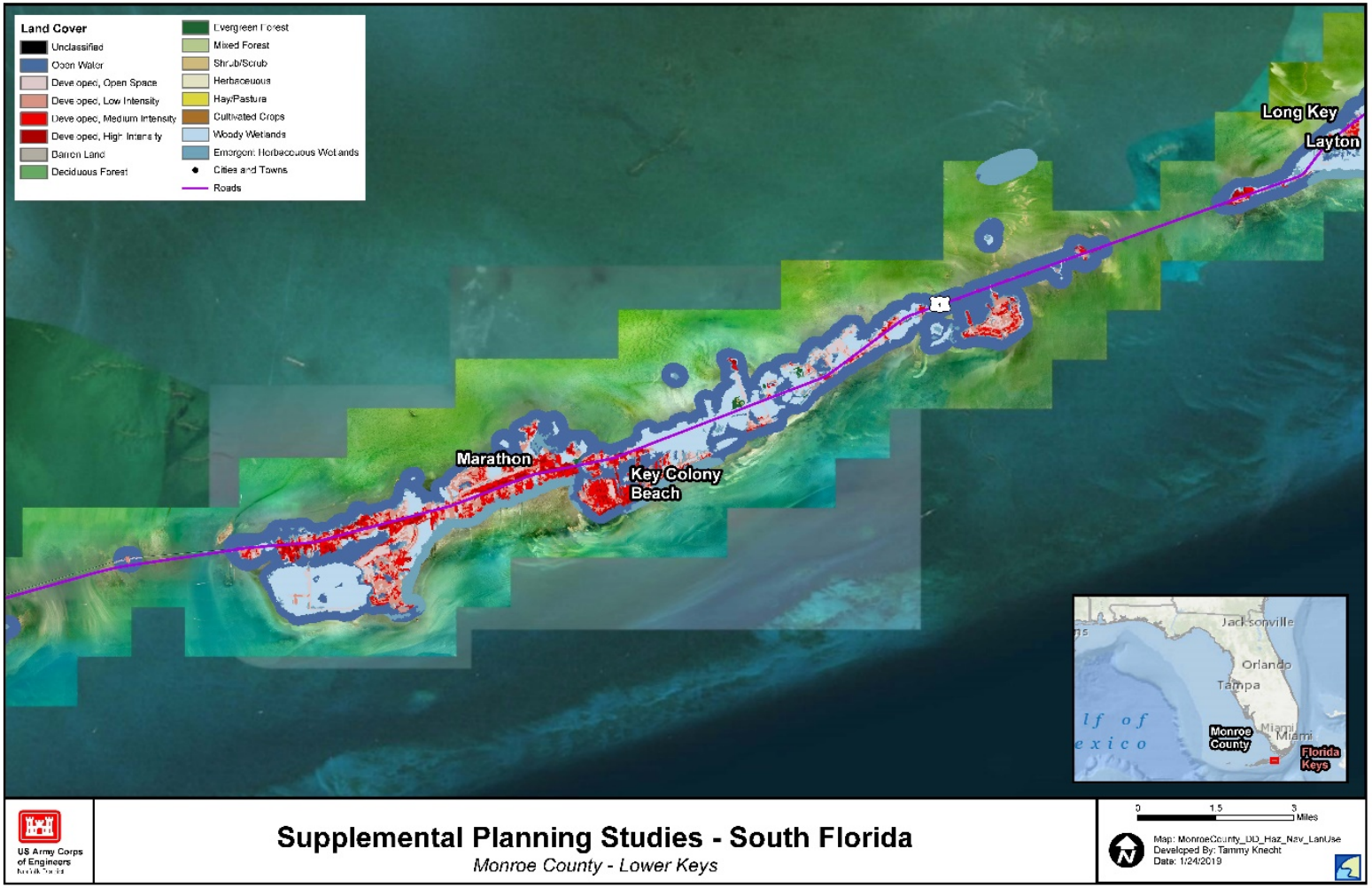

Figure 2-3: Land Use, Middle Keys

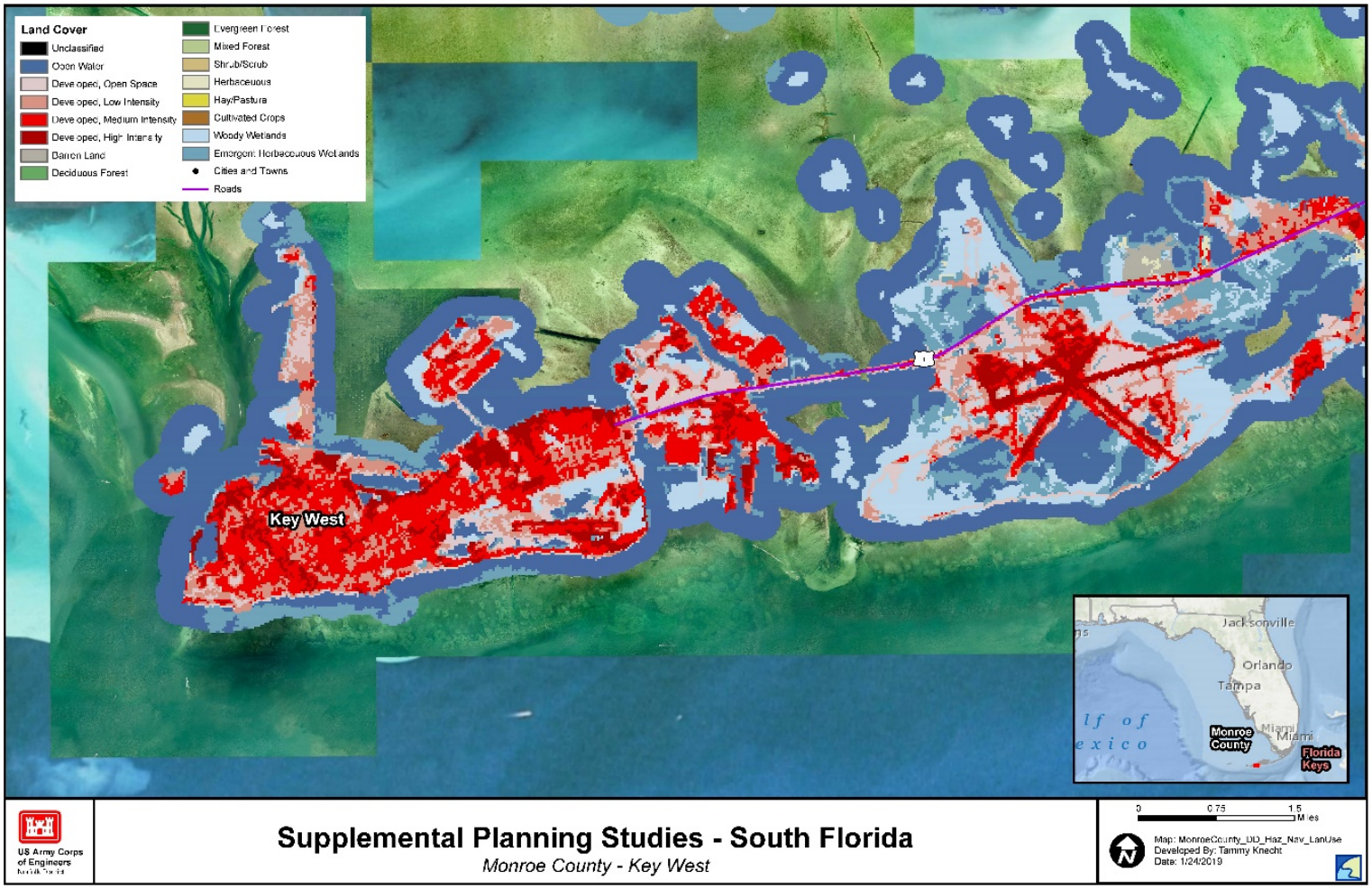

Figure 2-4: Land Use, Lower Keys.

More than 75 percent of land in the unincorporated Keys is set aside for conservation purposes. Of the developed land uses, residential is the largest land use category, representing approximately 6.8 percent of the land uses in the county, followed by military at 5.5 percent, utilities and rights-of-way at 4.4 percent, vacant at 3.2 percent, recreation at 1.8 percent and commercial at 1.2 percent (Monroe County, 2011).

A major land use in the Florida Keys is recreational and tourism. Monroe County has 11 state parks, including the Florida Keys Overseas Heritage Trail, which runs alongside U.S. Route 1. The Florida Keys Overseas Heritage Trail, which opened in 2011 is a 90 mile long string of pathways, bridges, and green spaces abutting U.S. Highway 1. The trail provides pedestrian and bicycle access to the scenic highway. It has the highest visitation of any state park in the Florida Keys. In 2015, it accounted for 38.5 percent of all state park visitation in the Florida Keys. State park visitation has been highly variable over the six-year period 2010-2015, ranging from a low of 2.1 million for all state parks in 2010 to a high of almost 4.6 million in 2013. This is discussed more in the recreation section of this document (Marine Sanctuary, 2019).
The ROI also includes military facilities: U.S. Navy facilities (Navy Air Station Key West on Boca Chica Key, lodging and task force areas in Key West), a U.S. Air Force Station in Summerland Key, and a U.S. Coast Guard Station in Marathon.

Monroe County residential development is controlled by the Rate of Growth Ordinance (ROGO). The limit on the amount of residential development is based upon the ability to safely evacuate the Keys within 24 hours. Under ROGO, the state only allocates 197 housing units per year to the county for building permit issuance. Monroe County also adopted a Non-Residential Rate of Growth Ordinance in 2001 to “ensure a reasonable balance between the amount of future non-residential (primarily commercial) development and the needs of a slower growing residential population.” The Non-Residential Rate of Growth Ordinance attempts to maintain a ratio of approximately 239 square feet (22.2 m2) of nonresidential floor area for each new residential permit issued through the Residential Rate of Growth Ordinance (Monroe County, 2011).

Of all the new single family housing growth in Monroe County since 1999, nearly 70 percent has been in non-homesteaded units. According to a population projection study in 2011, this is likely a function of both growth in seasonal population as well as permanent population loss, which may cause once permanently occupied existing units to become non-homesteaded (Monroe County, 2011).

Population projections for the functional population are also a driver for estimating future land uses. The functional population includes the number of permanent residents plus the number of seasonal residents in the Florida Keys on a given day. This number varies by season because of seasonal patterns of visitation. In addition, seasonal visitors are a classification used by the Monroe County Planning Department that ties population with demand for housing as well as for evacuation. Seasonal residents include visitors to Monroe County (including day visitors) and residents that are renting. The functional population projections are constrained by all the above noted constraints on growth and development (Leeworthy et al. 2010).

The functional population for Monroe County (unincorporated and incorporated areas) is important for planning roads, water supply, sewage treatment, and other infrastructure needs. One of the most important uses is for hurricane evacuation, which is a key element constraining growth in Monroe County. Most of the land that can be developed in Monroe County exists in the unincorporated areas, so the population projections are important in assessing the potential for growth in the development of those lands. From 2015 to 2030, the functional population for all of Monroe County is projected to increase 3.1 percent, adding an average of 330 people per year. In the unincorporated areas of the county, the functional population is projected to grow 3.05 percent, adding on average 146 people per year (Leeworthy et al. 2010).

2.2 SOCIOECONOMICS

Existing demographic and economic information was drawn from the U.S. Census Bureau, Bureau of Labor Statistics, and local planning agencies. The impacts of implementing proposed project measures to various segments of the population is considered, especially with regard to the geographic distribution of these population elements and the impacts of the project measures in these areas. U.S. Environmental Protection Agency guidance (USEPA 2010) on environmental justice was considered in evaluating these impacts.

Monroe County had an estimated population of 74,215 in 2016, compared with a state population of over 19 million for Florida. Florida's reputation as a retirement haven is reflected in its higher than the nation's 17.8 percent over 65 population, and Monroe County falls in line with 18.5 percent over 65. In stark contrast to Miami-Dade to the north, where more than 50 percent of the population is foreign born, only 17.4 percent of the population is foreign born, less that the state's percentage of 19.4 percent. Education levels are slightly above the state's, with Monroe having 28 percent with a BA or more and Florida having 26.4 percent. The Median Household Income (MHI) for Monroe is $53,607, well above the Florida MHI of $46,956; yet the average yearly employee wage for Monroe is $31,820, while the statewide figure is $41,022. This apparent contradiction reflects a mix of retirees or others living off investments, and the majority of the labor force in low paying service jobs. The minority portion of the population is well below that for the state, with 28.7 percent for Monroe and 42.1 percent for Florida. The minority population is mostly centered in Key Largo and especially Key West.

Figures 2-5 and 2-6 show percent of households below the poverty level and the number of black population below the poverty level, respectively, both by census tract based on the American Community Survey 2012-2016. The poverty level, as defined by the US Department of Health and Human Services (2019), is $12,490 annual income for a single person and $25,750 for a household of four.

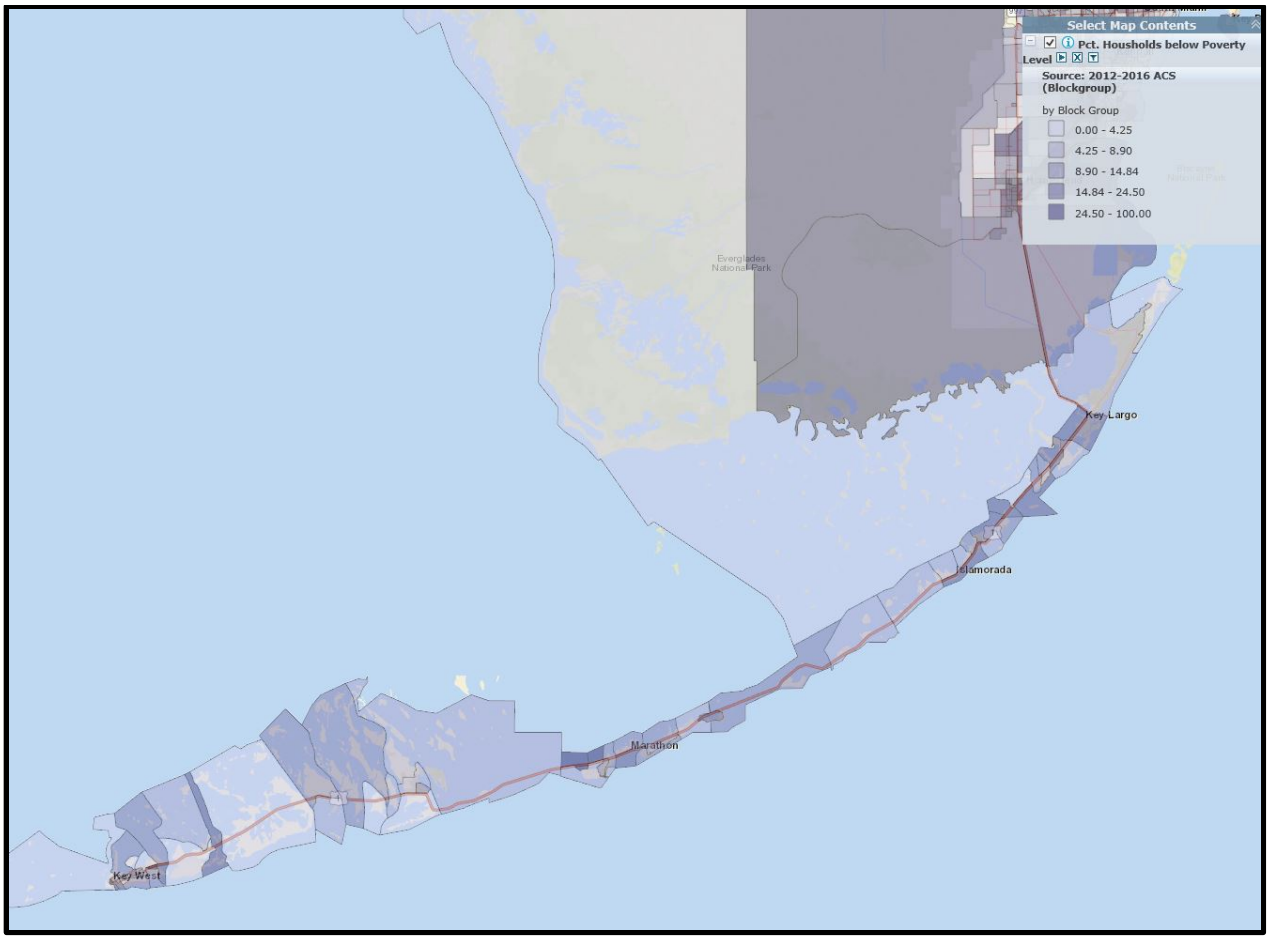

Figure 2-5: Percent of Households below the Poverty Level (USEPA, 2019)

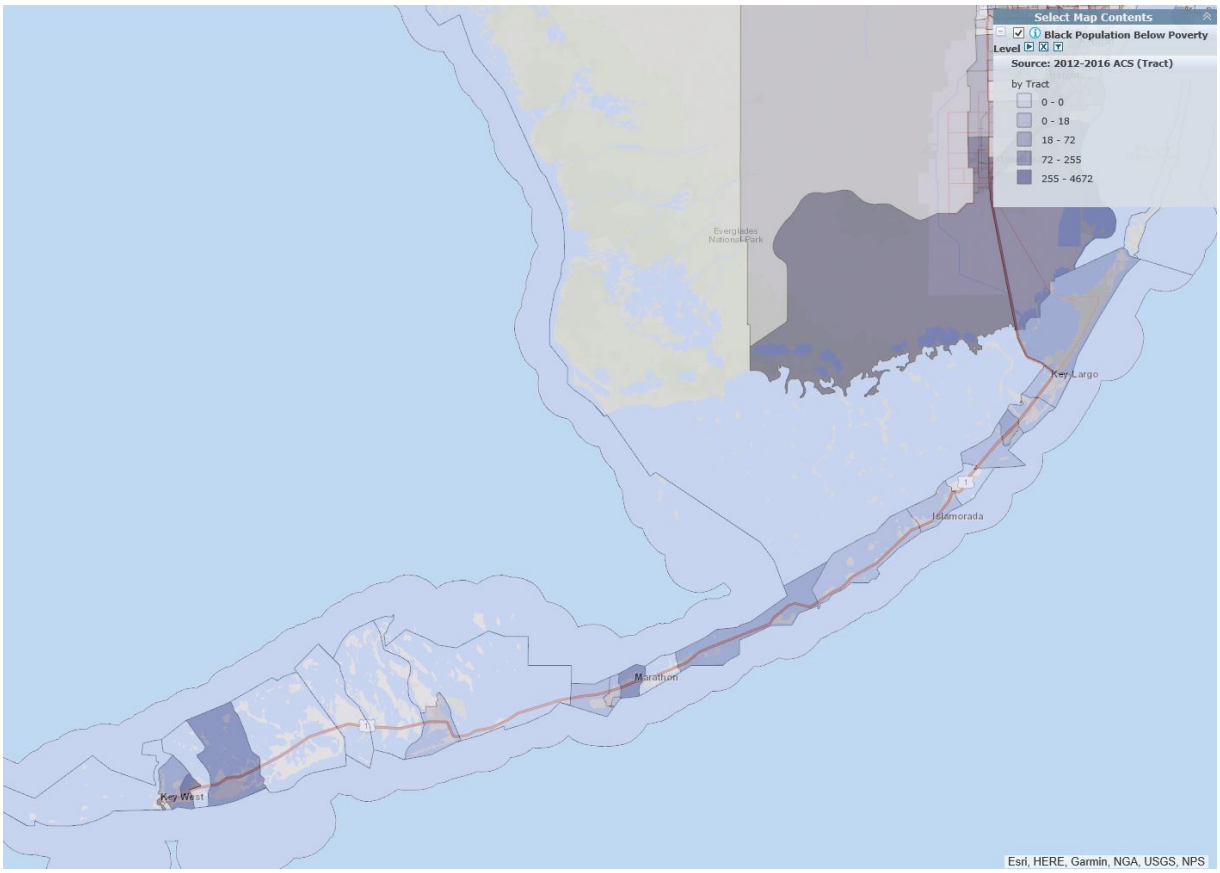

Figure 2-6: Black Population below the Poverty Level (USEPA, 2019)

2.3 TRANSPORTATION

Transportation refers to the operational characteristics of the land transportation network, including the network's capacity to accommodate existing and projected future travel demand. Networks may encompass many different types of facilities that serve a variety of transportation modes, such as vehicular traffic, public transit, and non-motorized travel. Access to, within, and from the study area is provided via a network of freeways, arterial streets, connector streets, public transit services, freight rail lines, and non-motorized transportation facilities (including bicycles, sidewalks, and pedestrian trails). However, it should be noted that recreational trails are covered under the recreation section of this document.

The ROI for transportation includes all roadways (freeways, major and minor arterial roads, collector roads, and neighborhood roads); air, train, light rail, bus routes, other mass transit, trails, and pedestrian sidewalks within the study area, that will be affected directly or indirectly by the project. It should be noted that navigation is covered in a separate section.

2.3.1 Existing Conditions

Roads

The spine or supporting structure of the Florida Keys is U.S. Route 1, or the Overseas Highway, which begins at Mile Marker 1 in Key West, Florida. Built upon an abandoned trail of the Florida East Coast Railroad, US Route 1 is the only major artery transporting tourists and residents throughout the Keys and likewise serves as the only roadway evacuation route from the Keys during storm events. It spans 113 miles and has 42 overseas bridges connecting mainland or peninsular Florida with the Keys.

In 2017, a Travel Time and Delay Study was conducted by URS Consultants in order to model the Level of Service (LOS) on U.S. Route 1. Traffic counts were conducted in Big Pine Key, Marathon, and Islamorada. The average annual daily traffic at each location was 19,047; 34,609; and 23,043, respectively. The median overall speed during the 2017 study was 46.0 mph. The report found that U.S. Route 1 functions at a LOS rating of "C," which is defined by USDOT as "stable flow, at or near free flow. Ability to maneuver through lanes is noticeably restricted and lane changes require more driver awareness." This is considered an acceptable rating for urban and rural highways (URS, 2017).

Monroe County's 2030 Comprehensive Plan requires the County to complete a Transportation Strategy Master Plan, through its Long Range Transportation Plan, by May 2021, incorporating an intermodal transportation system and consideration of climate change implications (Monroe County 2016, 2030 Comprehensive Plan).

The Overseas Trail runs parallel to U.S. Route 1. The trail opened in 2011 and is a 90 mile long string of pathways, bridges, and green spaces. The trail provides pedestrian and bicycle access to the scenic highway. Along most locations, it is separated from U.S. Route 1 by a narrow grass median; and over most of the bridges, it is within the bridge shoulder.

U.S. Route 1 is the only highway in Florida to be recognized as an "All-American Road" by the National Scenic Byways Program of the Department of Transportation's Federal Highway Administration. The program is a grass-roots collaborative effort established to help recognize, preserve, and enhance selected roads throughout the United States. The U.S. Secretary of Transportation recognizes certain roads as All-American Roads or National Scenic Byways based on one or more archeological, cultural, historic, natural, recreational, and scenic qualities.

Evacuation

Because all land evacuation must occur on U.S. Route 1, Monroe County's comprehensive emergency plan calls for a "Phased Evacuation." This evacuation plan is intended to avoid unnecessary evacuation if some zones are expected to be affected and others are not. Residents must locate the zone they live in so that they will know when to leave if an evacuation becomes necessary (Monroe County, 2020).

- Zone 1: Mile Marker (MM) 0 to MM 6
- Zone 2: MM 6 to MM 40
- Zone 3: MM 40 to MM 63

- Zone 4: MM 63 to the three-way stop at CR 905-A
- Zone 5: CR 905-A to mainland Monroe County, including Ocean Reef

Airports

In the Florida Keys, there are two commercial airports that contribute to the transportation infrastructure of Monroe County—Key West International Airport and Florida Keys Marathon International Airport. Both of these are critical to the regional economy and support health, welfare, emergency, and safety-related services. Both airports are located immediately adjacent to US Route 1 (Overseas Highway).

Key West International Airport encompasses 334 acres and provides services to visitors and residents traveling both nationally and internationally. It is located in the southeast quadrant of the City of Key West. Over 760,000 passengers fly into and out of Key West each annually and handled approximately 55,000 general aviation aircraft operations and pumped more than 3 million gallons of aircraft fuel in 2017.

Aircraft size landing in Key West are restricted by the size of the sole runway (5.073 feet x 100 feet). The airport sits at an elevation of three feet and is parallel to the South Roosevelt Boulevard immediately adjacent to the Atlantic Ocean. A recent upgrade to the airport elevated the runway six inches to accommodate sea level rise and in 2018, a new master planning document was approved by the BOCC for the expansion of the airport to accommodate expected increases in air traffic over the next ten years.

The other airport within the Study Area is the Florida Keys Marathon International Airport, a private airport, located in Marathon, Florida. This commercial service and general aviation airport is adjacent to Overseas Highway and covers 190 acres and has one runway. Although currently no commercial carriers land in Marathon, there is a new U.S. Customs and Border Control Facility in the former commercial terminal to handle Immigration Customs issues.

2.4 NAVIGATION

Navigation refers to the use of waterways, either primarily for transportation or recreational purposes, by any type of vessel. Vessels include ships, barges, ferries, boats, sailboats, small craft, and the like. “Navigable Waters” are administratively defined as waters that have been used in the past, are now used, or are susceptible to use as a means to transport interstate or foreign commerce up to the head of navigation.

The ROI for navigation includes the navigable waterways and channels surrounding and within the study area limits that can be used by any type of vessel and would be affected by any of the structural or nonstructural measures.

2.4.1 Existing Conditions

Overall, the waters surrounding the Florida Keys are used regularly by commercial fisheries, commercial tourism, and private use watercraft. Boating is both a recreational activity and a method of transportation for residents and tourists of the Keys.

Ports

The Port of Key West includes cruise berths at Mallory Square, the Navy's Outer Mole Pier, and a privately owned Pier B at the Weston Resort in downtown Key West. The city also maintains a domestic ferry terminal in the Key West Bight. These facilities constitute one of the busiest ports-of-call in the nation and one of the state's strongest and most sustained ferry port operations.

The Port of Key West is a major economic engine for the city and local businesses, bringing in almost a million total passengers per year resulting in a local business impact of approximately $85,000,000. Additionally, the Port of Key West supports cruise and ferry activities throughout the state, hosting cruise ships from Miami, Port Everglades, Canaveral, Tampa and Jacksonville as well as ferries from Fort Myers and Marco Island. The port provides 1,260 direct and indirect jobs to the citizens of Key West and contributes 15 percent of the city's total tax revenue. For a city with a total population of 22,000, these jobs represent a significant contribution to the overall economy (Florida Ports Council 2019).

Federal Channels

The waters around Key West draw tourists and residents for various recreational activities throughout the year. Within the ROI, the authorized federal navigation channels in the Upper and Middle Keys are the Intracoastal Waterway from Miami to Tavernier and the Key Largo Sound Channel (Figure.2-7). In the Lower Keys, Key West Harbor and Boot Key Harbor are federally maintained channels (Figures 2-8 to 2-10).

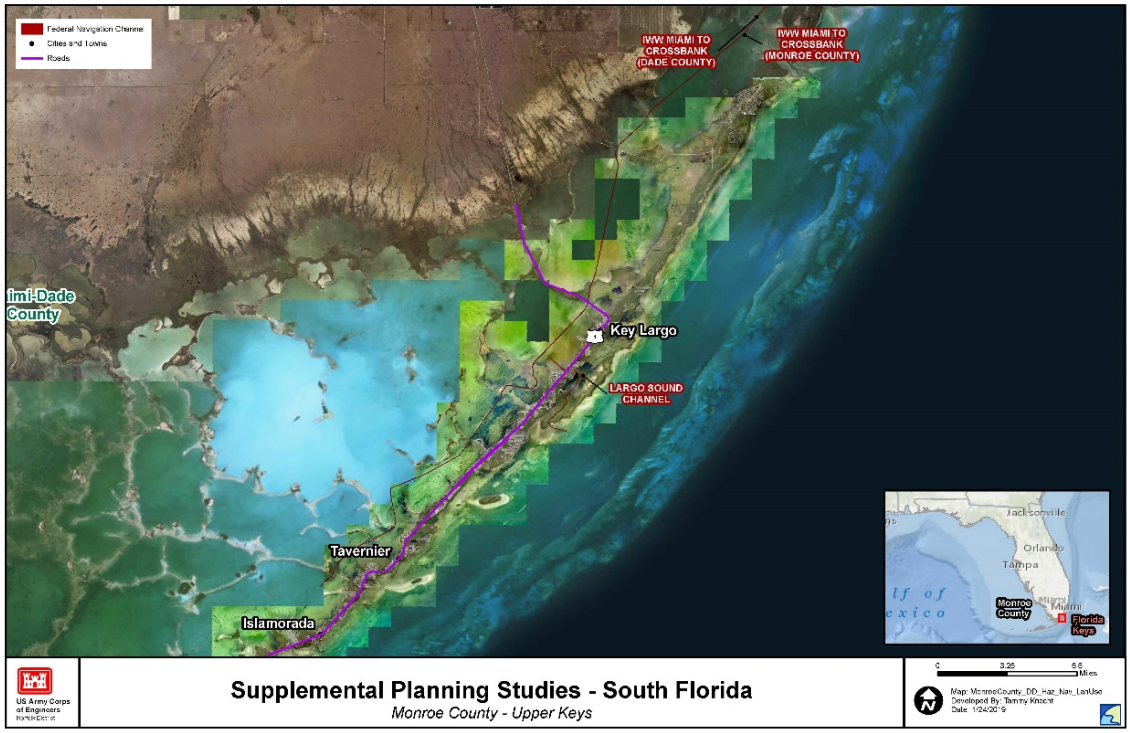

Figure 2-7: Federal Navigation Channels, Upper Keys

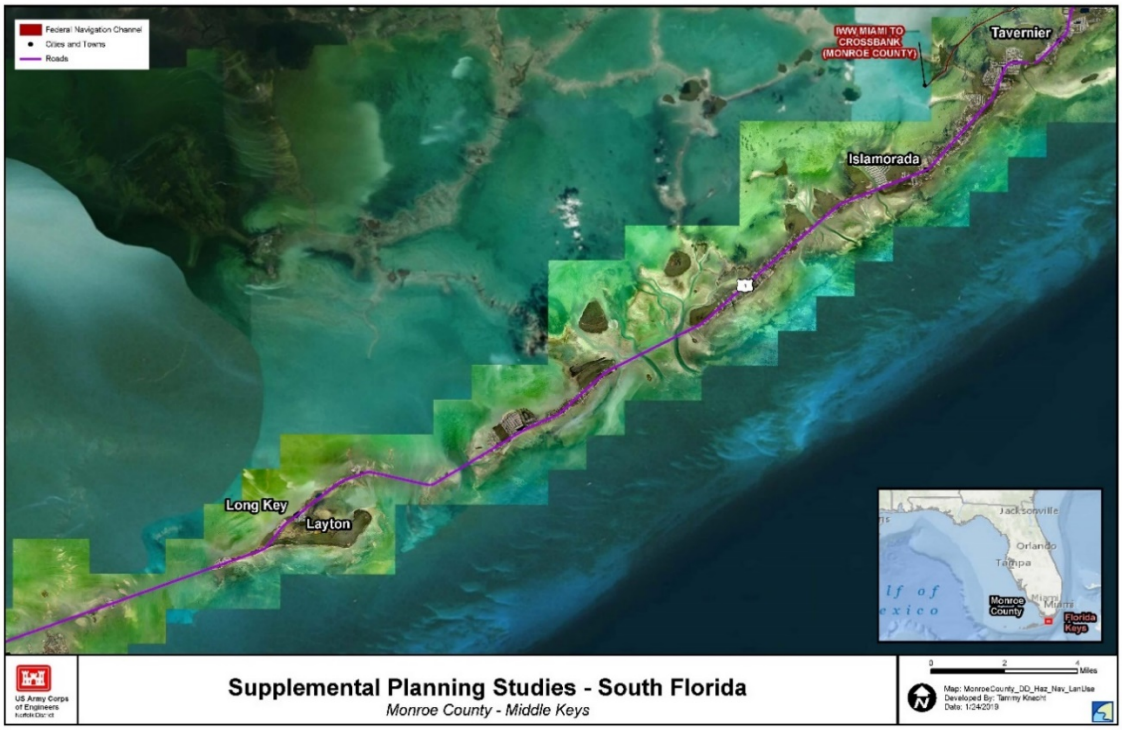

Figure 2-8: Navigation Channels, Middle Keys

Figure 2-9: Navigation Channels, Middle Keys

Figure 2-10: Federal Navigation Channels, Lower Keys

Non-Federal Channels

Kemp Channel is a marked channel located adjacent to Cudjoe Key, in the Lower Keys. It appears mostly to serve residents and visitors in the immediate area south of U.S. Route 1; there are no channel markers north of U.S. Route 1.

Toms Harbor Channel is a marked channel located adjacent to Duck Key, in the Middle Keys. Similarly, it appears to serve residents and visitors in the immediate area south of U.S. Route 1; there are no channel markers north of U.S. Route 1.

Within the vicinity of Indian Key in Islamorada there is a series of channels. The Lignumvitae Channel, the Indian Key Channel, and the Tea Table Channel are all marked, north and south of U.S. Route 1. There are also visible channels that parallel the south sides of Indian Key, though they are not marked.

Mooring Buoys

Mooring buoys, which are 18 inches in diameter with a blue stripe, have been used in the Keys since at least 1981, as an alternative to anchoring, which can break and damage the coral reef. There are over 490 mooring buoys available for use within the sanctuary on a first-come, first-served basis at no cost to the boater. Anchoring on living coral within the sanctuary in waters less than 40 feet and when the bottom is visible is prohibited (NOAA, 2019a). Other buoys used for marking zones such as Sanctuary Preservation Areas, Ecological Reserves, and Special-use Research only areas. These buoys are 30 inches in diameter and yellow and have no pick-up lines for the public to use for vessels. Spar buoys that are cylindrical, tall, and white with orange markings mark Wildlife Management Areas and sites on the Shipwreck Trail. A series of buoys are located along Oceanside Isle Channel, adjacent to Fiesta Key; and a series of buoys along on the north side of U.S, Route 1 adjacent to Indian Key in Islamorada.

2.5 GEOLOGY, TOPOGRAPHY, AND SOILS

Geological resources are defined as the topography, geology, mining resources, and soils of a given area. Topography describes the physical characteristics of the land such as slope, elevation, and general surface features. Geology refers to the earth's physical structure, underlying formations, and the processes that act upon it. Mining refers to the extraction of resources (e.g., gravel or sand). Soil refers to unconsolidated earthen materials overlaying bedrock or other parent material.

The ROI is all landforms of the Florida Keys along U.S. Route 1 and in existing development centers, from Palo Alto Key to Key West, that will be temporarily, permanently, directly, or indirectly disturbed or affected by any structural or nonstructural measures.

2.5.1 Existing Conditions

The Upper Keys extend from Virginia Key to Lower Matecumbe Key. The islands in the Upper Keys are long, narrow, and low-lying, with an average elevation of three to six feet (1-2 m). A few narrow channels connect Florida Bay to the Atlantic Ocean. The Middle Keys extend from

Lower Matecumbe Key in Islamorada to the Seven Mile Bridge, which connects the City of Marathon to Little Duck Key. The Middle Keys are similar in size, elevation, and orientation to the Upper Keys; however, many wide channels separate each island. The Lower Keys extend from Little Duck Key to Key West. The Lower Keys are broad, and flat. They are separated by long narrow channels, and are perpendicularly oriented as compared with the Middle and Upper Keys. Elevations in the study area range from eighteen feet above sea level at the highest point in Windley Key in the Upper Keys, to an average of three to five feet throughout the remainder of the Upper, Middle, and Lower Keys (NOAA, 2019a).

The Keys are a coral archipelago formed from a series of low limestone islands, within the South Atlantic Coastal Plain (NOAA 2019e). Two main geologic formations of the Pleistocene age are present in the study area – Miami Limestone and Key Largo Limestone. Miami Limestone is found on the mainland Florida peninsula and on the lower keys from Big Pine Key to Key West. It is highly porous and permeable containing fossils and composed of Ooids. The Ooids or grainstones are formed in a high energy environment and contains skeletal materials of corals, echnoids, mollusks and algae (Hailey et al, 2018). Throughout the Lower Keys, the exposed Miami limestone formation lies atop the Key Largo limestone formation. In the Lower Keys, the Miami limestone formation began forming in the late Pleistocene epoch when sea level conditions favored the accumulation of carbonate sand banks behind the outer reef (Clark, 1990).

At Big Pine Key, geologic formations transition to Key Largo Limestone, which is also permeable and porous. Key Largo Limestone is found throughout the Middle and Upper Keys, from Palo Alto Key to Big Pine Key. Both formations are part of the Biscayne Aquifer of the surficial aquifer system (Hailey et al, 2018). The last major drop in sea level exposed the ancient coral reefs which presently make up the Florida Keys. As sea level fluctuated during the Pleistocene Ice Ages the Key Largo limestone accumulated up to 200 feet thick**.** Intertidal erosion of the exposed Key Largo formation is a source of the sediment for the upper and middle Keys beaches (Clark, 1990).

The USGS soil survey identifies eight soils series within the Study Area: Bahiahonda, Cudjoe, Islamorada, Keylargo, Keyvaca, Keywest, Lignumvitae, and Matecumbe Series. Keyvaca and Keywest series are underlain by soft to hard, rippable oolitic limestone bedrock; the remaining series are underlain by soft to hard, rippable coral limestone bedrock. They include varying depths to bedrock, ranging from four inches (Keyvaca series) to 85 inches (Bahiahonda series) (USDA 1995).

Udorthents, or urban land complex, is also common in the Study Area. They consist primarily of crushed oolite limestone or coral rock limestone filled over top of the original soil material. In the Keys, up to 40 percent of the Udorthents areas are covered by houses and other urban structures (USDA, 1995).

2.6 HYDROLOGY, HYDRAULICS, AND BATHYMETRY

Hydrology is the science that deals with the properties, circulation, and distribution of water, its movement in relation to land, under the surface of the land, and in the atmosphere from the moment of precipitation until it returns to the atmosphere through evapotranspiration or is discharged into the ocean. Hydraulics is the science that deals with practical applications of runoff flowing through a channel. Collectively, hydrology and hydraulics are referred to as "H&H." Bathymetry, which is the configuration of the waterway bottom, influences H&H and where applicable, it will be discussed.

The ROI for H&H and bathymetry includes all areas within the study area to be directly filled, dredged, excavated, or otherwise temporarily or permanently converted to another use as a result of the construction of the structural and/or nonstructural measures, as well as all areas indirectly adversely affected by the structural and/or nonstructural measures, by means such as alteration in tidal flushing, sedimentation, currents, erosion, changes in salinity. It should be noted that sea level rise is discussed in the climate change section.

2.6.1 Existing Conditions

The nearshore areas of the Florida Keys are influenced by two main regional currents: the Gulf of Mexico Loop Current and the Florida Current. The variability of these currents in conjunction with local meteorology, tides, wind-driven currents, and surface runoff affects the circulation and nature of the Marine Sanctuary waters. Nearshore waters generally experience high variability in temperature, salinity, and other factors relative to the reef tract and deeper waters further offshore (NOAA, 2019a).

Due to erosion, all of the shorelines within the ROI have been impacted historically at least to some degree by artificial hardening, be it a seawall, riprap, scattered limestone rock, concrete block, or poured concrete. Generally, the beach shorelines within the ROI have been hardest-hit by erosion.

Clark (1990) notes that the primary causative factors for beach and dune erosion in Monroe County include periodic major storm events, onshore and longshore sediment budget deficits, historical development trends, and long term sea level rise. Because of the nature of the carbonate sediment of the beaches in Monroe County, the sediment supply is affected by the chemical and biological processes of adjacent waters. Not well understood, Clark states, are the environmental influences of changing salinity, hydrostatic pressure, temperature, turbidity, organic and inorganic pollutants, and other marine environmental factors on the chemical and biological production of sediments for the natural nourishment of the beaches (Clark 1990).

Clark (1990) notes that at the same time, naturally occurring beach and dune formation is not common in the Keys. Compared to the Florida peninsula, there is very little natural quartz sand on the Keys; instead sand is of carbonate origin derived from the erosion of limestone, from aragonite particles precipitated from seawater, and from the fragmented remains of corals, cast-off shells, and calcareous algae (Clark 1990). However, several of the beaches on the Keys have been artificially nourished historically, and therefore do contain quartz sand.

Indian Key Fill

The shorelines between Upper and Lower Matecumbe Key in the City of Islamorada are known as Indian Key Fill; they were created by artificial fill material. Within this area, Clark (1990) had noted that between Upper and Lower Matecumbe Keys, the small Tea Table Key is bulkheaded and the Indian Key shoreline is mixed sand and gravel fill along U.S. Route 1; and that the Lower Matecumbe Key shoreline fronting the Florida Straits/Atlantic Ocean also has a mix of riprap, bulkheads, and natural rock shoreline. Today, an old cemented riprap wall is still in place along nearly the entire shoreline lengths of these three Indian Key Fill sections. Most of the shoreline lengths appear to be relatively stable due to the riprap wall, and in some cases, red mangroves along the shorelines. Shallow channels parallel their shorelines, which then intersect perpendicularly to the Tea Table, Indian Key, and Lignumvitae channels that pass underneath U.S. Route 1. Tidal flushing and circulation along these channels and riprap walls likely occurs regularly and effectively (Figure 2-11).

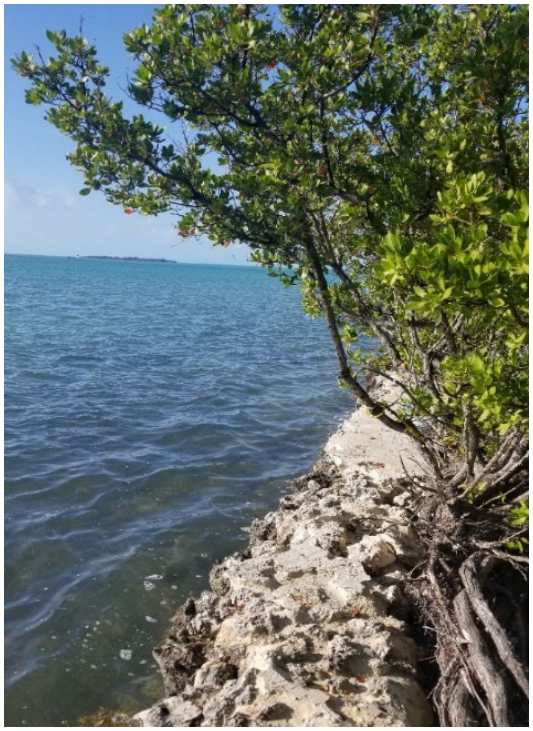

Figure 2-11: Shorelines along Indian Fill Key

Sea Oats Beach

Located in Lower Matecumbe Key in Islamorada, Sea Oats Beach is a 1.3 mile segment that was identified by the Florida DEP's (2019) *Strategic Beach Management Plan: Florida Keys Region* to be a critically eroded beach; and the erosion threatens both recreational interests and U.S. Route 1. In 2005, Hurricanes Rita and Wilma had caused moderate beach and dune erosion and flooding in this segment. FDEP (2019) also notes that Florida Department of Transportation (FDOT) had constructed a road shoulder stabilization project in 2008 that

included an articulating block mattress and a dune system with sand fill and sea oats, but that in 2017 Hurricane Irma severely impacted this area again. The Hurricane Irma Storm Report (2017) considered this structure and system substantially destroyed. U.S. Route 1 was breached, and sand was washed into the roadway and other areas.

Sea Oats Beach (Figure 2-12) has a wide fetch facing the Florida Straits/Atlantic Ocean, and therefore is highly exposed to wave energy and erosion. The Florida DEP's (2019) Strategic Beach Management Plan calls for the initiation of a feasibility study to determine environmentally acceptable erosion control alternatives and monitor. Currently, FDOT has developed a new roadway stabilization project along this area.

Figure 2-12: Sea Oats Beach. Facing south on left side; showing wide fetch across the Florida Straits, right side.

Fiesta Key

At the eastern end of Fiesta Key (Figure 2-13), adjacent to the bridge near Mile Marker 71, there is a steep fill slope that is heavily riprapped with coral rock on the south side of U.S. Route 1. This slope adjacent to the bridge approach is approximately 15 feet above mean sea level.

Two other sections bordering the Florida Straits/Atlantic Ocean along the west end of Fiesta Key between Mile Markers 69 and 70, have been damaged by erosion, with sections of the U.S. Route 1 Overseas Trail washed out by Hurricane Irma, and there is scour along the banks

immediately adjacent to the trail. However, these sections also have a mature wooded mangrove and buttonwood buffer channelward of them (Figure 2-13).

Figure 2-13: Fiesta Key. Near Mile Marker 70 at left, and near Mile Marker 69.5 at right, showing washouts of Overseas Trail.

Long Key State Park

Clark (1990) had noted that the western three quarters of Long Key has a west direction of longshore sediment transport; that critical erosion of 2,950 feet of shoreline exists along the camping and swimming areas within the State Recreation Area, and that at that time, park officials estimated that approximately 0.6 mile of the beach had been eroding as much as three feet per year since the park was opened in 1970 (Figure 2-14). A rock revetment was constructed along a limited segment of shoreline in 1976; however, Clark noted that erosion end effects are most apparent adjacent to the structure. Clark postulated that small tidal creeks, tidal lagoons, and a mangrove dominant shoreline fronting on the Florida Straits/Atlantic Ocean near the center of the island create a sediment budget deficit to the west, also affecting the shoreline campgrounds. This erosion was considered critical, due to the threat to the campground facilities (Clark 1990).

The FDEP's Strategic Beach Plan (2019) noted that the park was severely impacted by Hurricanes Georges and Irene in 1998 and 1999. Beach and dune restoration was considered necessary after these storms, and a feasibility study was initiated by the FDEP. However, in 2005, Hurricanes Rita and Wilma combined severely impacted the park again, and damaged all

the waterfront campsites and infrastructure. FDEP's Plan recommended construction of a beach restoration project that provides acceptable mitigation for sea grass beds and monitor. Long Key State Park is currently working on a plan.

Figure 2-14: Long Key State Park. Facing south at left, and north at right. Remnants of the revetment are still present.

Duck Key

Two bridge approaches along Duck Key adjacent to Toms Harbor, at Mile Markers 60.5 and 62, are both armored with coral rock and/or poured concrete. Both locations also have a mature thicket of woody species (Figure 2-15 to 2-16). At Mile Marker 60.5, there is a mixed mangrove and buttonwood community. The areas with the widest mangrove buffer experienced no damage.

A metal corrugated bulkhead is present along the shoreline at Mile Marker 62. Channelward of the wall, the water is approximately 40 inches deep. Although the metal corrugated wall is old and somewhat damaged, it is still intact. Concrete and coral rock are present behind and upslope of the wall also to be stable. Landward of it is a mature buttonwood thicket. It does not appear that regular tides wash over the seawall.

Figure 2-15: Bridge approach near Duck Key, near Mile Marker 61.5

Figure 2-16: Bridge approach near Duck Key, Mile Marker 60.

Bahia Honda Key

The FDEP's Strategic Beach Plan (2019) states that the most significant carbonate beaches and dunes of the Lower Keys are on Bahia Honda Key, which is part of Bahia Honda State Park. The island has 11,900 feet of beach, south of U.S. Highway 1, fronting the Straits of Florida. Sediment transport has been observed to occur primarily during storm events, with most of the material either being transported onshore or offshore (FDEP 2019).

FDEP (2019) notes that several attempts have been made to armor and fill the eroding areas since the early 1970's. The area was designated critically eroded, and was estimated to have receded about five feet between 1971 and 1986. Erosion control efforts have included the riprap along the 400 to 500 feet of threatened roadway in the early 1970's, the 1988/89 construction of a 1,200 foot long limestone rock revetment, and substantial sea oats planting during the 1980s and 1990s.

FDEP (2019) indicated that Hurricane Georges, in 1998, caused major beach and dune erosion and severely damaged the park facilities, roadway and bridge. In 2005, Hurricanes Rita inflicted minor to moderate beach and dune erosion; and that same year, Hurricane Wilma caused moderate to major beach and dune erosion. Wilma also caused severe damage to the park's recreation facilities at the public beaches. Overwash sediments were returned to the beaches as part of the post-storm recovery operations. FDEP indicated that in 2005, a feasibility study was completed to investigate sand sources for State Parks in the Florida Keys, including Bahia Honda State Park. In 2017, Hurricane Irma caused major beach and dune erosion and severely damaged the park facilities, parking areas and roadway (FDEP 2019). The section of limestone rock revetment that washed out is within the ROI. These areas, including the Park's campground roadway and campground, remain closed to the public.

FDEP's Strategic Plan (2019) recommends maintaining a beach project consisting of sand trucked from approved upland borrow sites, placed in an alongshore berm configuration above mean high water, and stabilized with plantings of native vegetation, and monitoring.

Figure 2-17: Bahia Honda State Park looking west along the Mean High Water line, at left; looking west along the vegetated upland beach area at right.

West Summerland Key

This location has a concrete seawall along the shoreline, and water approximately 40 inches deep immediately channelward of it. The seawall is damaged but mostly intact. Water seeps behind the seawall and is sufficient to support what is now a mostly emergent wetland (Figure 2-18). Hurricane Irma washed over and through the seawall, damaged mangroves, and washing out the U.S. Route 1 Overseas trail.

Figure 2-18: West Summerland Key, showing existing concrete seawall and the wetland landward of it. Photo at right shows the base of the wall where water seeps behind the wall.

Cudjoe Key

This location is adjacent to the bridge approach that crosses Kemp channel (Figure 2-19). This is a steep slope approximately 15 feet high that contains scattered limestone rock and concrete, and has a mature, dense stand of mangroves along the shoreline growing among smaller sized limestone rock, with a mature, dense buttonwood community upslope. Nearshore areas are shallow and gravelly. There is minimal visible shoreline erosion or scour at the waterline. However, there is upland scour, perhaps caused both by runoff and storm events, along the upland slope adjacent to the U.S. Route 1 Overseas Trail.

Figure 2-19: Representative photos of the shoreline along the bridge approach at Cudjoe Key, adjacent to Kemps Channel.

Nonstructural Areas

The source of hydrology in the nonstructural areas is largely tidal and storm-related flooding of low-lying areas. Flooding has become increasingly problematic and is exacerbated by sea level rise.

2.7 WATER QUALITY

Water quality affects the ability of a water body to support life and also human activities such as recreation. 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. This water quality analysis has been prepared considering the applicable federal and state regulations as discussed in the following sections.

2.7.1 Federal

Clean Water Act

The Clean Water Act (CWA) of 1972, as amended (33 USC §§ 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 U.S. The U.S. Environmental Protection Agency (USEPA) is responsible for administering the water quality requirements of the CWA. Section 303(d) of the CWA requires all states to identify waters that do not meet, or are not expected to meet, applicable water quality standards. In addition to the discharge restrictions, the CWA Section 404 requires a USACE issued permit for the dredging and/or filling of jurisdictional waters of the U.S. Areas meeting the "waters of the U.S." definition are under the jurisdiction of the USACE. Anyone proposing to conduct a project that requires a federal permit or involves dredge or fill activities that may result in a discharge to U.S. surface waters and/or waters of the U.S. is required to obtain a CWA Section 401 Water Quality Certification from the FDEP, verifying that project activities will comply with water quality standards.

Florida Keys National Marine Sanctuary (FKNMS) Program

In accordance with the standards set forth in title III of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended, also known as the National Marine Sanctuaries Act (Act) the mission of the National Marine Sanctuary program (Program) is to identify, designate, and manage areas of the marine environment of special national, and in some cases international, significance due to their conservation, recreational, ecological, historical, research, educational, or aesthetic qualities. Public Law 101-605 established the FKNMS. The purpose of the FKNMS regulations are to implement the designations of the National Marine Sanctuaries by regulating activities affecting them, consistent with their respective terms of designation, in order to protect, preserve, and manage and thereby ensure the health, integrity and continued availability of the conservation, ecological, recreational, research, educational, historical, and aesthetic resources and qualities of these areas.

Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 (as amended; 33 USC § 403) regulates structures or work that would affect navigable waters of the U.S. Structures include any tidal gate, storm surge wall, pump intakes, or outlets that might be built as a result of recommendations of this study as well as piers, wharfs, bulkheads, etc. Work includes dredging,

filling, excavation, or other modifications to navigable waters of the U.S. The USACE issues permits for work or structures in navigable waters of the U.S.

2.7.2 State

The determination whether the state's waters support their applicable designated uses as mandated by Section 305(b) of the Clean Water Act is made by FDEP and reported annually to USEPA based on monitoring data. There are six designated uses that may be applied to surface waters: aquatic life, fish consumption, shellfishing, recreation, public water supply, and wildlife. Water quality standards define the water quality needed to support each of these uses by establishing the numeric criteria for comparison of physical and chemical data. Section 303(d) of the CWA requires all states to identify waters that do not meet, or are not expected to meet, applicable water quality standards. If a waterbody contains more of a pollutant than is allowed by the water quality standards, it will not support one or more of its designated uses. Such waters are considered to have an "impaired" quality. An "impairment" refers to an individual parameter or characteristic that violates a water quality standard. A waterbody fails to support a designated use when it has one or more impairments. In most cases, a cleanup plan (called a "total maximum daily load") must be developed and implemented to restore impaired waters. The state creates total maximum daily loads (TMDLs) on a tributary level that indicate the total pollutants that a water body can assimilate and still meet water quality standards.

Section 403.061(27), Florida Statutes, grants FDEP the authority to establish rules that provide for a special category of waterbodies within the state, to be referred to as "Outstanding Florida Waters (OFW)," which shall be worthy of special protection because of their natural attributes. Generally, OFW include Marine Sanctuaries. Aquatic Preserves, State Parks, Wildlife Refuges, and the like. Projects regulated by the Department or a Water Management District (WMD) that are proposed within an OFW must not lower existing ambient water quality, which is defined for purposes of an OFW designation as the water quality at the time of OFW designation or the year before applying for a permit, whichever water quality is better (FDEP 2020).

The importance of water quality was recognized in the 1990 authorizing legislative language for FKNMS, which established of a Water Quality Protection Program (WQPP) to be administered by the FDEP and USEPA. The purpose of the WQPP is to identify and implement priority corrective actions to address point and nonpoint sources of pollution in order to maintain the chemical, physical, and biological integrity of the sanctuary. The goal of the program is to restore and maintain balanced indigenous populations of corals, shellfish, fish, and wildlife and recreational activities in and on the water. The WQPP supports long term monitoring programs of water quality, coral reefs, and seagrass/benthic communities and selected special studies to address a variety of related topics. Research and monitoring projects are designed to quantify status and trends, answer resource management questions, and develop new scientific hypotheses for the FKNMS. Since 1995, the Water Quality Monitoring Project of the WQPP has conducted regular monitoring at more than 100 fixed stations throughout the sanctuary. A variety of physical and chemical parameters are sampled, including salinity, water temperature, total phosphorus (TP), total nitrogen (TN), dissolved oxygen (DO), dissolved inorganic nitrogen (DIN), and total organic carbon (TOC) (NOAA, 2019a).

2.7.3 Existing Conditions

Water quality is generally good in the Florida Keys. However, nearshore water quality is impacted by stormwater runoff and wastewater. There are still onsite septic systems in portions of the Florida Keys, and older systems do not effectively remove nitrogen and phosphorus from effluent, which leads to eutrophication of nearshore waters. These are gradually being replaced by a county-wide sanitary sewer system. Stormwater runoff contributes to nearshore water quality degradation by carrying fertilizers, pesticides, contaminants, and pet waste into the water during rain events. Most of these pollutants are directly associated with coastal development (NOAA, 2019a).

The Marine Sanctuary waters are designated as OFW. However, currently, the Atlantic Ocean from Bahia Honda Key to Key West, is also is on the 303(d) impaired waters list for total nitrogen levels. This waterbody is impaired for this parameter because the annual geometric means exceeded the criterion more than once in a three year period during the verified period. This parameter is being added to the Verified List and the department is requesting USEPA add to the 303(d) List (FDEP, 2018b).

The Upper, Middle, and Lower Keys are on the 303(d) list for mercury in fish tissue. This is based on a Department of Health fish consumption advisory data from 2005-2008 for 76 King Mackerel with an average mercury concentration of 0.5 ppm. FDEP has adopted a USEPA approved mercury TMDL, and is requesting USEPA remove it from the 303(d) List (FDEP, 2018).

2.8 FLOOD PLAINS

For the purpose of the following discussion, flood plains is defined as any land area susceptible to being inundated by floodwaters from any source. The ROI is all flood plain areas within the Florida Keys where flooding has occurred in the past or there is a potential for flooding, including tidal and/or rainfall events.

Executive Order 11988 – Flood Plain Management

Through Executive Order (EO) 11988, federal agencies are required to evaluate all proposed actions within the one percent annual chance flood plain or Base Flood Plain as defined by FEMA. 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, and 3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, and licensing activities. In addition, the FEMA 0.2 percent annual chance flood plain should be evaluated for critical actions or facilities, such as storage of hazardous materials or construction of a hospital.

USACE Engineering Regulation (ER) 1165-2-26

Engineering Regulation (ER) 1165-2-26 sets forth general policy and guidance for USACE implementation of EO 11988 as it pertains to the planning, design, and construction of Civil Works projects and activities under the Operation and Maintenance and Real Estate Programs. As shown in ER 1165-2-26 and in accordance with EO 11988, USACE uses an eight step process as part of the decision making for projects that have potential impacts to or are within the Base Flood Plain. The eight steps and project specific responses for EO 11988 are discussed further in chapter 9, Environmental Compliance.

Section 202(c) of Water Resources Development Act of 1996

Section 202(c) of WRDA 1996 provides that before the construction of any project for local flood damage reduction or hurricane or storm damage reduction that involves assistance from the Secretary of the Army, the non-federal interest must agree to participate in and comply with applicable federal flood plain management and flood insurance programs. It also requires non-federal interests to prepare a Flood Plain Management Plan designed to reduce the impacts of future flood events in the project area within one year of signing a Project Partnership Agreement (PPA) and to implement the plan not later than one year after completion of construction of the project.

More specifically, Section 202(c) requires that the non-federal interest shall prepare a plan designed to reduce the impacts of future flooding in the project area. It should be based on post-project flood plain conditions. The primary focus of the Plan should be to address potential measures, practices, and policies which will reduce the impacts of future residual flooding, help preserve levels of protection provided by the USACE project, and preserve and enhance natural flood plain values. In addition, the plan should address the risk of future flood damages to structures within the post project flood plain and internal drainage issues related to USACE levee/floodwall projects. Since actions within the flood plain upstream and downstream from the project area can affect the performance of a USACE project, the plan developed by the non-federal sponsor should not be limited to addressing measures solely within the immediate project boundaries. Monroe County has a Hazard Mitigation/Flood Plain Management Plan approved by FEMA in 2015. FEMA approvals are conducted on a five-year cycle, with the next review and approval in 2020 (MCWG 2015).

2.8.1 Existing Conditions

As with many coastal communities, Monroe County can be prone to flooding caused by coastal storm events. By having exposed waterfront areas, flat topography, land areas with low elevations, and populated and urbanized areas, the impacts to people, property, and the environment have been experienced from past storm events and continue to be a problem and concern.

The Florida Keys are typically long, narrow, and low-lying islands. The average elevations of the various larger islands generally range from four to seven feet above sea level. Only one small area in the city of Key West, referred to as Solares Hill, is approximately 16 feet above sea level. Other relatively high areas are several coral ridges in Key Largo near mile marker 106. The entire mainland portion of Monroe County is within the Everglades National Park or the Big Cypress National Preserve and is virtually uninhabited, with only 14 residential buildings

(MCWG 2015). In some areas that are low in elevation, Monroe County experiences nuisance type or minor flooding during a normal astronomical high tide, even on a sunny day when there is no storm or heavy rainfall. Water levels can be higher when the tide is highest during a Spring tide cycle, sometimes referred to a King Tide. While the flooding may not be life threatening, it can disrupt transportation and cause added public works expenses for the local community.

Severe or major flooding usually occurs during tidal storm events and/or from heavy rainfall, usually associated with tropical systems or just a heavy rainfall weather event. Flooding can be short term or long term in duration. For tropical events, peak tidal flooding will typically last during one astronomical tide cycle. For any coastal community with flat topography, low land elevations, and developed areas, flooding can be significantly worse when there is combined tidal and rainfall flooding, especially with respect to storm water drainage systems. Aside from tropical storms, rainfall events by themselves can cause flooding. With sudden and brief heavy downpours, drainage systems that are not designed to discharge the large amount of rainfall runoff can easily be overwhelmed. With the amount of impervious surface area, urban areas are most prone to flash flooding, where there is a large amount of rainfall in a short amount of time. Steady rainfall that occurs over a multi-day/week period or from back-to-back weather events can cause the ground to become over saturated and unable to absorb water, thus increasing the amount of rainfall runoff that may enter the drainage system and cause flooding. In some cases, standing water can last for days on properties, roadways, agricultural fields, etc.

Before official records were initiated, historical evidence shows Florida was impacted by storms prior to the 1900s (FEMA 2005). NOAA began weather records for the South Florida area in Key West as early as 1828 (NOAA 2020a). NOAA has three tide gages that may apply to the upper, middle, and lower Florida Keys: Virginia Key, established in 1994, near Miami; Vaca Key, established in 1970; and Key West, established in 1913, respectively. The highest recorded storm tide elevation for the period of record at Virginia Key is 3.8 feet, NAVD88 on September 10, 2017 (Hurricane Irma); 5.4 feet at Vaca Key in October 24, 2005 (Hurricane Wilma); and 3.2 feet at Key West also on October 24, 2005 (NOAA 2020b). Table 2-1 lists notable storm events with storm tide elevations and rainfall amounts collected at various locations within the Florida Keys (FEMA and USACE 1993; USACE 1998; FEMA 2005; MCWG 2015; NOAA 2020 a,b,c,d) (Table 2-1). The table shows a storm tide elevation of 15.3 feet, NAVD88 for Hurricane Andrew in 1992 at nearby Homestead, where surveys at Key Largo showed a lower storm tide elevation of 2.7 feet, NAVD88. The last hurricane event for the area with a comparable storm tide to Hurricane Andrew was the 1935 Labor Day Hurricane, with a storm tide elevation of 16.5 feet, NAVD88 at Lower Matecumbe Key.

Table 2-1: Notable Storm Events for the Florida Keys

Storm Event	Location	Storm Tide Elevation, feet, NAVD88	Rainfall, inches
September 22 to October 4, 1929	Key Largo / Key West	7.4 / 4.7	2.9 (Key West Airport)
August 29 to September 10, 1935 (Labor Day Hurricane)	Key Largo / Lower Matecumbe Key / Key West	12.4 / 16.5 / 0.7	1.6 (Key West Airport)
September 12-19, 1945	Southern Biscayne Bay, Carrysfort Reef	12.1	0.2 (Key West)
September 19-25, 1948	Vaca Key / Key West	6.6 / 1.4	8.0 (Key West Airport)
Hurricane Donna, August 29 to September 13, 1960	Upper Matecumbe Key / Plantation Key / Key Largo / Key West	12.0 / 8.5 / 7.3 / 3.4	12.1 (Marathon Shores)
Hurricane Betsy, August 26 to September 12, 1965	Key Largo	7.4	10.5 (Big Pine Key) / 11.8 (Plantation Key)
Hurricane Andrew, August 24, 1992	Homestead, near Charles Deering Estate / Key Largo	15.3 / 2.7	2.0 (Cudjoe Key)
Hurricane Georges, September 1998	Cudjoe Ocean Shores	6.1	8.4 (Tavernier, Key West)
Hurricane Wilma, October 2005	Vaca Key / Key West	5.4 / 3.2	1.5 (Key Largo)
Hurricane Irma, September 2017	Big Pine Key	7.9	6 to 10 (across the Florida Keys)

Sources: FEMA and USACE 1993; USACE 1998; FEMA 2005; MCWG 2015; NOAA 2020 a,b,c,d

The Florida Keys were also impacted by Hurricanes Mitch (November 1998), Irene (October 1999), and Rita (September 2005), but the level of storm surge was less than five feet. The number of National Flood Insurance Program (NFIP) flood claims was less than 400 for each event: 41, 396, and 171, respectively. However, for Hurricanes Georges, Wilma, and Irma, the number of NFIP flood claims was over 3,000 for each event: 3,055, 4,070, and 3,163, respectively (MCWG 2015).

EO 11988 references the FEMA one and 0.2 percent annual chance flood plains. Monroe County participates in FEMA's NFIP. The effective FEMA Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRM) for Monroe County and incorporated areas are dated

February 18, 2005. Generally, the majority of the Florida Keys are located within the effective one and 0.2 percent annual chance flood plains, except for one area in Key West and isolated high areas along U.S. Route 1 that are north of Islamorada as shown in Figures 2-20 and 2-21. The one percent annual chance flood plain is shown in blue color and the 0.2 percent annual chance flood plain is orange color. Because of the approximate 120 miles of linear distance covering the Florida Keys and due to map scale, no other effective FEMA FIRMs are shown, but can viewed online at FEMA's Map Service Center using the National Flood Hazard Layer Viewer (FEMA 2020). For comparison to historical data, the effective maximum FEMA one percent annual chance stillwater storm tide elevation (no wave setup) is nine feet, NAVD88 and the maximum one percent annual chance wave crest elevation is 15.8 feet, NAVD88.

The effective 2005 FIS and FIRMs are currently going through a revision and scheduled to be final in 2021-2022. The revision includes new coastal engineering (storm surge and wave height analyses) and more accurate topographic mapping. The coastal areas shown on the effective FIRMs, except for two site specific locations from submitted Letters of Map Revision, are based on an engineering analysis completed in 1988 and U.S. Geological Survey 7.5 Minute Quadrangle Topographic Mapping, where the topographic contour interval is five feet (FEMA 2005). With new engineering and more detailed and accurate topographic mapping, there could be significant changes with the revised coastal one and 0.2 percent annual chance flood elevations and flood plain mapping boundaries (Figures 2-20 and 2-21).

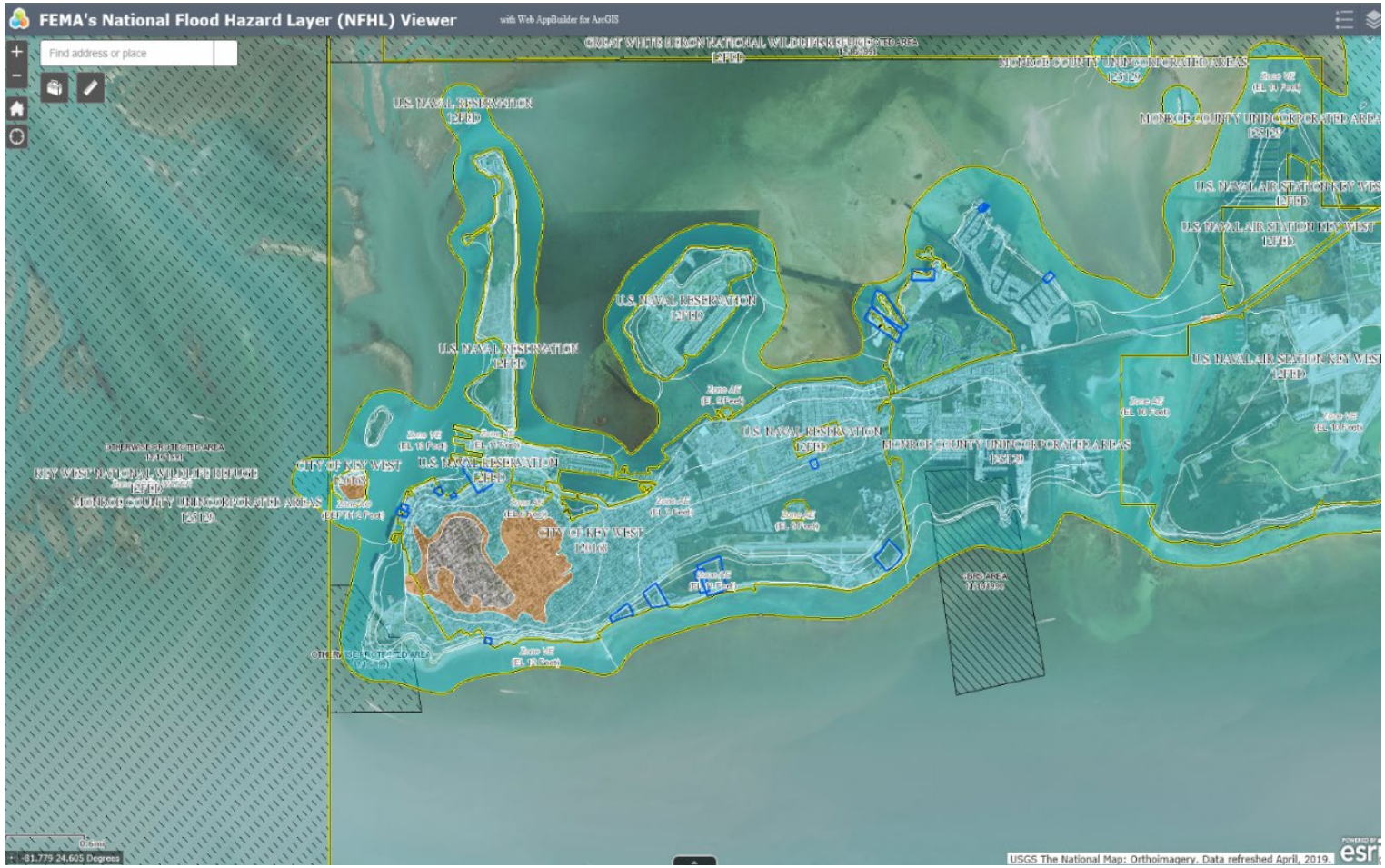

Figure 2-20: Effective 2005 FEMA 1 and 0.2 Percent Annual Chance Flood Plains – Key West (FEMA Map Service Center, National Flood Hazard Layer Viewer)

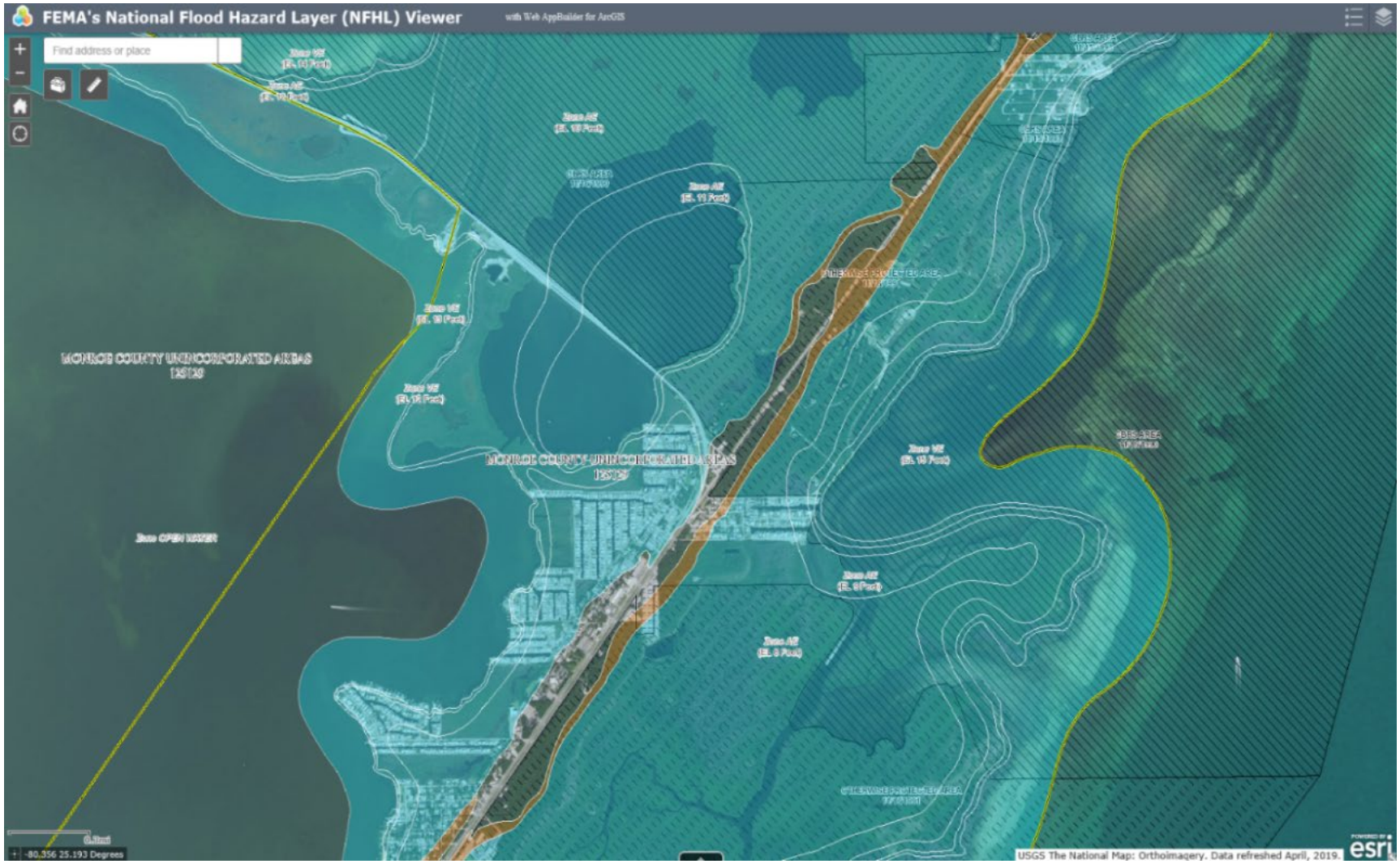

Figure 2-21: FEMA 1 and 0.2 Percent Annual Chance Flood Plains – Along U.S.-1, Near Key Largo (FEMA Map Service Center, National Flood Hazard Layer Viewer)

Monroe County has an estimated permanent population of 77,000, with an additional seasonal population of approximately 81,000, for a total of 158,000 during the peak time of the year. There are approximately 54,000 housing units within Monroe County. Monroe County obtained FEMA Repetitive Loss data (2015), of which 916 properties were designated as Repetitive Loss properties, where 631 properties were within the unincorporated areas of Monroe County and 221 within the city of Key West (MCWG 2015). The Repetitive Loss information provides a good indication of areas that may be most vulnerable to flooding, where mitigation actions may be implemented. As defined by FEMA, a Repetitive Loss property is any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling ten year period, since 1978. A Repetitive Loss property may or may not be currently insured by the NFIP.

Even if an area only had one Repetitive Loss property from past flooding, there could be many others in that area that could be just as vulnerable if the water level was only a few inches higher. As such, unincorporated Monroe County recently completed a repetitive loss analysis looking at other properties located adjacent to or near designated FEMA Repetitive Loss properties within geographic areas or neighborhoods. Nearly 14,000 properties within the unincorporated areas within the County have flood insurance; the majority of the buildings are located in a coastal floodplain. Many were built before January 1975, when the County adopted its first flood plain regulations, which means they were likely built without any flood protection considerations. Of the 14,000, approximately 4,500 structures were built before January 1975 and 9,500 after. The analysis identified over 9,500 properties that are potentially exposed to the same flood risk, referred to in the analysis as “repetitive loss properties in waiting.” Note, the draft analysis identified approximately 400 FEMA designated Repetitive Loss properties within unincorporated Monroe County, verses 631 in the 2015 Local Mitigation Strategy Update (Monroe County 2019). The reduction in number may be due to properties that have had flood mitigation measures implemented.

In addition to buildings being impacted by flooding, impacts to water supply, saltwater intrusion, sanitary and septic systems, oil/fuel/chemical facilities, gas/electrical/oil/chemical fires, stormwater systems, water quality, roadways/evacuation routes, other critical infrastructure, dangers of floating debris, shoreline erosion, natural habitat areas and animals, historic and cultural resources, life-safety (death from drowning or electrocution), etc. are also concerns of Monroe County. Continued sea level rise, when combined with a storm surge and/or rainfall events, will only make the flooding experienced so far only worse. The historic rate of sea level rise at the Virginia Key tide gage (1931-2018) is approximately 0.11 inches per year; Vaca Key (1971 to 2018) at 0.14, and Key West (1913 to 2018) at 0.09, or approximately one foot per 100 years for each of the gages (NOAA 2020b). A 2016 study titled “Increasing flooding hazard in coastal communities due to rising sea level: Case study of Miami Beach, Florida” evaluated tide and rain gauge records, media reports, insurance claims, and photo records from Miami Beach acquired during 1998-2013. The study indicated that significant changes in flooding frequency occurred after 2006, in which rain induced events increased by 33 percent and tide induced events increased by more than 400 percent. The study also analyzed tide gage records from Southeast Florida and detected decadal-scale accelerating rates of sea level rise. The average

pre-2006 rate is 0.12 ± 0.08 inches per year, similar to the global long term rate of sea level rise, whereas after 2006 the average rate of sea level rise in Southeast Florida rose to 0.35 ± 0.16 inches per year (Wdowinski et al. 2016).

As discussed, while there can be direct impacts to buildings, infrastructure, the environment, life safety, etc. from flooding, indirect impacts also exist that could apply to an individual or to a larger community, and short term or long term depending on the situation. This could include loss of wages for homeowners, loss of revenue for businesses, loss of government tax revenue, the need for temporary housing, lower property values, increased travel time due to loss of transportation routes, increase in crime, mental and physical health issues, deaths, school closings, reduced tourism, business closings, foreclosures, bringing a non-compliant structure into compliance with local floodplain regulations if substantially damaged, etc. Direct and/or indirect impacts can be worse or prolonged if back-to-back floods occur. Before, during, and after a flood, local, state, and federal governments and citizens may have expenses to contend with that may not be covered by insurance or other means.

With respect to a substantially damaged structure mentioned above, for a structure within the one percent annual chance flood plain, regardless of whether the structure has flood insurance, is not in compliance with the requirements for lowest floor being elevated to or above the one percent annual chance flood plain (or floodproofed if nonresidential) in accordance with local flood plain regulations, is flooded or damaged by fire, wind, rain, or other natural or human induced hazard and the cost of restoring the structure to its before damaged condition would equal 50 percent of the market value of the structure before the damaged occurred, then the structure will be required to be brought into compliance. For a property owner who does not have proper insurance, it could be very costly to restore the structure and meet local flood plain regulations.

In addition, the effective 2005 FIRMs also show Coastal Barrier Resources System (CBRS) and Otherwise Protected Area (OPA) boundaries. The Coastal Barrier Resources Act (CBRA) was passed by Congress in 1982 to encourage conservation of hurricane prone, biologically rich coastal barriers. 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 CBRS are not eligible for certain federal funding and financial assistance, including coverage under the NFIP. Development can still occur within the CBRS, as long as private developers or other non-federal parties bear the full cost. More specifically, the 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 NFIP may provide flood insurance for units built or substantially improved before the subject property was included in a designated CBRS unit. If an NFIP insured building within a designated CBRS unit is substantially improved or substantially damaged, the NFIP policy will be cancelled. NFIP flood insurance can be provided within CBRS units for new structures supporting conservation uses. Minimum NFIP flood plain management standards do not prohibit the rebuilding of substantially damaged buildings in CBRS units. However, such structures must meet the community's floodplain management regulations, and NFIP coverage is not available for such structures. Note, although shown on the effective

FIRMs, CBRS, and OPA boundaries can change; the official and most up to date boundary information is maintained by the USFWS.

Flood mitigation activities are used to help reduce or eliminate the impacts from flooding. Monroe County has completed many activities in trying to address the many flooding problems and help its citizens. FEMA encourages communities to be proactive with flood mitigation activities by joining the Community Rating System (CRS). The CRS is a voluntary program for communities that participate in the NFIP to complete FEMA approved mitigation projects. In general, projects can include activities involving public information, mapping and regulations, flood damage reduction, and warning and response. Participation in CRS provides residents of those communities with flood insurance discounts. The discounts are based upon the CRS rating of the community from a Class 10 to a Class 1 with a five percent discount for each class obtained, ranging from ratings of Class 1, a 45 percent discount, to Class 9, a five percent discount. As of October 2019, the following CRS class ratings were earned: Islamorada – 6, Key Colony Beach – 7, Key West – 7, Layton - 6, Marathon – 6, and Monroe County – 5 (FEMA 2019). A listing of completed flood mitigation activities can be found in Monroe County's Hazard Mitigation Plan (MCWG 2015); some communities may have the information posted on their websites.

2.9 BEACHES AND TERRESTRIAL VEGETATION HABITAT

For the purpose of the following discussion, this section is intended to focus on terrestrial habitat above mean high water (MHW). However, due to the interconnectedness of ecosystems, there is some overlap with other sections.

The ROI is all areas within the Keys that will be temporarily or permanently filled, graded, cleared, excavated, or otherwise converted to another use as a result of the construction of the structural or nonstructural measures. It also includes all noise and disturbance effects indirectly adversely affected by the project, by means such as erosion, alteration of wildlife passage corridors, or changes in community type.

Section 307(c)(1) of the Coastal Zone Management Act (CZMA) requires that any federal agency that undertakes any development project in the coastal zone of a state shall insure that the project is, to the maximum extent practicable, consistent with the enforceable policies of the approved state management programs. It also requires that the federal agency shall complete and provide a federal consistency determination to the state that includes effects on wildlife.

The Coastal Construction Control Line (CCCL) defines by Florida Statutes that portion of the beach and dune system subject to severe fluctuations based on a 100-year storm event and establishes the landward limit of jurisdiction of FDEP along sandy beaches of the state along the Gulf of Mexico, the Atlantic Ocean, and the Straits of Florida. Unless otherwise exempt, a permit is required from FDEP for construction and excavation activities seaward of the CCCL. The CCCL is not a seaward limit for construction of upland structures (as in a setback line), but is an area wherein special siting and design considerations are required to protect the beach and dune system, proposed or existing structures, adjacent properties, public beach access, native salt-tolerant coastal vegetation, and marine turtles. On sandy beach areas where no CCCL has been established pursuant to Section 161.053, Florida Statutes (F.S.), coastal

construction is prohibited within 50 feet of the line of MHW unless authorized by waiver or variance of the setback requirements pursuant to Section 161.052, F.S (FDEP, 2020a).

2.9.1 Existing conditions

Beaches

Within the ROI, which includes shorelines within 100 feet of U.S. Route 1, three locations considered to be beach habitat are at Bahia Honda and Long Key State Parks and Sea Oats Beach. The beach berm, dune, and intertidal zones there tend to be very narrow. Although historically wider, they have been eroded more recently by storms and hurricanes. Therefore, the beach habitat quality and areas within the ROI are more limited in the amount of habitat they can provide than they were in the past.

Beach berms are dynamic and fragile ecosystems that host a wide diversity of species. The beach berm is considered to be any sandy areas within a ten foot (three meter) elevation range above mean high water (MHW). These ecosystems are dynamic systems that are formed and maintained naturally through the accretion and erosion of sediment from storm and wind events. Succession of vegetation occurs through disturbance, and recolonization of vegetation occurs through deposition of seeds that are transported through oceanic currents (NOAA, 2019a).

The wrackline is the area on the beach where organic material and other debris is deposited at high tide (Figure 2-22). Typical rack material includes uprooted seagrasses, algae, seeds, mangrove leaves and propagules, sponges, soft corals, and shells. Small crustaceans called amphipods feed among the seagrass wracklines, and shorebirds come along and forage on them. The foraging breaks down the seagrass in the wrackline, and the particles become nutrients for the dunes. The wrackline also helps stabilize the sand, which promotes dune life (Florida State Parks, 2020).

Figure 2-22: Rack Line at Bahia Honda State Park (l). Rack line and vegetated beach at Long Key State Park (r).

Within the beach berm zone are coastal dunes, which are found at an elevation of zero to four feet (1.2 meters) and adjacent to the intertidal zone. This area is primarily made up of sandy soils and is sparsely vegetated with species such as bay cedar (*Suriana maritima*), sea oats (*Uniola paniculata*), seashore dropseed (*Sporobolus virginicus*), beach panicum, and railroad vine (*Ipomoea pes-caprae*) (Long Key State Park, 2016). Sea lavender, a rare species, can also be found within this zone in these two state parks.

Dunes are a fragile habitat easily damaged by people and storms, the extent of which depends on dune size and profile, quantity and type of flora, beach characteristics, and surrounding water depth. The beach-dune interface is an important ecotone that produces sustained levels of biological activity (Liddle and Greig-Smith 1975, McDonnell 1981, Nickerson and Thibodeau, 1983).

Terrestrial vegetation

Other nearshore terrestrial species of vegetation that can be found along shorelines areas include seaside grape, buttonwood, (*Conocarpus erectus*), white mangrove (*Laguncularia racemosa*), and saltbush (*Baccahris hamifolia*).

Invasive plant species

Some of the more common invasive plant species that occur within the ROI include Brazillian pepper (*Schinus terebinthifolius*), seaside mahoe (*Taliparti tiliaceum*), and Australian pine (*Casuarina equestifollia*). Australian pines outcompete native vegetation due to the chemical properties in their fallen branches which suppress germination, and results in a monoculture

(FDEP, 2016). Brazilian pepper can form dense forests that exclude all other plant life by producing a dense closed canopy that is considered to be poor habitat for native wildlife species and may negatively impact bird populations (Florida Fish and Wildlife Conservation Service, 2020)

2.10 WETLANDS

Wetlands are defined by CWA regulations 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” (USEPA 2016). The two major categories of wetlands are tidal (subject to the ebb and flow of tide), and nontidal (freshwater). Wetlands may be forested, scrub/shrub, or emergent.

The ROI for wetlands includes all wetland areas within the study area to be directly filled, dredged, excavated, or otherwise temporarily or permanently converted to another use as a result of the construction of the measures, as well as all wetlands indirectly adversely affected by the project, by means such as alteration in tidal flushing, sedimentation, currents, erosion, changes in salinity, and community type. It should be noted that all wetlands within the ROI are tidal and brackish.

2.10.1 Existing Conditions

Forested and Scrub/Shrub wetlands: Mangroves

Mangroves grow along more than 1,800 miles of shoreline within FKNMS. In the Florida Keys, the red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove *Laguncularia racemosa*) tend to dominate wetland landscapes. These forests help stabilize coastlines and help reduce erosion from storm surge, currents, waves, tides, and hurricane damage. They also slow down and filter runoff, assisting in keeping waters clean and clear (NOAA 2019a).

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. Most red mangrove dominated wetlands are flooded at least two times per day. The roots of these trees are either fully submerged in water or inundated daily with the tidal cycle. They are important habitat for wildlife, both above and below the water. The prop roots of the red mangrove serve as nursery areas for many commercially and recreationally important fin and shellfish aquatic species. Above the water, they are critical nesting, resting, and feeding sites for many birds including wading birds like great white herons and reddish egrets, magnificent frigatebirds, white crowned-pigeon, osprey, bald eagles, resident and migratory songbirds, hawks, and falcons. The black and white mangrove species are found further up-slope in coastal wetlands (NOAA, 2019a). Buttonwood trees (Conocarpus erectus) are sometimes intermingled with black and/or white mangrove species; however, usually buttonwood is found slightly upslope, and near the transitional wetland/upland border.

Since the 1940s, when dredge and fill operations began in the Florida Keys, mangrove forests have suffered significant losses. Approximately 60 percent of shallow water mangroves in the Upper Keys were lost between 1965 and 1985 due to construction of marinas, airports, and seawalls; dredging of channels; and other commercial and residential construction. Mangrove forests in the Florida Keys have most recently been impacted by the high winds, storm surge, and hypersalinity caused by Hurricane Irma. While some recovery has occurred, mangrove forest recovery can take 10 to 15 years (NOAA, 2019a).

Within the ROI, mangrove fringed wetland shorelines can be found on Cudjoe Key, Spanish Harbor Key, Duck Key, Fiesta Key, and Indian Key (Figures 2-23 to 2-25). These locations all had mature mangroves estimated to be at least 15-30 years old. Within the ROI, most of the mangroves were healthy and mature; in many cases, they were growing and even thriving among old concrete blocks, rocks, and existing riprap or seawalls.

Figure 2-23: Mangrove wetlands within the ROI, growing among concrete at Cudjoe Key.

Figure 2-24: Representative Photos of mixed mangrove wetlands within the ROI.

Herbaceous wetlands

The only other wetland community type in the ROI are a few herbaceous wetland communities dominated by sea purslane (*Sesuvium portulacastrum*) and sea oxeye (*Borrichia frutescens*). These communities can be found landward of the existing seawalls at West Summerland Key and Indian Key. Specifically, at West Summerland Key, landward of an existing concrete seawall, there were several dead and few live mangroves standing, but the herbaceous community of these two species was thriving and young mangrove shoots were coming up.

Figure 2-25: Herbaceous Wetlands at West Summerland Key. U.S. Route 1 at top left.

2.11 BENTHICS AND SUBMERGED AQUATIC VEGETATION

Benthos include organisms living near, in, or on the bottom sediments of the various bodies of water included in the study area. They include highly and semi-motile forms capable of relocating short distances in response to changes in their environment, and sessile invertebrates that remain in place all their adult lives, such as corals. The benthic habitat within the Florida Keys includes both estuarine and marine hydrologic regimes, and is a uniquely productive resource that supports both sensitive, diverse biological systems and a booming commercial and recreational fishery.

The ROI for benthic habitat and submerged aquatic vegetation (SAV) is the intertidal and submerged lands from Palo Alto Key to Key West extending approximately 120 miles, that are to be directly filled, dredged, excavated, or otherwise temporarily or permanently converted to another use as a result of the construction of the measures, as well as all such areas indirectly adversely affected by the project, by means such as alteration in tidal flushing, sedimentation, currents, erosion, changes in salinity, and community type.

These areas may include unconsolidated substrate (sand or mud), red mangrove fringes, hardbottom, and seagrass beds. The ROI includes Critical Habitat for Elkhorn and Staghorn corals, which are further discussed in the Special Status Species section. However, as the structural measures are shoreline stabilization, the ROI footprint would be nearshore and relatively limited.

2.11.1 Existing Conditions

Unconsolidated Substrate: Beaches, Sandflats, and Mudflats

In the Florida Keys, common types of unconsolidated substrates include coralgal, marl, mud, mud/sand, sand, or shell. Unconsolidated sediments can come from organic sources, such as decaying plant tissues (e.g., mud) or from recent or fossilized calcium carbonate depositions of plants or animals (e.g., coralgal, marl, and shell substrates). Infaunal organisms in subtidal zones can be substantial, making these areas important feeding grounds for many bottom-feeding fish. Common infaunal organisms can include mollusks, isopods, amphipods, and an assortment of crabs. The intertidal and supratidal zones are extremely important feeding grounds for many shorebirds and invertebrates (FNAI 2010).

Tidal flats are non-vegetated areas of sand or mud that are tidally submerged and protected from wave action. They provide habitat for a host of marine and terrestrial species throughout the year. Tidal flats provide essential foraging habitat for wading and shorebirds that hunt small fish, crustaceans, and marine invertebrates during low tide cycles (NOAA, 2019a).

Red Mangrove Habitat

As mentioned in the wetland section, red mangroves occur within the ROI. They assist in trapping and cycling various organic materials, chemical elements, and important nutrients throughout the interconnected reef-seagrass-mangrove system. Detritus from mangrove leaves are an important part of the food web that supports decomposers and consumers. In addition, mangrove roots provide nearshore attachment surfaces for various marine organisms, many of which filter water and trap and cycle nutrients. Mangrove prop roots also provide cover used by commercially and recreationally important reef fishes and crustaceans (NOAA, 2019a)

Consolidated Substrate: Hardbottom and Corals

Shallow hardbottom communities are found throughout nearshore environments within the Florida Keys, on both the ocean and bay side, and can be found in up to 30 percent of the nearshore environment of the Florida Keys (Bertelsen et al. 2009). Hardbottom communities can form on solid rock or on low-relief limestone substrates covered with a layer of sediment and sparse seagrass (FNAI 2010).

Hardbottom communities close to shore typically have low species diversity, but can support gorgonians, algae, sponges, and a few stony coral species. These habitats provide important cover and feeding areas for many fish and invertebrates (Florida Museum, 2019). Hardbottom communities are often divided into two types:

- Nearshore restricted hardbottom communities have limited water movement. This bottom community typically is dominated by algae including epilithic algae that attaches itself directly to the limestone bottom as well as drift algae. Algae are at the bottom of the food chain, and provide a primary food source for a variety of organisms including invertebrates, fishes, and even the endangered green sea turtle (Chelonia mydas).
- Nearshore high-velocity hardbottom communities are exposed to strong currents. Gorgonians, easily recognized with their rod-like appearance and flexibility, and sponges can dominate these communities (Florida Museum, 2019).

Although biodiversity of visible organisms on hardbottom may be low compared with patch reefs and deep water reefs, it is much higher on nearshore reefs than on sandy bottom. The term nearshore reefs is meant here to include all solid physical substrate below the mean high water line (MHW) and seaward of Atlantic Ocean or Gulf of Mexico shoreline which may be vulnerable to fill deposition and turbidity (loss of light penetration through the water column) associated with beach nourishment. The zone has been defined by the FDEP as the area landward of the 4 meter (13.1 foot) depth contour (U.S Fish and Wildlife, 1999).

Hardbottom habitat can be easily degraded through siltation, sedimentation, or placement of fill; and is also sensitive to water quality changes associated with thermal stress, salinity changes, and harmful algal blooms.

Corals

Corals and coral reefs in the Florida Keys depend on the Florida Current to bring the warm, low-nutrient waters that corals require to live. Reefs are well developed seaward of the Upper Keys and Lower Keys, but are absent or poorly developed near the wider channels in the middle Keys, where conditions for optimal growth are adversely affected by water quality variations. The Florida Tract Reef is well offshore of the Keys, but there are many patch reefs throughout the Marine Sanctuary, and the Marine Sanctuary is also working to create and enhance reefs (NOAA, 2019a).

The ROI is limited to shorelines and nearshore areas and does not include any known coral reefs or patch reefs. However, as mentioned, it is within the Critical Habitat for Elkhorn and Staghorn Coral, both federally endangered species that are discussed under the Special Status Species section. Also, nearshore hardbottom habitat may include individual corals. Sedimentation, overturned coral colonies, and scouring all have a negative impact on corals and coral reef habitat. Many of the indirect impacts to coral can be derived from declining water quality and clarity (Figure 2-26).

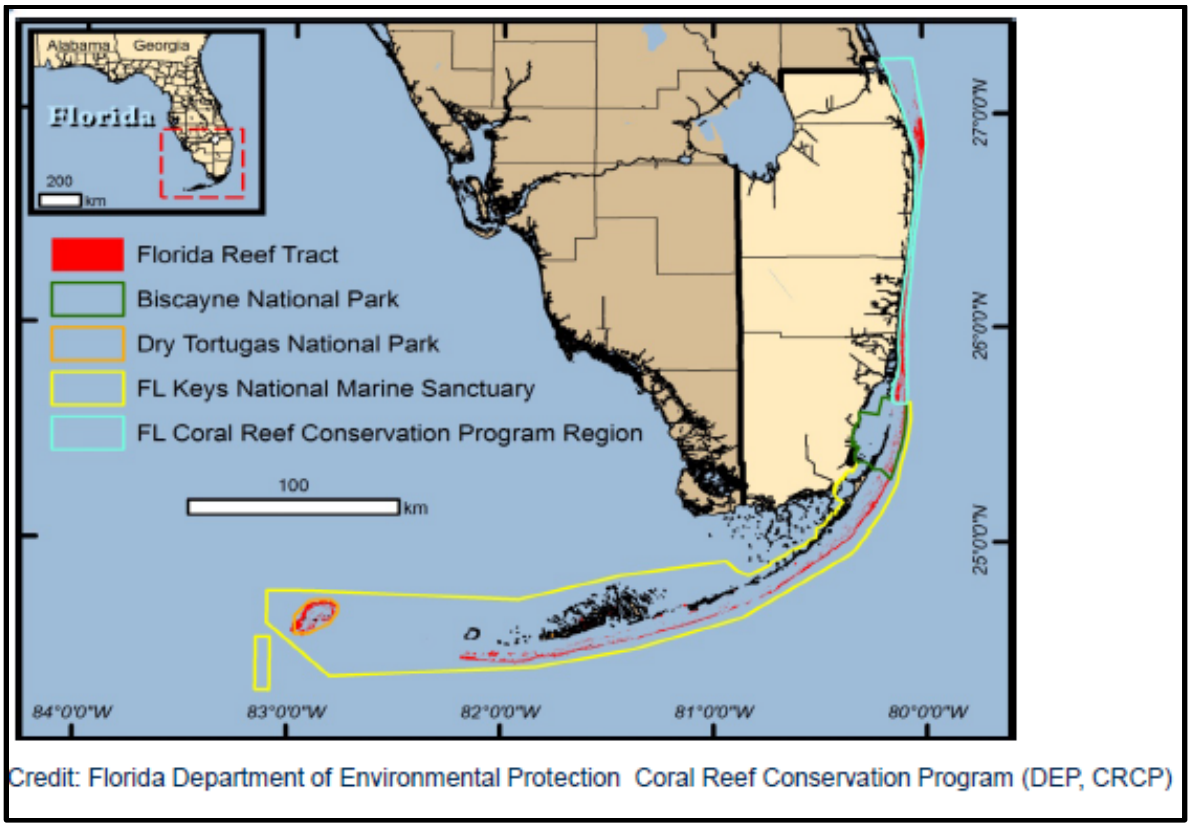

Figure 2-26: Federally Protected Waters within the Florida Keys.

Seagrasses/SAV

Seagrass occurs throughout the soft-bottom, shallow-water areas within the Marine Sanctuary 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. There are both sparse and continuous seagrass beds mapped throughout the FK waters.

Seagrass beds have declined in abundance and distribution and species composition has shifted in some nearshore areas due to water quality degradation and through the direct loss of habitat related to dredging, infilling, coastal development, and boating impacts (e.g., propeller scars and groundings (NOAA, 2019a).

Within the footprint of the ROI, which is limited to nearshore areas, there is no observable seagrass. It is present farther offshore, and includes turtle grass (*Thalassia testudinum*), the dominant seagrass community; shoal grass *(Halodule wrightii*); and manatee grass *(Syringodium filiforme*).

2.12 FISH AND FISHERY RESOURCES

Fish and fishery resources exist in the Marine Sanctuary waters within the Upper, Middle, and Lower Keys. The Upper Keys extend from Virginia Key to Lower Matecumbe Key, the Middle Keys extend from Lower Matecumbe Key to the Seven Mile Bridge, and the Lower Keys extend from Little Duck Key to Key West.

The ROI includes all nearshore environment areas that would be affected temporarily or permanently by structural or nonstructural measures; typically in areas channelward of mean high water (MHW).

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. §§ 1801 et seq.) governs the management of marine fisheries in U.S. federal waters to the 200 mile nautical limit. The 1996 amendments to the MSA, or the Sustainable Fisheries Act, identified fish habitat as a vital component to fisheries management and set forth a mandate for NOAA's National Marine Fisheries Service (NMFS) and regional Fisheries Management Councils to designated Essential Fish Habitat (EFH) for species managed under federal fishery management plans. The MSA defines Essential Fish Habitat as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Habitat Areas of Particular Concern (HAPCs) are subsets of EFH that identify sensitive and high priority EFH conservation areas which support vital ecological functions for designated species. Consultation with NOAA Fisheries is required by the MSA for proposed Federal actions that may adversely affect EFH by reducing the quality and/or quantity of EFH through direct, indirect, or cumulative impacts. An EFH Assessment containing further information is provided in the Environmental Appendix (Appendix D).

The South Atlantic Fishery Management Council (SAFMC) currently manages eight fisheries along the Atlantic Coast within the 200 nautical mile limit extending from North Carolina to Key West. The eight fisheries managed under existing Fishery Management Plans include: snapper grouper, Caribbean spiny lobster (*Panulirus argus*), coastal migratory pelagics (mackerel and cobia), coral and live bottom habitat; dolphin and wahoo; golden crab, and Sargassum.

2.12.1 Existing Conditions

The diverse assemblage of fishes found in the Florida Keys region is vital to the health of the marine ecosystem which supports commercial and recreational fishing as well as various ecotourism activities. Tropical and subtropical fish utilize coral reef, shallow bank, seagrass, and mangrove habitats as nursery and spawning grounds throughout the region. Fishes and marine invertebrates depend on healthy habitats throughout their lives for survival, and they are vulnerable to habitat degradation and other anthropogenic impacts associated with overexploitation, climate change, and poor water quality.

Aquatic Preserves are designated as Outstanding Florida Waters under 62-302.700 Florida Administrative Code (FAC) and provide protection to Florida's valuable aquatic natural resources and cultural heritage. There are 41 aquatic preserves in Florida; however, Lignumvitae Key, which functions as nursery habitat and EFH for species managed by the SAFMC, is the only designated aquatic preserve in the ROI.

Snapper and Groupers

Snappers (family *Lutjanidae*) and groupers (family *Serranidae*) comprise an ecologically important complex of reef fishes with commercial and recreational value in the region. The life history characteristics of these slow growing, late maturing, and long lived species increase their vulnerability to overexploitation with long-term sustainability a concern due to slow recovery times. Methods to prevent overfishing and rebuild stocks include the use of protected areas and stringent harvest regulations established by the SAFMC under the Snapper-Grouper Fishery Management Plan for the South Atlantic Region. These fishes utilize inshore and offshore habitats throughout their life cycle (Ault et al. 2005), with the majority of eggs/larvae dispersing and settling into nearshore environments.

Hogfish (Lachnolaimus maximus)

An economically important reef fish, hogfish are found in tropical and subtropical waters of the Atlantic Ocean, Gulf of Mexico, and Caribbean. In 2017, the SAFMC designated a distinct hogfish stock for the Florida Keys/East Florida. Hogfish rely on reef habitat for protection from predators and for feeding on benthic invertebrates.

Following a 30-40 day pelagic larval phase, hogfish settlement occurs nearshore in shallow seagrass, reef, or estuarine habitats. Hogfish eventually move offshore and onto reef habitats. As protogynous hermaphrodites, hogfish begin life as females and eventually mature into males (McBride and Johnson 2007). In the Florida Keys, the hogfish spawning season typically peaks between December and April. Hogfish form social groups called harems, where one male will protect and spawn with a group of females within his territory. Due to their life history characteristics and history of overfishing, hogfish are vulnerable to overharvesting.

Marine Invertebrates: Caribbean Spiny Lobster and Shrimp Species

The Caribbean spiny lobster (*Panulirus argus*) is widely distributed from North Carolina to Brazil, with the commercial fishery and the majority of the recreational fishery occurring off of South Florida and primarily in the Florida Keys (GMFMC 2017).

Caribbean spiny lobsters utilize mangrove, shallow hardbottom, seagrass, and reef habitats of the Florida Keys. Larvae, which may originate elsewhere in the Caribbean, are transported by ocean currents to the hardbottom habitats of the Florida Keys where postlarvae settle nearshore often in hardbottom habitat covered by red macroalgae where they feed on invertebrates. Caribbean spiny lobsters emerge from the macroalgae and seek protection in crevices under sponges, octocorals, and corals, and also within dissolved limestone burrows and seagrass blowouts after reaching a carapace length of approximately 15-20 millimeters (mm). Larger juveniles migrate to patch reef and offshore reef systems, and both male and female lobsters travel from their shelters to foraging grounds on a daily basis. Caribbean spiny lobsters are also an important prey species in the Florida Keys seagrass ecosystem.

The shrimp fishery represents one of the most important commercial fisheries in the Florida Keys. The various federally managed species that comprise the fishery includes: brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), pink shrimp (*Farfantepenaeus duorarum*), royal red shrimp (*Hymenopenaeus robustus*), and rock shrimp (*Sicyonia*

brevirostris). Various protection measures implemented by SAFMC and the Gulf of Mexico Fishery Management Council include: closed areas in federal waters, the use of bycatch reduction devices, and the prohibition on rock shrimp trawling in Oculina coral areas. Pink shrimp, brown shrimp, and white shrimp can be found in shallow environments while royal red and rock shrimp generally occur in deeper waters. Adult pink shrimp spawn off of the Dry Tortugas, and larvae are transported to shallow-water estuaries where they spend the majority of their lifecycle. Postlarval pink shrimp spend from two to seven months in Florida Bay's seagrass nursery grounds before moving back into the Gulf of Mexico off the Dry Tortugas where they are the dominant species within the Dry Tortugas shrimping grounds (SAFMC 2019).

Habitats

The following section focuses on the primary habitats designated as EFH in the ROI.

Hardbottom

Nearshore environments on the Atlantic Ocean side of the Florida Keys are characterized by shallow hardbottom communities which serve as critical nursery areas for many commercially important fishes and invertebrates, such as the Caribbean spiny lobster. These communities support various sponge species, stony corals, macroalgae, sea fans, and branching gorgonians. Stony coral cover is generally low with sponges as the dominant invertebrates providing shelter and habitat for nearshore marine organisms. Hardbottom habitats are sensitive to water quality changes resulting from thermal stress and harmful algal blooms, and they are easily degraded from sedimentation and fill impacts due to their proximity to land.

Mangroves

Mangrove communities are characterized by three species in the Florida Keys, the red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*). Mangrove roots are inundated daily by tides and their elevation ranges from shallow submerged land to approximately four inches above sea level. Red mangroves are an essential feature of the Florida Keys ecosystem and provide ecosystem services including: trapping and cycling organic materials and nutrients, serving as a carbon sink (living plant material and soil/peat layers in the mangrove substrate) and also as a source of carbon in the food web, and shoreline protection through buffering wave action and storm surge. Mangrove communities are among the most biologically productive ecosystems in the world (Lugo and Snedaker 1974) and are vital to the marine environment.

Coral Reef

Corals reefs are formed by reef-building (stony) corals, calcareous marine algae, and other invetebreate that create or produce structures consisting of calcium carbonate, or limestone. Over time, the structures fuse together to form large expanses of reef tract elevation off of the seafloor and that can also serve as wave-attenuating structures. Coral reefs create habitat for a myriad of organisms by providing food sources and shelter. The Florida Reef Tract, which extends from the Dry Tortugas in the west to St. Lucie inlet off of the southeast coast of the Florida peninsula, is the most extensive living coral reef ecosystem in North American waters.

Hard coral species that characterize the Florida Reef Tract include elkhorn coral (*Acropora palmata*), staghorn coral (*Acropora cervicornis*), mountainous star coral (*Orbicella faveolata*), brain corals (*Pseudodiploria strigosa*, *Diploria labyrinthiformis*, *Pseudodiploria clivosa*, and *Colpophyllia natans*), mustard hill coral (*Porites astreoides*), finger coral (*Porites porites*), starlet coral (*Siderastrea siderea*), and lettuce corals (*Agaricia agaricites*). Coral reefs are vulnerable to drastic and extended sea water temperature fluctuations which contribute to coral bleaching and disease susceptibility.

2.13 SPECIAL STATUS SPECIES

2.13.1 Federally Listed Species and Critical Habitat

In reference to the Endangered Species Act of 1973, as amended, an “endangered species” is defined as any plant or animal species in danger of extinction throughout all or a substantial portion of its range. A “threatened species” is any species likely to become an endangered species in the foreseeable future throughout all or a substantial part of its range. “Proposed Species” are animal or plant species proposed in the Federal Register to be listed under Section 4 of the ESA. “Candidate species” are species for which the FWS and NMFS have sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA. “Critical habitat” is designated per 50 CFR parts 17 or 226 and defines those habitats that are essential for the conservation of a federally threatened or endangered species and that may require special management and protection. The ESA provides for the conservation of species that are 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.

2.13.2 State Listed Species

Federally listed species are included on the Florida Endangered and Threatened Species List as “Federally designated Endangered, Federally designated Threatened, Federally designated Threatened Due to Similarity of Appearance,” or “Federally designated Non-Essential Experimental Population” species. Additional species specifically designated by the Florida Fish and Wildlife Commission are included on the Florida Endangered and Threatened Species List as State designated Threatened species and are listed in the Florida Administrative Rule 68A-27.003.

2.13.3 Marine Mammals

In reference to the Marine Mammal Protection Act of 1972, as amended, a marine mammal refers to a species found in the U.S. that is classified into one of the following four distinct groups: cetaceans (whales, dolphins, and porpoises), pinnipeds (seals, sea lions, and walruses), sirenians (manatees and dugongs), and marine fissipeds (polar bears and sea otters). For this project, only sirenians have the potential to occur in the Action Area.

The Marine Mammal Protection Act of 1972, as amended (MMPA) prohibits, with certain exceptions, the “take” of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. (NOAA, 2019a). All marine mammals in the U.S. are afforded protection under the MMPA.

The term “take” per the MMPA is defined as harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal. For most activities “harassment” refers to the act of pursuit, torment, or annoyance which:

- Has the potential to injure a marine mammal or a marine mammal stock in the wild which is referred to as Level A Harassment; or
- Has the potential to disturb a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns that include but are not limited to the following: migration, breathing, nursing, breeding, feeding, or sheltering which is referred to as Level B Harassment.

2.13.4 Migratory Birds

Migratory birds are defined as those described by the USFWS in the 50 CFR 10.13 and consists of species that that belongs to a family or group of species in the United States as well as Canada, Japan, Mexico, or Russia. Most birds native (naturally occurring) to the U.S. belong to a protected family and are protected by the Migratory Bird Treaty Act (MBTA). A species qualifies for protection under the MBTA if it meets one or more of the following four criteria:

(1) It (a) Belongs to a family or group of species named in the Canadian convention of 1916, as amended in 1996; (b) specimens, photographs, videotape recordings, or audiotape recordings provide convincing evidence of natural occurrence in the United States or its territories; and (c) the documentation of such records has been recognized by the American Ornithologists Union or other competent scientific authorities.

(2) It (a) Belongs to a family of group of species named in the Mexican convention of 1936, as amended in 1972; (b) specimens, photographs, videotape recordings, or audiotape recordings provide convincing evidence of natural occurrence in the United States or its territories; and (c) the documentation of such records has been recognized by the AOU or other competent scientific authorities.

(3) It is a species listed in the annex to the Japanese convention of 1972.

(4) It is a species listed in the appendix to the Russian convention of 1976.

The MBTA and Executive Order 13186 (EO) requires 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 the USFWS (FWS IPaC, 2019). 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 ROI (or Action Area per 50 Code of Federal Regulation (CFR) 402.02 with respect to federally listed threatened and endangered species), is defined as those areas that have the potential to be directly or indirectly impacted by an alternative as it pertains to Special Status Species. The terms ROI and Action Area will be used interchangeably in this section.

The ROI includes the limits of physical disturbance of the habitat caused by construction, maintenance, and operations of the potential structural and nonstructural project features as well as the extent of hydraulic and water quality impacts that have the potential to impact special status species. The ROI is also defined by the extent of noise impacts as they pertain to special status species.

Lists of the state and federally listed species, marine mammals, and migratory birds were compiled that have the potential to occur in the ROI based on the following sources:

- Official Species List correspondence by the USFWS on December 17, 2019 (provided in the Environmental Appendix, Appendix D);
- Official Species List correspondence provided by the NMFS, on December 3, 2019 (provided in Appendix D);
- Florida Fish and Wildlife Conservation Commission's Statewide Atlas of Sea Turtle Nesting Occurrence and Density http://ocean.floridamarine.org/SeaTurtle/nesting/FlexViewer/
- Information, Planning, and Conservation Database (U.S. Fish and Wildlife Service 2019);
- Florida Administrative Rule 68A-27.003 (Effective Date: February 17, 2020); and the
- Florida Fish and Wildlife Commission (FWC) Bald Eagle Locator (FWC 2016-2017).\
- Florida Fish and Wildlife Conservation Commission's Statewide Eagle Nest Locator http://myfwc.maps.arcgis.com/apps/webappviewer/index.html?id=253604118279431984e8bc3ebf1cc8e9

Nesting Buffers to estimate potential impacts to nesting bald eagles (*Haliaeetus leucocephalus*) were calculated in accordance with the USFWS National Bald Eagle Management Guidelines (2007). To avoid disturbing bald eagles, a nest buffer is recommended between the human activity and the nest where applicable. Human impacts are considered detrimental to nesting success within the primary buffer and within the secondary buffer human impacts are thought to impact the quality of the primary buffer. The primary buffer is a distance of 330 feet from the nest and the secondary buffer is a distance of 660 feet from the nest. Human activities that are considered detrimental to breeding activities (e.g. development, logging, use of toxic chemicals, etc.) are to be limited within the primary buffer and those that could impact the integrity of the primary buffer are restricted within a secondary buffer (e.g. developments, roadways, etc.). Per the Management Guidelines, a nest buffer of 2,640 feet is recommended from the nest for loud, disturbing noises such as those caused by blasting and other loud, intermittent noises.

2.13.5 Existing Conditions

Federally Listed Species and Critical Habitat

Table 2-2 provides the federally listed species that have the potential to occur in the ROI and also designated critical habitats located in the ROI. For a detailed description of federally listed species and designated critical habitat please refer to the Biological Assessment provided in Appendix D. Maps of the designated critical habitats in the ROI are provided in the Biological Assessment provided in Appendix D.

Table 2-2: Federally Listed Species ith the Potential to Occur in the ROI and Critical Habitat

Taxonomic Category/Common Name	Scientific Name	Federal Status	Critical Habitat
Birds			
Piping Plover^	*Charadrius melodus*	T	Y
Red knot^	*Calidris canatus rufa*	T	N
Fish			
Nassau grouper	*Epinephelus striatus*	T	N
Smalltooth sawfish (U.S. DPS)	*Pristis pectinata*	E	Y*
Oceanic whitetip shark	*Carcharhinus longimanus*	T	N
Giant manta ray	*Manta birostris*	T	N
Invertebrates			
Pillar coral	*Dendrogyra cylindrus*	T	N
Rough cactus coral	*Mycetophyllia ferox*	T	N
Lobed star coral	*Orbicella annularis*	T	N
Boulder star coral	*Orbicella franksi*	T	N
Mountainous star coral	*Orbicella faveolata*	T	N
Elkhorn coral	*Acropora palmata*	T	Y
Staghorn coral	*Acropora cervicornis*	T	Y
Mammals			
West Indian manatee^	*Trichechus manatus*	T	Y
Reptiles			
American alligator^	*Alligator mississippiensis*	SAT	N
American crocodile^	*Crocodylus acutus*	T	Y
Hawksbill sea turtle	*Eretmochelys imbricata*	E	Y*
Leatherback sea turtle	*Dermochelys coriacea*	E	Y*
Loggerhead sea turtle (Northwest Atlantic Ocean DPS)	*Caretta caretta*	T	Y
Green sea turtle (North and South Atlantic DPS)	*Chelonia mydas*	T	Y*
Kemp's Ridley sea turtle	*Lepidochelys kempii*	E	N
Plants			
Cape Sable Thoroughwort^	*Chromolaena frustrata*		

DPS = Distinct Population Segment; E = Endangered; T = Threatened; Y = Yes; N = No; SAT = threatened due to similarity of appearance; Species classification is reported as it pertains to the DPS/Action Area; *Critical Habitat designated but is not located in the ROI/Action Area; ^Species under the jurisdiction of the USFWS; remaining species are under the jurisdiction of the NMFS

Source: (U.S. Fish and Wildlife Service 2019; National Oceanic and Atmospheric Administration 2019).

State Listed Species

Federally listed species are also designated as state listed species in Florida. Therefore, all of the endangered and threatened species provided in Table 2-2 are also designated as state listed species with the same respective listing classification.

Additional species listed by the FWC are included on the Florida Endangered and Threatened Species List as State designated Threatened species. The ROI provides habitat for several state listed species (Table 2-3) besides those already described in Table 2-2. State listed species with the potential to occur in the ROI are provided in Table 2-3.

Table 2-3: Additional State Listed Species with the Potential to Occur in the ROI

Taxonomic Category / Common Name	Scientific Name	State Status
Birds		
Black skimmer	*Rynchops niger*	T
Florida burrowing owl	*Athene cunicularia floridana*	T
Least tern	*Sternula antillarum*	T
Little blue heron	*Egretta caerulea*	T
Reddish egret	*Egretta rufescens*	T
Roseate spoonbill	*Platalea ajaja*	T
Tricolored heron	*Egretta tricolor*	T
Snowy plover	*Charadrius nivosus*	T
White-crowned pigeon	*Patagioenas leucocephala*	T
Reptiles		
Florida Keys mole skink	*Plestiodon egregius egregious*	T
Key ringneck snake	*Diadophis punctatus acricus*	T
Rim rock crowned snake	*Tantilla oolitica*	T
Fish		
Key silverside	*Menidia conchorum*	T

Source: (Florida Fish and Wildlife Conservation Commission, 2019)

Marine Mammals

In addition to the federally listed marine mammals described in Table 2-2, bottlenose dolphins (*Tursiops truncatus*) are known to commonly occur in the ROI (FWC, n.d.). Bottlenose dolphins are blue-gray on top with lighter coloration on their sides and bellies and are typically six to 12 feet long. Common prey items of the bottlenose dolphin include a variety of fish species such as mullet (*Mugil cephalus*), sheepshead (*Archosargus probatocephalus*), pinfish (*Lagodon rhomboides*), flounder (*Paralichthys lethostigma*), and marine invertebrates. They are known to inhabit inshore as well as offshore areas. Other non-federally listed dolphins and whales have

the potential to occur in the ROI but occurrences would be unlikely based on their preferential breeding and foraging habitats.

Species Protected under the Migratory Bird Treaty Act of 1918 and Executive Order 13186

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. In addition to the already described federally listed piping plover and red knot, additional migratory bird species with the potential to occur in the ROI are provided in Table 2-4.

Table 2-4: Migratory Birds with the Potential to Occur in the ROI (USFWS 2020)

Common Name	Scientific Name
American Kestrel	*Falco sparverius paulus*
American Oystercatcher	*Haematopus palliatus*
Audubon's Shearwater	*Puffinus lherminieri*
Bald Eagle	*Haliaeetus leucocephalus*
Black Scoter	*Melanitta nigra*
Black Skimmer	*Rynchops niger*
Black-whiskered Vireo	*Vireo altiloquus*
Bonaparte's Gull	*Chroicocephalus philadelphia*
Bridled Tern	*Onychoprion anaethetus*
Brown Pelican	*Pelecanus occidentalis*
Clapper Rail	*Rallus crepitans*
Common Ground-dove	*Columbina passerina exigua*
Common Loon	*Gavia immer*
Common Tern	*Sterna hirundo*
Cory's Shearwater	*Calonectris diomedea*
Double-crested Cormorant	*Phalacrocorax auritus*
Dunlin	*Calidris alpina arcticola*
Great Black-backed Gull	*Larus marinus*
Great Shearwater	*Puffinus gravis*
Herring Gull	*Larus argentatus*
King Rail	*Rallus elegans*
Least Tern	*Sterna antillarum*
Lesser Yellowlegs	*Tringa flavipes*
Magnificent Frigatebird	*Fregata magni□cens*
Mangrove Cuckoo	*Coccyzus minor*
Nelson's Sparrow	*Ammodramus nelsoni*
Northern Gannet	*Morus bassanus*

Common Name	Scientific Name
Parasitic Jaeger	*Stercorarius parasiticus*
Pomarine Jaeger	*Stercorarius pomarinus*
Prairie Warbler	*Dendroica discolor*
Prothonotary Warbler	*Protonotaria citrea*
Razorbill	*Alca torda*
Red-breasted Merganser	*Mergus serrator*
Reddish Egret	*Egretta rufescens*
Ring-billed Gull	*Larus delawarensis*
Roseate Tern	*Sterna dougallii*
Royal Tern	*Thalasseus maximus*
Ruddy Turnstone	*Arenaria interpres morinella*
Semipalmated Sandpiper	*Calidris pusilla*
Short-billed Dowitcher	*Limnodromus griseus*
Short-tailed Hawk	*Buteo brachyurus*
Smooth-billed Ani	*Crotophaga ani*
Sooty Tern	*Onychoprion fuscatus*
Surf Scoter	*Melanitta perspicillata*
Swallow-tailed Kite	*Elanoides forficatus*
Whimbrel	*Numenius phaeopus*
White-crowned Pigeon	*Patagioenas leucocephala*
Willet	*Tringa semipalmata*
Wilson's Plover	*Charadrius wilsonia*
Wilson's Storm-petrel	*Oceanites oceanicus*
Yellow Warbler	*Dendroica petechia gundlachi*

Species Protected under the American Bald and Golden Eagle Act of 1972

Once federally listed as endangered, the bald eagle (*Haliaeetus leucocephalus)* has made a remarkable comeback. It is currently protected under the American Bald and Golden Eagle Act, and the MBTA. Bald eagles breed throughout much of Canada and Alaska, in addition to scattered sites across the lower 48 states, from California to the southeastern U.S. coast and Florida. Wintering covers most of the contiguous U.S., with some year-round distribution in the northwest. A large raptor, the bald eagle has a wingspread of about seven feet. Adults have a dark brown body and wings, white head and tail, and a yellow beak. Juveniles are mostly brown with white mottling on the body, tail, and undersides of wings.

Bald eagles typically breed and winter in forested areas adjacent to large bodies of water. However, such areas must have an adequate food base, perching areas, and nesting sites. Throughout its range, it selects large, super-canopy roost trees that are open and accessible. Nests are constructed from an array of sticks placed in an interwoven pattern. Other materials

added as fillers may include grasses, mosses, even corn stalks. Per the Florida Fish and Wildlife Commission Bald Eagle Locator Database (FWC 2016-2017), there are no known bald eagle nesting territories in the ROI (Figure 2-27).

Figure 2-27: Bald Eagle Nesting Locations (FFWC 2016-2017)

2.14 WILDLIFE AND TERRESTRIAL HABITAT

For the purpose of the following discussion, this section is intended to focus on wetland and terrestrial wildlife species and habitat for invertebrates, amphibians, reptiles, resident birds, and mammals; however, due to the interconnectedness of ecosystems, there is some overlap with other sections. Threatened and endangered species and migratory birds are discussed more in the Special Status Species Section; and aquatic species are discussed in the fisheries and benthics sections.

The ROI is all areas within the Keys that are temporarily or permanently filled, graded, cleared, excavated, or otherwise converted to another use as a result of the construction of the structural or nonstructural measures. It also includes all noise and disturbance effects indirectly adversely affected by the project, by means such as erosion, alteration of wildlife passage corridors, or changes in community type.

The Fish and Wildlife Coordination Act requires the USACE to coordinate with the USFWS and VDGIF on water resources related projects to obtain their views toward preservation of fish and wildlife resources and migration of unavoidable impacts.

2.14.1 Existing conditions

The Keys have a rich abundance of wildlife and unique ecosystems, as well as many federal and state wildlife refuges and Wildlife Management Areas (WMA). Much can and has been written about the wildlife throughout the Keys; however, discussion herein is limited to within the ROI.

Within the ROI for nonstructural measures such as those specifically limited to enhancement and protection of existing buildings and critical infrastructure in urbanized and suburbanized areas, it is presumed that wildlife habitat and species would be limited. However, the locations of structural measures are shorelines. Shorelines along the Keys contain habitat for a wide variety of wildlife species.

Mangrove Communities

Mangrove communities are thought to be among the most biologically productive ecosystems in the world (Lugo and Snedaker 1974). As mentioned previously, these forests are a primary component of the estuarine and marine environment, providing an important detrital source and essential nutrients for the food web; important habitat for tree-dwelling, intertidal, and subtidal organisms; nursery areas for juvenile fish and crustaceans and other invertebrates; nesting sites; cover and foraging sites for migratory birds; and habitat for some reptiles and mammals (NOAA, 2019a).

Mangrove tree canopies serve as rookeries, for herons, reddish egrets, and brown pelicans (*Pelecanus occidentalis*), and oceanic birds such as magnificent frigatebirds Red-bellied woodpeckers (*Melanerpes carolinus*), red-winged blackbirds (*Agelaius phoeniceus*), gray kingbird (*Tyrannus dominicensis*), black-whiskered vireo (*Vireo altiloquus*), white-eyed vireo (*Vireo griseus*), white-crowned pigeon, and mangrove clapper rail (*Rallus longirostris*) are some of the more common resident breeding birds in the Keys. Mangrove and shallow water habitats are important foraging and loafing areas for several species of wading birds and migratory shorebirds. Bird species known to nest in the Keys include great white heron, great blue heron (*Ardea herodias)*, great egret, reddish egret, tricolored heron, little blue heron, green heron (*Butorides virescens*), yellow-crowned night-heron (*Nyctanassa violacea*), and the white ibis (*Eudocimus albus*) (NOAA, 2019a).

Beach Community Habitats

Beach berms are dynamic and fragile ecosystems that host a wide diversity of species. The beach berm is considered to be the area within a ten foot (three meter) elevation range above MHW. These ecosystems are created and maintained naturally through the accretion and erosion of sediment from storm and wind events. Succession of vegetation occurs through disturbance, and recolonization of vegetation occurs through deposition of seeds that are transported through oceanic currents. Wider and less disturbed beach berms can support terrestrial invertebrates, neotropical migrant and resident passerine and raptor species, reptiles, and small mammals; breeding and nectaring plants for imperiled butterfly species; refuge for eastern diamondback rattlesnakes (*Crotalus adamanteus*) and the Florida Keys mole skink

(*Plestiodon egregius egregius*); and nesting habitat for green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and hawksbill (*Eretmochelys imbricata*) sea turtles (NOAA, 2019a).

Within the beach berm zone are coastal dunes, which are found at an elevation of zero to four feet (1.2 meters) and adjacent to the intertidal zone. This area is primarily made up of sandy soils and is sparsely vegetated with species such as bay cedar (*Suriana maritima*), sea oat (*Uniola paniculata*), and seashore dropseed (*Sporobolus virginicus*). Dunes are a fragile habitat easily damaged by humans and storms, the extent of which depends on dune size and profile, quantity and type of flora, beach characteristics, and surrounding water depth (Liddle and Greig-Smith 1975, McDonnell 1981, Nickerson and Thibodeau, 1983). The beach-dune interface is an important ecotone that produces sustained levels of biological activity.

The beach berm, dune, and intertidal zones within the ROI tend to be very narrow. Although historically wider, they have been impacted more recently by erosion and in particular, by storms and hurricanes. The ROI focuses on the narrowest locations, and those closest to U.S. Route 1. Therefore, the beach habitat quality and areas within the ROI are some of the more limited in the amount of wildlife habitat they can provide, compared with less disturbed and wider beach berm habitats.

Invasive plant species that occur within the ROI include Brazillian pepper, seaside mahoe, Australian pine. Two key invasive animal species within the ROI are Green iguana (*Iguana iguana*) and spiny-tailed iguana (*Ctenosaura* spp.).

2.15 CULTURAL RESOURCES

Several federal laws and regulations have been established to manage cultural resources, including the National Historic Preservation Act (NHPA) of 1966, the Archeological and Historic Preservation Act of 1974, the American Indian Religious Freedom Act of 1978, the Archeological Resource Protection Act of 1979, and the Native American Graves Protection and Repatriation Act of 1990. In addition, DoDI 4710.02, *Department of Defense Interactions with Federally-Recognized Tribes* (2006), governs DoD interactions with federally-recognized tribes and EO 13175, *Consultation and Coordination with Indian Governments* (2000), charges federal departments and agencies with regular and meaningful consultation with Native American tribal officials in the development of policies that have tribal implications. In order for a cultural resource to be considered significant, it must meet one or more of the following criteria for inclusion on the National Register of Historic Places (NRHP):

“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: 1) that are associated with events that have made a significant contribution to the broad patterns of our history; or 2) that are associated with the lives or persons significant in our past; or 3) 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 4)

that have yielded, or may be likely to yield, information important in prehistory or history" (36 CFR 60.4).

2.15.1 Existing Conditions

Historic and Prehistoric Context

Although evidence is growing that North America may have been inhabited thousands of years earlier, the earliest well documented inhabitation of South Florida was by the Clovis Culture of the Paleo Indian Period about 11,500 years ago. At that time, the transition from the Pleistocene or Ice Age to the Holocene or recent period was underway, with sea levels vastly lower. This meant the coastline was many miles away, with the west coast being up to 100 miles past its present location. What is now the Everglades was an arid sandy area (McCally 1999). This period was characterized by widely scattered camps as the people pursued large game. Around 11,000 years ago Pleistocene fauna like saber-toothed cats and giant ground sloths died out (Fiedel 2009). The Paleo-Indians had focused on hunting these large mammals, and as the climate became warmer and wetter adapted by ever broadening their subsistence base with plants, aquatic resources, and smaller game. This change in culture is referred to as the Archaic Period which lasted between 7000 and 1500 BCE, and is subdivided into the Early, Middle and Late Archaic Periods. Through the Archaic Period material culture became increasingly sophisticated as shown by the discovery of a variety of textiles at the Windover Site, a burial ground in what had been a lake dating to the Middle Archaic. The Archaic Period is followed by the Transitional Period from 1500 to 500 BCE. Corresponding to the Woodland Period in the northeast, south Florida has the Glades period from 500 BCE to the Historic Period, and like the Woodland it is divided into early, middle and late subperiods. Unlike native peoples in the northeast, the south Florida tribes did not practice maze agriculture, and yet developed complex societies based on hunting, gathering, and fishing. The two main groups were the Calusa on the southwest coast, and the Tequesta on the southeast coast.

Recorded Historic Resources in Monroe County

There are 54 NRHP listed properties in Monroe County (Figure 2-28). Among these are the Key West Historic District, the 1733 Spanish Plate Fleet shipwrecks, and several Indian mounds. Archaeological surveys number 179, and have resulted in 486 recorded sites (Figure 2-29). Of these 100 were recommended as eligible, 134 as not eligible, 68 needed more information, one was considered likely eligible, and no recommendation was recorded on 180 of them. Historic architecture survey has covered 5214 buildings with 162 considered eligible, 4807 ineligible, and 249 had either no recommendation or insufficient information. The historical significance of bridges linking the Keys is reflected in the evaluation of 28 bridges as eligible for listing.

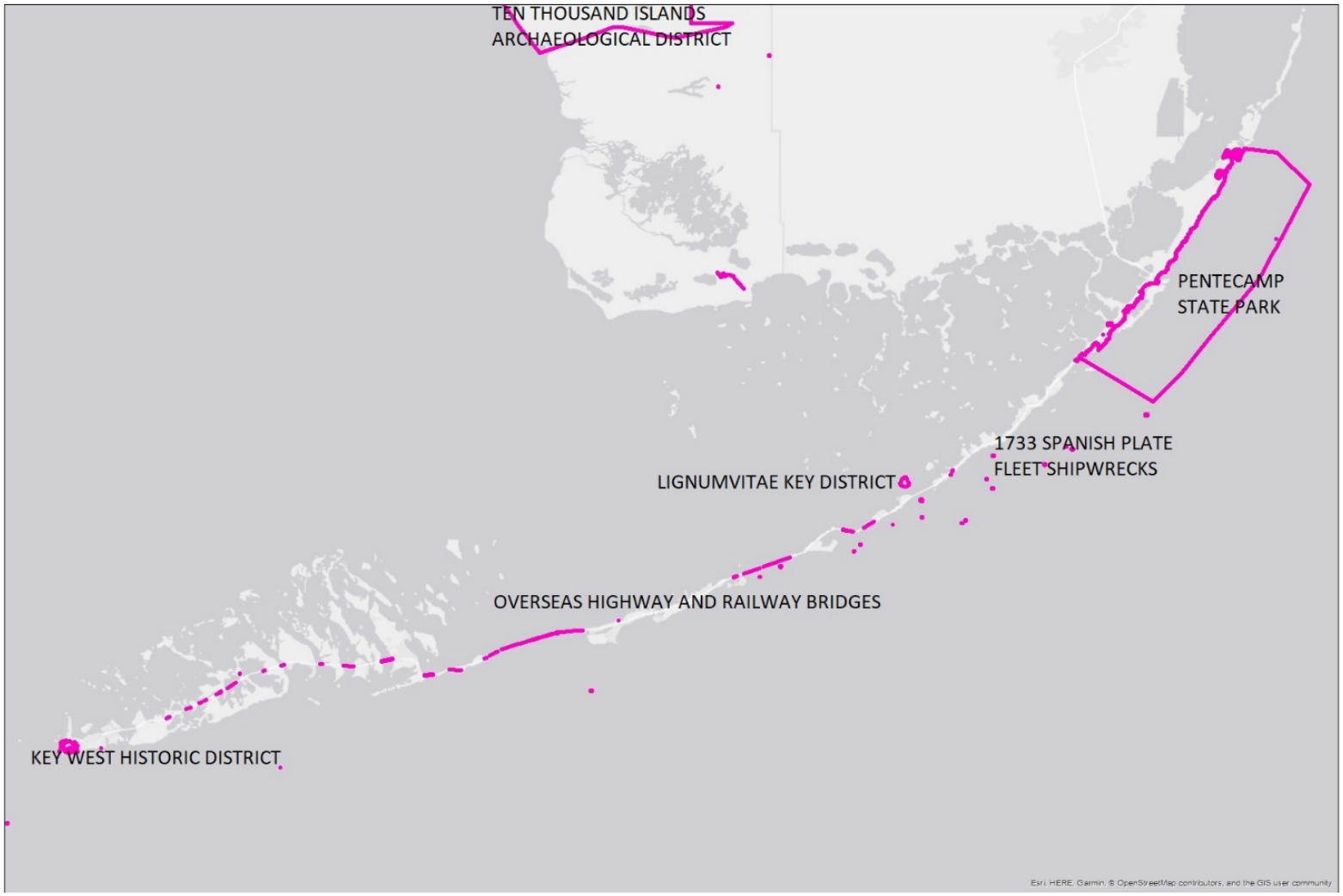

Figure 2-28: NRHP Listed Properties in Monroe County (larger districts labeled, most archaeological sites not shown) (Florida Department of Historic Resources 2018).

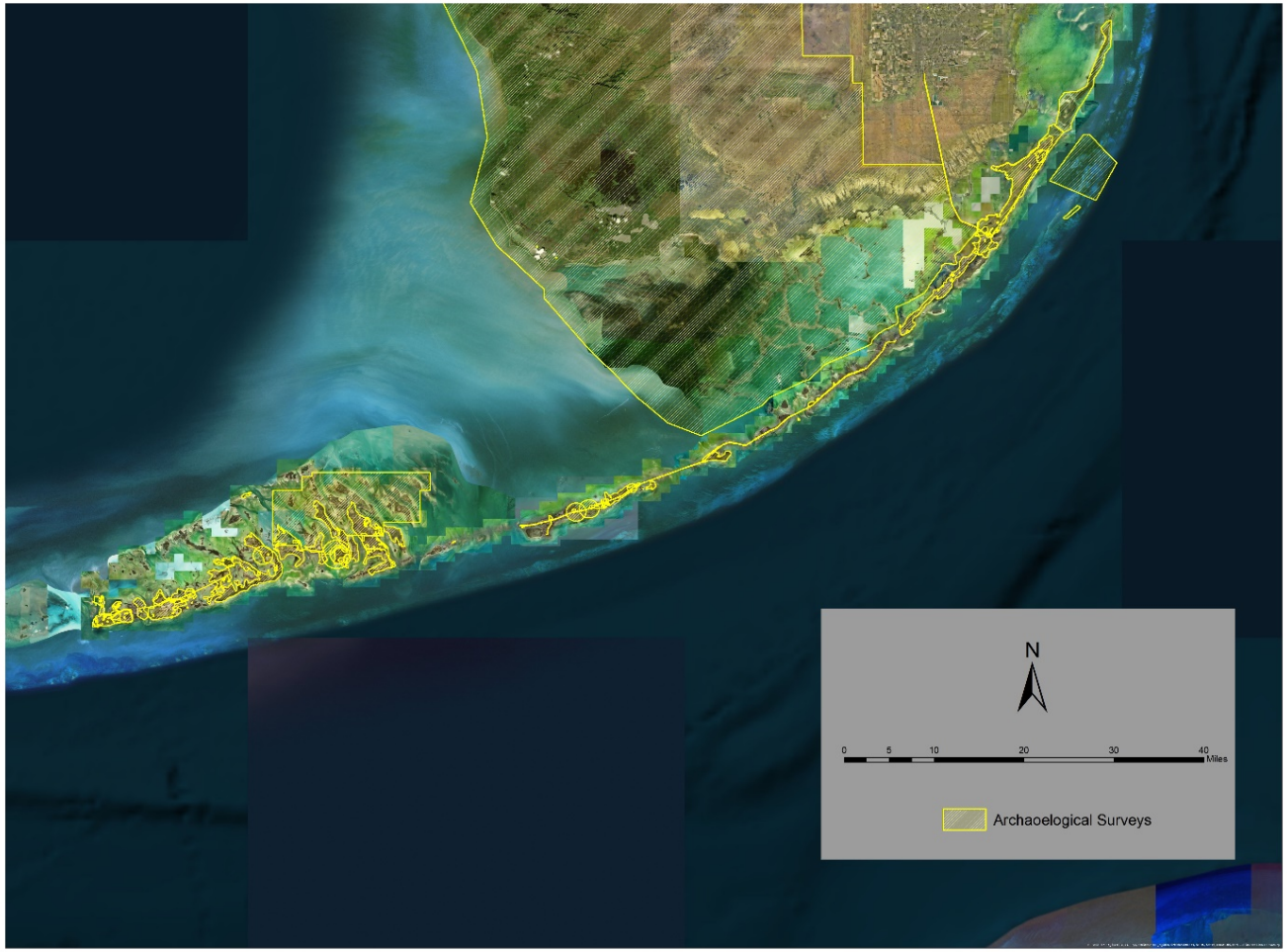

Figure 2-29: Archaeological Surveys in Monroe County (Florida Department of Historic Resources 2018)

2.16 RECREATION

Recreational facilities are defined as those amenities that provide for relaxation, rest, exercise, activity, enjoyment, education, or opportunities for leisure and community support that enrich the quality of life. These include, but are not limited to, parks, wildlife refuges, trails, boat ramps, piers, beaches, and marinas. Recreational areas may include any type of activity in which residents or visitors may participate. Activities include hiking, bike riding, boating, fishing, swimming, sunbathing, picnicking, wildlife viewing, or participation in sports.

The ROI is defined as all recreational lands and facilities within Florida Keys that would be affected either directly or indirectly by the project. This includes recreational areas where structure or fill is temporarily or permanently graded, cleared, excavated, or otherwise converted to another use as, or that will result in limited recreational use, as a consequence of the construction of the measures. It also includes areas indirectly and/or temporarily adversely affected by the project, such as by means of construction activities.

2.16.1 Existing Conditions

The share of the Monroe County economy accounted for by recreating visitors accounted for 59.9 percent of output/sales in 2007-2008. For income, recreating visitors accounted for 43.8 percent in 2007-08, while for employment recreating visitors accounted for 55.3 percent of all full-time and part-time jobs in 2007-08. In 2013, domestic leisure/recreation visitors spent 15.98 million person-days in the Florida Keys. This increased to 16.22 million in 2014 and to 16.52 million in 2015, with international visitors making up 20 percent of the 20.57 million total in 2015 at 4.05 million estimated person-days (NOAA, 2019a). The Keys are a popular tourist attraction for charter fishing, snorkeling, diving, wildlife watching, camping, and biking, as well as for their rich historical heritage, dining, and nightlife.

Monroe County has 11 state parks, including the Florida Keys Overseas Heritage Trail, which passes through most of the ROI. The trail opened in 2011 and is a 90 mile long string of pathways, bridges, and greenspaces that parallel U.S. Route 1. The trail provides pedestrian and bicycle access to the scenic highway. Along most locations, it is separated from U.S. Route 1 by a narrow grass median; and over most of the bridges, it is within the bridge shoulder. It has the highest visitation of any state park in the Florida Keys. In 2015, it accounted for 38.5 percent of all state park visitation in the Florida Keys (NOAA, 2019a). However, many sections of the trail along the shoreline and roadway were washed out by Hurricane Irma in 2017, and remain in need of repair. FDOT has plans to repair the damaged sections of trail and banks.

The two state parks within the ROI are Bahia Honda and Long Key State Parks. Bahia Honda was ranked third in state park visitation from 2010-2015, accounting for 19 percent of all state park visitation in the Keys, and almost 15 percent of all state and national park visitation (NOAA, 2019a). However, both state parks were damaged by Hurricane Irma. Specifically both parks' campgrounds and shorelines within the ROI sustained erosion damage, including washouts of

riprap, mangrove areas, and park campground access roadways immediately landward. At this time, both roadways and campgrounds remain closed to the public while repairs are planned.

Recreational fishing, boating, wildlife watching, swimming, and wading occur throughout the Keys, including along shorelines adjacent to U.S. Route 1. Indian Fill Key, located between Upper and Lower Matecumbe Key (Sites 11-13), is one of few locations along the Keys that has free public access to the shorelines, and is therefore heavily used by the public, particularly on holidays and weekends. A boat ramp is located on Indian Key on the north side of U.S. Route 1, and channels deep enough for recreational boating parallel the shorelines of those sites. Currently the City of Islamorada and FDOT are working to prepare a long term lease that will govern safe and orderly public use of the area.

A long public pier is located along Fiesta Key, parallel to U.S. Route 1. It is heavily used for fishing, walking, bird watching, and other activities.

2.17 AESTETHICS

Visual resources are the natural and man-made features that comprise 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, man-made features, and the degree of panoramic view available are examples of visual characteristics of an area.

Monroe County’s 2030 Comprehensive plan (Objective 301.6) indicates that it:

- shall provide a transportation system that facilitates scenic corridor enhancement and beautification within the Florida Keys;
- shall continue to ensure that development along the U.S.1 Florida Keys Scenic Highway Corridor provides the landscaping and setbacks necessary to minimize impacts on the visual environment;
- supports the Vision, Goals, Objectives, and Strategies of the Florida Scenic Highway Corridor Management Plan and the recommendations of the *Florida Scenic Highway Interpretive Master Plan* in its transportation planning. (Ord. 022-2009). (Monroe County, 2016).

The ROI for aesthetics (visual resources) is the residential, recreational, transportation corridors and tourist sites from Palo Alto Key (North Key Largo) to Key West, Florida, in which temporary or permanent, structural or nonstructural measures that would change the viewshed could occur.

2.17.1 Existing Conditions

The visual experience in any locale is dependent upon the pattern of the land (i.e., the topography), the pattern of water bodies, vegetation, and manmade development. Within the ROI, the topography is relatively flat decreasing in elevation moving westward from the Upper Keys to the Lower Keys. Viewers can generally see long distances from the locations that are only slightly higher than the surrounding area, particularly from the high rise bridges of U.S. Route 1 (Figures 2-30 & 2-31). The predominant visual experiences for residents and tourists of

the Florida Keys are the natural vistas of Florida Bay, the Gulf of Mexico, and the Atlantic Ocean from U.S. Route 1 intermingled with small towns. Scenic resources include large swaths of mangrove forests, uninhabited islands with diverse species, beaches, long stretches of open ocean, bays, busy marinas, bridges and residential and hotel development. Clearly, the aesthetics of the Florida Keys is an important part their appeal for both visitors and residents.

U.S. Route 1, the Overseas Highway, is the only highway in Florida to be recognized as an “All-American Road” by the National Scenic Byways Program of the Department of Transportation’s Federal Highway Administration. The program is a grass-roots collaborative effort established to help recognize, preserve and enhance selected roads throughout the United States. The U.S. Secretary of Transportation recognizes certain roads as All-American Roads or National Scenic Byways based on one or more archeological, cultural, historic, natural, recreational, and scenic qualities.

Figure 2-30: Aerial View of the Florida Keys.

Figure 2-31: Aerial View of Key West

In contrast to the lesser developed keys, in Key West the vista changes to more urbanized landscape with an historic City Center that overlooks open ocean with recreational marinas and hotels. Fort Zachary Taylor National Monument on the southern tip of Key West provides visual access to sights and sounds of this maritime setting reinforcing the historic visual and natural character of the keys. The US Naval Air Station Key West (NAS Key West) is also a large part of the visual environment of Key West. It is located on Boca Chica Key four miles east of the Central Business District of Key West. NAS KEY West's national security mission supports operational and readiness requirements for Department of Defense, Department of Homeland Security, National Guard units, federal agencies, and allied forces.

2.18 HAZARDOUS, RADIOACTIVE, OR TOXIC WASTES (HRTW)

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 due to their quantity, concentration, or physical and chemical properties. Hazardous wastes are characterized by their ignitability, corrosivity, reactivity, and toxicity. Hazardous materials and wastes, 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 following analysis of hazardous materials and wastes includes a description of existing contamination and the risk of exposure to hazardous materials and waste related to the contamination and to routine use, storage, and transportation of hazardous materials, along with the associated regulatory framework.

The primary relevant federal regulations include those promulgated under the Resource Conservation and Recovery Act (RCRA) of 1974 and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980.

The state rules regarding asbestos adopt existing federal Occupational Safety and Health Administration (OSHA) and USEPA regulations and apply them to all public facilities in which

activities involving the disturbance or removal of asbestos containing material (ACM) may occur. The USEPA maintains guidance on management inspection of facilities that may have lead-based paint (LBP). The TDSHS regulates LBP inspection, remediation and management. The state rules regarding LBP adopt existing OSHA and USEPA regulations and apply them to all public facilities in which activities involving the disturbance or removal of LBP may occur.

The ROI for hazardous materials and wastes is defined as all areas to be disturbed temporarily or permanently or otherwise converted to another use, in order to install the structural or nonstructural measures.

2.18.1 Existing Conditions

There are no Superfund National Priorities List (NPL) sites within the Florida Keys. There are no known contaminated sites within the structural or nonstructural project components. No areas of potential contamination were observed during site visits for the revetment sites in December 2019. However, the structures to be demolished, elevated, wet floodproofed or dry floodproofed could contain ACM or LBP if they were constructed before 1978.

2.19 SAFETY

The safety resource examines those elements of the study area that might be at risk of harm from a flood event, as well as the emergency response systems in place to respond to such events. Intense, heavy rainfall and tidal flooding that has the ability to cause property damage and destruction, life threatening injuries, and the possibility of loss of life for those affected. An occupational health and safety plan will also need to be implemented for the personnel that will be constructing, operating, and maintaining the project features within the study area.

The FEMA Disaster Operations Legal Reference Version 2.0, describes the legal authorities for FEMA's readiness, response, and recovery activities. The FEMA Public Assistance Program is the largest grant program that provides emergency assistance, such as debris clearance and protective measures as well as permanent restoration of community infrastructure. The FEMA Public Assistance reimbursement process is a significant undertaking as it requires coordination across all departments within a community to provide proper documentation on damage as well as repairs completed to infrastructure and public facilities (Monroe County, 2019c).

The FEMA Hazard Mitigation Program can be used to strengthen community infrastructure and public facilities so it is rebuilt in a way that mitigates future risk from storms (Monroe County, 2019c).

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-707, signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, PL 93-288, constitutes the statutory authority for most Federal disaster response activities especially as they pertain to FEMA and FEMA programs.

According to the Draft Monroe County Post-Disaster Recovery Strategy for Hurricane Irma (November 2019):

- "The 2015 Monroe Countywide Local Mitigation Strategy (LMS) recognizes future scenarios for increased flood risk due to sea level rise and describes the risk and

vulnerability of the communities in detail. Its first and foremost strategy is to promote public health, safety, and general welfare.

- In 2016 the County began its implementation of the GreenKeys Plan, which outlines specific actions for long-term flood mitigation. Further, the County adopted goals, objectives, and policies into their comprehensive plan to provide a proactive policy structure to consider new vulnerabilities.
- The Monroe Countywide Post-Disaster Recovery Strategy identifies goals, strategies, and projects for redevelopment following Hurricane Irma. A full list of roles and responsibilities is detailed in the Monroe County Comprehensive Emergency Management Plan."

2.19.1 Existing Conditions

Coastal Flooding

The Florida Keys are situated within estuarine and marine environments, between the Florida Bay and the Atlantic Ocean. The Keys are located in a low-lying physiographic region, which presents additional challenges in flood mitigation because drainage gradients are limited and nearly all portions of the Keys are below an elevation ten feet. Close proximity to water paired with low drainage gradients results in a significant percentage of the Keys being susceptible to flooding from high tides, king tides, hurricanes, and other storm events. The intensity of this flooding ranges from nuisance flooding, typically associated with high and king tides, to severe, albeit less frequent flooding from hurricanes.

Numerous secondary roadways are low-lying and flood on an occasional or even regular basis. However, U.S. Route 1 (the Overseas Highway), being the sole roadway route connecting the island chain, is crucial for evacuation, rescue, recovery providers, and suppliers. If this area were inundated or washed away, no resources could be brought into the Keys south of this area to Key West by land.

Hurricane Damage and Safety

Hurricane Irma struck the Florida Keys on September 10, 2017, as a Category 4 storm. It had maximum sustained winds of 132 mph and storm surge up to eight feet in the hardest hit areas in the Lower and Middle Keys. Due to the linear geography of the island chain, some parts of the Keys were hit harder than others. The eye of the storm made landfall over Cudjoe Key (Cangialosi, et al, 2017). According to the Monroe County Medical Examiner, in the Florida Keys, three victims drowned during the hurricane. Another 14 people died due to hurricane related causes, such as being unable to obtain life-saving medical treatment. There were more than 40 injuries reported after the storm (Monroe County, 2019d).

In unincorporated Monroe County, approximately 727 homes were destroyed and another 1,034 homes are considered to have substantial damage, bringing the total number of homes that needed to be rebuilt to 1,761. Of these numbers, the hardest hit dwellings were the mobile homes, manufactured homes and RVs, which included 666 destroyed and 378 suffering major damage (2019d).

While no part of the island chain was spared, the Middle and Lower Keys were hit the hardest. Over two years later, the Keys continue to recover and rebuild. The Monroe County Post-Disaster Recovery Strategy (PDRS) is being developed to guide long term recovery and resilience efforts following this storm, to help the community learn from its experiences from this event, and to prepare for the future. Hurricane Irma illuminated the vulnerability of this island chain. When the debris was cleared, homes built to new codes were found to have withstood wind impacts stood as a prime example of wind mitigation in action as well as a sound investment. However, the impacts from flooding could have been much worse. As the Florida Keys plans for the future, it will be important to consider not only current flooding vulnerability but how these vulnerabilities can be further exacerbated by sea level rise (Monroe County 2019c).

Hurricane Irma dramatically demonstrated the benefit of investment in a hardened infrastructure. Despite the 130 mph winds, the county did not have substantial structural damage to roads, bridges, and water or wastewater systems. While these systems experienced intermittent outages and limitations immediately following the storm, they were able to be restored efficiently. The primary roadway system, water, and wastewater systems remained largely resilient. The electrical grid and the communications system, however, remain highly vulnerable to wind and storm surge (Monroe County 2019d).

The need to continue to build redundancy and resilience within the communications systems, power utility infrastructure and within public safety critical infrastructure facilities became evident after Irma. The immediate response capability was hampered within the public and private sectors by a lack of communications. Similarly, the Emergency Operations Center and the Sheriff's Office facilities displayed weaknesses in supporting continued operations. Long term recovery efforts focus on enhancing, hardening, and replacing these vital, life-saving infrastructure components and public facilities (Monroe County 2019c).

2.20 UTILITIES

This section focuses on the following major utilities and associated infrastructure within the Study Area: potable water, wastewater, and stormwater, power, and telecommunication. Potable water is suitable for drinking or use for cooking without risk of illness and has typically been through treatment that includes filtration and disinfection to ensure its safe use. Wastewater generated from residential and commercial sources has been adversely affected in quality by human use and is treated at a wastewater treatment plant to reduce contamination to acceptable level prior to its release into the environment. Stormwater runoff is a type of non-point source pollution because the discharge to receiving waters comes from diffuse sources.

Regional utilities occurring within the study area are discussed below. Potential impacts and mitigation measures related to implementation of the Proposed Action are assessed based on their impacts to the existing utility infrastructure. The ROI for utilities is all utilities within the study area in Monroe County and its bordering waterways that have the potential to be impacted temporarily or permanently by structural and/or nonstructural measures.

Surface Water Quality Standards are defined in Chapter 62-302 of the FAC and establishes the water quality standards for surface waters for designated use classifications throughout the state of Florida. Regulations relating to stormwater discharge are contained in Section 62-25 of the FAC. Subsection 403.0885, of the Florida Statutes, a collection of state laws organized into a code by subject matter, authorizes FDEP to establish a state National Pollutant Discharge Elimination System (NPDES) permitting program in accordance with Section 402 of the Clean Water Act. Chapter 9.5, Land Development Regulations, of the Monroe County Code of Ordinances is the primary Monroe County ordinance that controls stormwater (Monroe County 2001). Section 9.5-293 of the Monroe County Code of Ordinances establishes criteria and guidelines for surface water management and requires the development of a stormwater management plan for all development.

The South Florida Water Management District 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.

2.20.1 Existing Conditions

The major utilities within the study area include: buried potable, wastewater, and stormwater infrastructure, and buried and aboveground power transmission lines and associated infrastructure. Other underground telecommunication utilities such as fiber optic cables are also present within the Study Area.

Water and Wastewater

The Florida Keys Aqueduct Authority (FKAA) is the water service provider for the Florida Keys and delivers approximately 17,000,000 gallons per day of potable drinking water to Florida Keys residents (FKAA 2018). Treated water is primarily sourced from the Biscayne Aquifer, however it is also supplemented by the Florida Aquifer. The J. Robert Dean Water Treatment Plant and wellfield is located west of Florida City on the mainland near Everglades National Park. The FKAA wellfield contains high quality groundwater from the Biscayne Aquifer. Following treatment, the water is pumped to the Florida Keys through a 130 mile long transmission main utilizing 800 horsepower electric motors to pump the water south (FKAA 2018). Booster pump stations are located in Key Largo, Long Key, Marathon, Ramrod Key, and Stock Island to maintain adequate pressure. For emergency situations, the FKAA has the capacity to supply additional water from two seawater plants, one located in Marathon and one in Stock Island.

The FKAA also provides central wastewater services to seven regions of the Florida Keys and utilizes advanced technologies to ensure nutrient and pollutant removal. Reclaimed water, or recycled water, which is safe for non-potable (non-drinking) uses, is also available to several of the Florida Keys and provides a safe and cost efficient alternative for freshwater supply conservation (FKAA 2018).

Wastewater Service Areas not currently under FKAA jurisdiction include the City of Key West, Key West Resort Utilities, City of Marathon, the Village of Islamorada, and the Key Largo

Wastewater Treatment District. The Richard A. Heyman Environmental Pollution Control Facility is a wastewater treatment plant located in Key West. It was constructed in 1989, and the sewer collection systems operations and maintenance are contracted to Operations Management, Inc. (OMI). Wastewater is treated and discharged into a deep injection well located onsite. Wastewater from Islamorada is conveyed through a transmission main installed adjacent to U.S. Route 1 to the Key Largo Wastewater Treatment Facility (Islamorada 2016).

Stormwater

Throughout the Florida Keys, the major stormwater management systems are associated with roads and highways; however, other stormwater management systems exist and include both structural and nonstructural controls as Best Management Practices (BMPs) (Monroe County 2001). Examples of stormwater BMPs recommended as suitable for the Florida Keys in the Monroe County Stormwater Management Master Plan include: 1) structural BMPs such as buffer strips; water quality inlets, porous pavement, and vegetated swales and 2) nonstructural BMPs such as land use planning, low impact development, and impervious reduction (Monroe County 2001).

The City of Key West has developed a storm water capital plan to address and improve storm water drainage and to minimize/eliminate contaminant discharges to nearshore waters (City of Key West 2019). Stormwater runoff currently drains through 63 outfalls that release into nearshore waters; however, the City of Key West continues to reduce stormwater runoff through the installation of well systems that coincide with the construction of intersection improvements (Key West 2019).

Power

The Florida Keys Electric Cooperative (FKEC), is a not-for-profit electric utility that services approximately 33,000 accounts from the Monroe-Dade County line to the Seven Mile Bridge. Within the existing territory, six substations, and over 800 miles of power lines are maintained (FKEC 2011). The FKEC also maintains a 130,000 kilo-volt transmission line, which brings power to the Florida Keys from the mainland. The FKEC purchases almost all of its energy needs from Florida Power and Light (FPL) which serves more than five million accounts throughout the state of Florida. Additional contributions to the FKEC power supply come from generators in Marathon and FKEC's two solar arrays located in Marathon and Crawl Key.

Keys Energy Services (KEYS) is the public power utility servicing the lower Lower Florida Keys. Keys provides electricity from Key West to the Seven Mile Bridge and provides service to approximately 28,000 customers (KEYS 2019). The KEYS currently imports the majority of its power supply from the mainland due to the less expensive costs than local generation. Local power generation is a back-up supply used only in emergency situations. The Florida Municipal Power Agency (FMPA), in partnership with numerous municipalities, including Key West will expand the Florida Municipal Solar Project to include Phase II which will consist of two 74.5 megawatt solar farms in Alachua County and Putnam County (FMPA 2019). The KEYS is one of the utilities that will be receiving power from Phase II expected to be completed in 2023 (FMPA 2019).

Telecommunication utilities and associated infrastructure, such as fiber optic cabling and cellular communication towers, are present throughout the Florida Keys allowing residential and commercial access to services for purchase such as high speed internet and wireless communications.

2.21 AIR QUALITY

Air quality is the degree to which the ambient air concentration is contaminated with any one or more pollutant that has been scientifically proven to be a health concern. The USEPA has identified six criteria pollutants (ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead) as causing detrimental health effects when their concentrations in the ambient air are found above the thresholds that have been established at levels that are known to be safe. The USEPA has established National Ambient Air Quality Standard (NAAQS) for each criteria pollutant, which represents the maximum allowable atmospheric concentrations to ensure protection of public health and welfare.

2.21.1 Criteria Pollutants

Ozone

Ozone (O_3), forms through a series of complex chemical reactions involving Volatile Organic Compounds (VOCs) and oxides of nitrogen (NO_x) in the presence of sunlight. Ground level ozone concentrations vary depending on the weather conditions and is more readily formed on warm, sunny days when the air is stagnant. A health-based air quality standard has been established by the USEPA for ozone. The Florida Department of Environmental Protection, in cooperation with several county air pollution control agencies, monitors ozone air quality in Florida's major urban areas.

Carbon Monoxide Carbon monoxide (CO) is a colorless, odorless gas produced by the incomplete combustion of fossil fuels. Sources of carbon monoxide affecting outdoor air include motor vehicles and machinery that burns fossil fuels. Harmful health effects can result from exposure to large amounts of CO which reduces oxygen transport through the bloodstream.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a primary component of nitrogen oxides (NO_x), and is produced when fuel is burned in motor vehicles, power plants, industrial boilers, and other sources. Exposure to elevated levels of nitrogen dioxide can irritate the respiratory system and can increase a person's susceptibility to respiratory infections and diseases.

Sulfur Dioxide

Sulfur dioxide (SO_2) is produced by power plants and other industries that burn fossil fuels containing sulfur, such as coal and oil. Exposure to sulfur dioxide can have harmful health effects particularly on the human respiratory system.

Particulate Matter

Particle pollution, also known as particulate matter (PM), is the general term used for a mixture of solid particles and liquid droplets found in the air and is made up of a number of components, including acids (such as sulfates and nitrates), organic chemicals, metals, soil or dust particles, and allergens (such as fragments of pollen or mold spores). $PM_{2.5}$ describes fine particles that are 2.5 micrometers in diameter or less in size (such as those found in smoke and haze) and pose the greatest health threat. PM_{10} or coarse particles describe particles that are greater than 2.5, but less than or equal to ten micrometers in diameter.

Fine particles can result directly from emissions of fuel combustion from motor vehicles, power generation, and industrial facilities, as well as from residential fireplaces and wood stoves. Coarse particles are generally emitted from sources such as vehicles traveling on unpaved roads, materials handling, crushing and grinding operations, and windblown dust. Their chemical and physical compositions vary depending on location, time of year, and weather.

Lead

Sources of lead (Pb) sources in the air may include incinerators, utilities, lead-acid battery manufacturers, and lead-producing plants. Levels of lead in the air have decreased by 98 percent between 1980 due to the removal of lead from motor vehicle gasoline and other regulatory efforts by the USEPA (USEPA 2017).

Greenhouse Gas Emissions

Greenhouse gases (GHGs) are gases that trap heat in the atmosphere. Major GHGs include carbon dioxide, methane, nitrous oxide, and various synthetic chemicals. These emissions occur from natural processes and human activities. The accumulation of GHGs in the atmosphere can influence the earth's temperature. Predictions of long term environmental impacts due to global climate change include sea level rise, changing weather patterns with increases in the severity of storms and droughts, and changes to local and regional ecosystems including the potential loss of species.

The ROI for air quality is all of The Florida Keys, from Key Largo south to Key West. The USEPA establishes air quality control regions which delineate areas, either intrastate or interstate, that share a common airshed. Monroe County is part of the Southeast Florida Intrastate Air Quality Control Region.

To protect the overall health and wellbeing of the public and to address air pollution problems, Congress established the Clean Air Act of 1970 (amended 1990), which requires the USEPA to set and implement the NAAQS for the six criteria pollutants with the potential for harmful health effects. The USEPA is required to designate geographical areas as either attainment or nonattainment for the criteria pollutants. Areas in attainment meet or exceed the NAAQS; whereas areas in non-attainment do not meet the NAAQS. States are required to develop a general plan to attain and maintain the NAAQS in all areas of the country, and a specific state implementation plan (SIP) to re-attain the standards for each area designated nonattainment for a NAAQS. According to the plans that are outlined in the SIP, states and local agencies are given delegated authority to implement the regulations in order to control emissions sources of

criteria pollutants.

In accordance with Chapter 403 of the Florida Statutes, FDEP's Division of Air Resource Management is responsible for the protection and management of Florida's air resource, including air quality monitoring, permitting, and compliance. FDEP manages a Title V air operation permit program which is approved by the USEPA. In general, Title V permits are issued to facilities that are considered a major stationary source or air pollution. Non-title V permits are also issued by FDEP for facilities with minor sources of air pollution.

2.21.2 Existing Conditions

Florida's air quality has improved over the last two decades with monitored levels of criteria pollutants declining since 2000 and currently the lowest recorded on record. Although there are 99 monitoring sites located throughout Florida, there are no air quality monitoring sites in Monroe County.

Monroe County is currently in attainment for all NAAQS criteria pollutants. According to FDEP's map of active air-permitted facilities which shows the locations of all active facilities with current air permits in Florida, there are only two Title V Facilities located in Monroe County, Stock Island Power Plant located on Stock Island, and the Charles A. Russell Generation Facility in Marathon (DEP 2019). Numerous non-title V permitted facilities also exist throughout Monroe County.

2.22 NOISE

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air, and are sensed by the human ear as well as most fauna. 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. The human environment is generally characterized by a certain consistent noise level that varies by area. This is called ambient, or background, noise. Although exposure to high noise levels has been demonstrated to cause hearing loss, the principal human response to environmental noise is annoyance. The response of individuals to similar noise events is diverse and influenced by the type of noise; perceived importance of the noise and its appropriateness in the setting; time of day and type of activity during which the noise occurs; and sensitivity of the individual. Wildlife near areas of human activity and associated noise react similarly. Boating noise can carry for long distances underwater and disrupt the behavior of aquatic life for considerable distances from the source, depending on the size of and noise produced by marine engines

Changes in noise are typically measured and reported in units of decibels (dBA), a weighted measure of sound level. The A-weighted sound level (dBA) is a single number measure of sound intensity with weighted frequency characteristics that corresponds to human subjective response to noise (FHA, 2001). Noise ranging from about ten dBA for the rustling of leaves to as much as 115 dBA, the upper limit for unprotected hearing exposure established by OSHA, is common in areas where there are sources of industrial operations, construction activities, and vehicular traffic (OSHA, 2016).

Table 2-5: Common Sounds and their Noise Levels

Outdoor	Sound level (dBA)	Equivalent
Snowmobile	100	Subway train
Tractor	90	Garbage disposal
Noisy restaurant	85	Blender
Downtown (large city)	80	Ringing telephone
Freeway traffic	70	TV audio
Normal conversation	60	Sewing machine
Rainfall	50	Refrigerator
Quiet residential area	40	Library

Source: Center for Hearing and Communication, 2020.

The impact analysis of the Proposed Action is focused upon potential noise increases at sensitive noise receptors resulting from the construction and operation of the various project components. Noise sensitive receptors are buildings or parks where quiet forms a basic element of their purpose; residences and buildings where people normally sleep (e.g., homes, hotels, hospitals), where nighttime noise is most annoying; and institutional land uses (e.g., schools, libraries, parks, churches) with primarily daytime and evening use. Because noise levels at sensitive receptors are reduced by obstructions (such as sound walls) lying between them and the noise source, special emphasis is placed on sensitive receptors having a direct line of sight to the Proposed Action construction sites and facilities.

Section 4(b) of the Noise Control Act (NCA) of 1972 (42 USC §§ 4901-4918) directs federal agencies to comply with applicable federal, state and local noise requirements with respect to the control and abatement of environmental noise. Congress defined environmental noise in the NCA of 1972 to include the intensity, duration, and character of sounds from all sources. Applicable federal guidelines for noise regulation derive from the USDOT or, more specifically, the Federal Transit Administration and the FHWA. In addition, Monroe County has its own noise ordinance.

The ROI for noise analysis includes all structural and nonstructural area footprints, plus a buffer including all areas within 500 feet.

2.22.1 Existing Conditions

The main source of noise within the ROI of all of the proposed structural project components is traffic noise from U.S. Route 1. All of the structural project components are within 100 feet of U.S. Route 1. There is occasional navigation traffic nearshore and within existing federal and local navigation channels; however, this is a minimal source of noise. Sites 3 (Bahia Honda State Park), Site 6 (Long Key State Park) are noise sensitive receptors, by virtue of their being parks for recreational use. Site 10 (Sea Oats Beach) is adjacent to noise sensitive receptors that include homes and commercial businesses within 500 feet of the structural project components. Sites 11-13 constitute noise sensitive receptors by virtue of their use for recreation by the public.

The Cities of Key West and Marathon and Boca Chica Key have commercial and/or military airports with light air traffic, and are within or adjacent to the nonstructural project component areas. These areas also include residential communities and commercial uses, and therefore, have noise levels are typical of such land uses.

2.23 CLIMATE CHANGE

Global climate change is a transformation in the average weather of the Earth, which is measured by changes in temperature, wind patterns, and precipitation. Emission of greenhouse gases above natural levels is suggested to be a significant contributor to global climate change. Greenhouse gases are known to trap heat in the atmosphere and regulate the Earth's temperature. These gases include water vapor, carbon dioxide, methane, nitrous oxide, ground level ozone, and fluorinated gases such as chlorofluorocarbons, and hydrochlorofluorocarbons. Increasing temperatures are contributing to melting glaciers and sea level rise. The ROI for climate change includes the entire study area.

2.23.1 Existing Conditions

The threat of sea level rise profoundly affects the Florida Keys. Based on Southeast Florida Regional Climate Change Compact Working Group (2015) estimates, in the short term, sea level rise is projected to be six to ten inches by 2030 and 14 to 26 inches by 2060 (above the 1992 mean sea level). Sea level has already risen 3 inches from 1992 to 2015. In the long term, sea level rise is projected to be 31 to 61 inches by 2100, also according to the SFRCCCWG (2015). This could have a significant effect on the land of the Florida Keys, as the average elevation of the larger islands range from four to seven feet (1.2 to 2.1 meters) above current sea levels.

Already, tidal flooding inundates many areas of the Keys during extreme high tides (UCS, 2015). Several times a year, king tides can cause coastal flooding. With the increase in sea level projected for the Keys by 2045, high tides on top of these normal tidal variations will reach farther inland and cause more frequent flooding. The Union of Concerned Scientists' (UCS) 2015 analysis using the USACE scenario projects that:

- Tidal flooding will occur in Key West 114 times a year by 2030 and 375 times a year by 2045, when flooding would essentially occur with daily high tides on many days; and

- Tidal flooding will occur in Big Pine Key and Marathon (Vaca Key) 23 times a year by 2030 and about 180 times a year by 2045.

The flooding will worsen as the sea level rises, which will threaten the county's primary economic driver: a $2.2 billion tourism industry that attracts approximately 3 million people to the Keys each year (Monroe County 2014). Moreover, the intrusion of salt water that can accompany rising sea levels will threaten the region's unique ecosystems and the Keys' primary freshwater supply. Also, storms in combination with higher seas can flood larger areas, putting more residential and commercial property at risk (UCS, 2015).

Climate change can mean stronger and more costly hurricanes as well. NOAA (2019a) notes that Hurricane Irma, with maximum winds of 185 miles per hour, became the strongest storm on record in the Atlantic Ocean outside of the Caribbean and Gulf of Mexico. It sustained 185 mph winds speeds for 37 hours and spent three consecutive days as a category 5 hurricane, which made it the longest of any cyclone in the world since 1932 to maintain that intensity. The occurrences of Harvey and Irma—making landfall within two weeks of each other—were the first time in recorded history that two category 4 or higher hurricanes struck the U.S. mainland in the same year (NOAA 2019a).

As sea level rise increasingly inundates coastal areas, there also is the potential for degradation of natural resources and loss of their services to the surrounding environment. SFRCC (2015) notes:

> Ecosystems will transition either by retreat and migration, adaptation, or elimination of functions and certain species. Shallow water habitats may transition to open water, forcing ecological changes in coastal wetlands and estuaries affecting nesting, spawning and feeding locations and behavior. Intrusion of saltwater inland, into inland water bodies and within the aquifer is negatively impacting freshwater resources, and these impacts will worsen or accelerate with further sea level rise. Inundation of shorelines will increase the extent and severity of beach erosion and 11 previously stable coastal areas. In combination, these impacts will cascade throughout the region's ecosystems even if they are not immediately adjacent to open water areas.

With its low lying, elevation specific vegetation, the lower Florida Keys will have dramatic terrestrial impacts even at low (one foot/0.3 meter) levels of sea level rise. LaFever et al. (2007) found that various sea level rise scenarios (one to three feet/0.3-0.9 meters estimated by IPCC 2001) resulted in loss of both coastal and upland vegetation structure as sea level rise strained the ability of vegetation to migrate vertically. A recent Florida International University research study also found that South Florida mangrove forests would not be able to adapt effectively to current sea level rise projections (Meeder and Parkinson, 2018). Upland communities are expected to decrease in area extent and fragment based on small differences in elevation. With the loss of both waterholes and freshwater marshes, the loss of freshwater would be an important limiting factor for many terrestrial wildlife species (NOAA, 2019a).

Yet USC (2015) notes that some of the coastal vulnerability can be reduced and investing in coastal preparedness measures can go a long way toward protecting the infrastructure, private property, and livelihood of Keys residents. During the past decade, Monroe County has taken a

leading role in the regional effort to combat climate change and adapt to rising seas. The County is continuing its coordination and activities with the SFRCCC. In 2016, the County set priorities, a work plan, and implementation strategies, which can be found at its Green Keys website. The Green Keys Sustainability Action Plan identifies the County's vulnerabilities to sea level rise and climate change and provides a comprehensive five year roadmap on how best to proactively deal with these issues that likely will worsen in the future. This study also aims to address the coastal storm damage associated with climate change.

CHAPTER 3 PLANNING CONSIDERATIONS

3.1 PROBLEMS AND OPPORTUNITIES

3.1.1 Problems

The overarching problem to be addressed by this study is that coastal storm events cause damage to the natural and built environment in the Florida Keys as a result of flooding, wave action, and erosion. There are several more specific risk drivers and issues within this problem:

- Structures (commercial and residential) in the Florida Keys are vulnerable to damage from inundation caused by coastal storm surge.
- Critical infrastructure in the Florida Keys including fire stations, airports, hospitals, etc. are vulnerable to damage from inundation caused by coastal storm surge.
- Critical transportation routes and U.S. Route 1 specifically are vulnerable to damage from wave energy and erosion caused by coastal storms. In previous storm events and most recently when Hurricane Irma hit the Keys, there were instances of roadway damage contributing to a delay the timely return of residents back into the Keys once the evacuation order was lifted after the storm.
- Inundation caused by coastal storm surge limits or in some locations prevents vehicle travel on U.S. Route 1, the only evacuation route out of the Florida Keys northward toward mainland Florida, during and immediately before and/or after a coastal storm event. In previous storm events and most recently when Hurricane Irma hit the Keys, there were instances of this inundation affecting evacuation immediately before the storm event.
- The reduced evacuation efficiency and structure inundation caused by coastal storm events creates life safety risks to the population of the Florida Keys.
- There are rich environmental resources that are unique to the study area that are vulnerable to the effects of coastal storms. Some of these resources, mangroves for example, provide a reduction in the impacts of coastal storms on the study area and their loss increases the risk of storm damage to the built environment in the study area.

3.1.2 Opportunities

Opportunities that could be addressed by a CSRM project in the Florida Keys include:

- Reduce economic damage caused by coastal storms to the built environment in the Florida Keys.
- Reduce damage caused by coastal storms to the natural environment in the Florida Keys.
- Reduce the risks to human life, health, and safety caused by coastal storm events.
- Reduce the vulnerability of Route 1, the primary and only evacuation route from the Keys, to the effects of coastal storms including limited vehicle travel and damage to the roadway structure.
- Increase the resilience of the Florida Keys to the impacts of coastal storms and flooding (Note: the USACE principles of resilience are Prepare, Absorb, Recover, and Adapt).
- Protect and/or restore the natural coastal system of defenses that are existing or were historically present in the study area.

- Improve residential canals to include measures that address sediment management, debris removal, erosion control, and water quality.
- Provide incidental risk reduction to the Department of Defense facilities located in the vicinity (ex. the Naval Air Station in Key West) of the measures recommended by this study.
- Reduce impacts of general sea level rise (sunny day flooding) in the Florida Keys.

3.2 OBJECTIVES

The Federal objective of water and related land resources project planning is to contribute to the national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, treaties, and other federal planning requirements. The specific planning objectives for this study include:

1. Reduce the risk of damage to U.S. Route 1 caused by wave action and erosion associated with coastal storms in the Florida Keys over the 50 year period of analysis.
2. Reduce the risk of damage to critical infrastructure caused by storm surge inundation associated with coastal storms in the Florida Keys over the 50 year period of analysis.
3. Reduce the risk of damage to development (residential and non-residential structures) caused by storm surge inundation associated with coastal storms in the Florida Keys over the 50 year period of analysis.
4. Reduce the risk to human life, health, and safety to the population in the Florida Keys that is caused by the inundation of development and critical infrastructure and the reduced evacuation efficiency that is associated with coastal storm events over the 50 year period of analysis.

3.3 CONSTRAINTS

Constraints are identified to avoid undesirable changes between the future without and future with plan conditions. While plans are formulated to achieve planning objectives, they are also formulated to avoid violating the constraints. The following planning constraints have been identified for this study:

- Risk to human health and life safety should not be increased by the recommended plan.
- The recommended plan should not create new inundation/flooding problems and/or exacerbate existing coastal storm risk.

In addition to constraints, planning considerations are identified to highlight the conditions, policies, resources, etc. that would not limit plan formulation like a constraint, but may have a significant effect on plan formulation. Considerations can identify factors such as public support for the recommended plan, risk and uncertainty, implementation issues, etc. that are unique to the study area and/or are important to the NFS and other stakeholders. In addition to constraints, the following planning considerations were identified:

- The study area includes a significant amount of protected lands, including the Florida Keys National Marine Sanctuary, multiple State and National Parks, and some conservation easements held by NGOs
- The Florida Keys National Marine Sanctuary surrounds almost the entire study area and close coordination will be required to ensure that plan formulation incorporates the Sanctuary's regulatory requirements should measures be proposed within their boundaries.

- There are a variety of unique and/or endangered species located within the study area including by not limited to:
    - Extensive coral reef
    - Key deer
    - Mangroves
- Site conditions such as low elevation, porous geology, etc. may limit the applicability of structural measures in the Keys.
- There are multiple different water and wastewater management organizations within the study area
- There are cultural/historic assets in the study area (ex. Indian Key)
- There are strict state and local codes that govern building and development within the study area, for example there is a cap on the number of new building permits in the study area designated by a Rate of Growth Ordinance.
- Close coordination with FDOT will be critical in the formulation of plans that include risk reduction measures for U.S. Route 1.
- Some of the canals in the study area are privately owned
- Current FKLNMS policy prevents construction of artificial coral reefs in the vicinity of the study area
- Upstream water management operations in the Everglades National Park, which is outside of the study area, may affect the hydrology in Key Largo.
- Work to reduce coastal storm risk to lands under the jurisdiction of another Federal agency must be accomplished on a reimbursable basis, upon request from the agency. Civil works funds cannot be used for the protection of military installations/lands. For this reason, plans considered in this study will not be formulated to specifically reduce coastal storm risk within military installations and other federally owned property within the study area, but there may be incidental benefits provided by the recommended plan to these areas/facilities.

3.4 PERIOD OF ANALYSIS

The period of analysis is 50 years. The economic base year has been established as 2030 which is the year that it is expected the recommended project would begin accruing benefits. With the base year of 2030 as the start year, the period of analysis ends in 2079.

3.5 DEVELOPMENT/REDEVELOPMENT PROJECTIONS

3.5.1 Population Growth

The current permanent population of Monroe County is approximately 77,000 and the seasonal population is approximately 81,000, for a total functional population of approximately 158,000. Population projections in the Monroe County Comprehensive Plan show permanent population is projected to slowly decline from now to 2030, but seasonal population is expected to increase for an overall slight growth in functional population to approximately 162,000.

3.5.2 Future Development

Monroe County is required to regulate new residential development based upon the finite carrying capacity of the natural and man-made systems and the growth capacity while maintaining a maximum hurricane evacuation clearance time of 24 hours as mandated by the

State of Florida, pursuant to Section 380.0552, F.S. and Rule 28-20.140, FAC, and to maintain the public health, safety, and welfare. The county currently maintains a Permit Allocation System for new residential development known as the Residential Rate of Growth Ordinance (ROGO) System. The Permit Allocation System limits the number of permits issued for new residential dwelling units. New residential dwelling units included in the ROGO allocation system include the following: affordable housing units; market rate dwelling units; mobile homes; and institutional residential units (except hospital rooms). The number of permits issued for residential dwelling units under the ROGO shall not exceed a total of 1,970 new allocations for the time period of July 13, 2013 through July 12, 2023, plus any available unused ROGO allocations from a previous ROGO year. In 2012, pursuant to Rule 28-20.140, FAC, the Department of Economic Opportunity completed hurricane evacuation clearance time modeling and found that with 10 years' worth of building permits, the Florida Keys would be at a 24 hour evacuation clearance time. This creates challenges for the State of Florida and Monroe County as there are 8,168 privately owned vacant parcels and with 1,970 new allocations this may result in a balance of 6,198 privately held vacant parcels at risk of not obtaining permits in the future. Monroe County and the State of Florida are currently developing a mutually agreeable position defending inverse condemnation cases and Bert J. Harris, Jr. Private Property Rights Protection Act cases, with the State having an active role both directly and financially in the defense of such cases.

In recognition of the possibility that the inventory of vacant parcels exceeds the total number of allocations which the State will allow the County to award, the County was allowed to consider adopting an extended timeframe for distribution of the ROGO allocations through 2033 with committed financial support from its state and federal partners. Additional time was approved and the current end year for residential permits is now 2026. This additional time provides Monroe County additional time to implement land acquisition and other strategies to reduce the demand for ROGO allocations and help transition land into public ownership.

3.5.3 FDOT Responsibility for Overseas Highway/U.S. ROUTE 1

As the agency responsible for the continued maintenance and repair of U.S. Route 1, FDOT receives funding for and completes maintenance work that is required to keep the roadway operational. Following storm events, FDOT also makes any repairs required to return the roadway to pre-storm conditions. However, they do not expect to receive significant funding in the near future to improve U.S. Route 1 beyond its current design/condition other than the planned projects discussed in section 1.8 and Appendix A of this report. FDOT can be expected to maintain the roadway to the extent that their funding allows and has processes in place to respond to damage caused by coastal storms in a timely fashion. However, this is a mostly reactive approach. The focus of this study in reducing risk to U.S. Route 1 is to prevent damage to the roadway in segments that have been identified as particularly vulnerable to coastal storms. There is benefit to NED in reducing the likelihood and/or extent of damage to U.S. Route 1.

Improvements are programmed separately as reconstruction projects and are funded and justified differently than emergency repairs.

a. Reconstruction projects require an economic analysis.

b. Reconstruction projects rarely are completed in the Keys due to the limit on growth/development—most reconstruction projects are done to increase roadway capacity to meet increased traffic demand.
c. Last time reconstruction projects were completed in the Keys was when new bridges were constructed in the 1970's.

3.6 CRITICAL ASSUMPTIONS

The study authority limits the study analysis to the effects of coastal storms that impact the Florida Keys. This includes storm surge with consideration for wave attack, erosion, and sea level change in the estimates of inundation and how it is expected to damage infrastructure. This study did not formulate plans to address the impacts of general sea level rise that is often referred to as "sunny day flooding" or precipitation not associated coastal storm events. Direct effects of wind associated with coastal storms were also not considered in the development of alternatives. Due to the limitations of the study, there is some risk that will remain even with the recommended plan. This remaining risk is referred to as residual risk, which is inherent to any coastal storm risk management study as there is not one project that can address all facets of coastal storm risk that exist in any study area.

Scenario planning is a purposeful examination of a range of potential futures that address the uncertainty inherent in long-term planning. Unlike forecasts, scenarios do not indicate what the future will look like so much as what the future could look like. Scenario construction helps planners, decision makers, and stakeholders better adapt to a rapidly changing and complex future. Scenario planning acknowledges the critical influence of a few uncertainty drivers on the future condition that provides the base condition for evaluation. Critical assumptions from various disciplines were deliberated within the USACE and communicated with decision makers in the form of a risk register. A few of the most significant assumptions for each discipline are listed below:

- Assumptions were made using the best available information to estimate the future without project conditions in the Florida Keys, especially considerations pertaining to development and land use, sea level rise, and work completed by the sponsor and others in the Keys.
- It was assumed that FDOT will continue to maintain and repair U.S. Route 1 over the 50 year period of analysis so that it remains a viable travel route between each of the Keys and to mainland Florida. However, other than the projects FDOT has planned that are accounted for in the FWOP, the agency does not currently anticipate receiving funding for any projects that would significantly reduce the risk of U.S. Route 1 to damage from coastal storms such as elevating and/or armoring large segments of the roadway.
- Assumptions were made in development of the structure inventory and running the economic model used in the study based on best available data. The economic model includes various assumptions that reflect expected future conditions, for example, that severely structures will be rebuilt to meet the current FFE requirement of BFE+1 foot and the maximum number of times a structure will be rebuilt was set at five. More information pertaining to the economic model and analysis of the results can be found in Appendix

C, Economics.

- Interim environmental and cultural resources impacts analysis was used from available existing surveys and data to inform the TSP selection with a more thorough analysis to be conducted during the Preconstruction Engineering and Design (PED) phase of the project.

3.6.1 Storm Intensity and Water Surface Elevations

There are multiple storm variables that affect the intensity of storm surge. The wind magnitude, storm size, and exposure time are some of these variables. The FEMA South Florida Storm Surge Study developed coastal water surface elevations (WSELs) based on a suite of storms in order to estimate the probability of various storm surge WSELs. Lower probability events represent more extreme storms that produce higher WSELs.

3.6.2 Relative Sea Level Rise Projections

This study is formulated to consider the impacts that RSLR will have on future conditions both with and without project alternatives in place and is consistent with ER 1100-2-8162, "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 Florida Keys. The resulting RSLR 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 RSLR and climate change.

The forecast for the Florida Keys includes a relative sea level change for the 50 year period of analysis of 2030 – 2079. According to the USACE Sea Level Rise Calculator, water levels will rise 0.74, 1.35, and 3.14 feet for the USACE low, intermediate, and high curve estimates. Other entities have made RSLR predictions for the area. The National Oceanic and Atmospheric Administration predicts higher rates of RSLR for the High curve than USACE. Additional information on SLR is included in Appendix B, Engineering.

The USACE high curve was selected for use in estimating future design water surface elevations and plan formulation. The high curve is believed to represent a reasonable estimate of RSLR with the information available today and is recommended for use in this study.

CHAPTER 4 HYDROMODELING ANALYSIS

For the Florida Keys CSRM study, the Norfolk District used the FEMA Region IV South Florida Storm Surge Study (SFL Study) stillwater elevations and wave heights for the project analysis and design. The FEMA SFL Study includes the coastal counties of Miami-Dade, Broward, Palm Beach, and Monroe. The purpose of the study is to determine the flood risk from 50 percent (two year), 20 percent (five year), ten percent (ten year), four percent (25 year), two percent (50 year), one percent (100 year), and 0.2 percent (500 year) annual chance floods for these coastal areas for production of revised FIRMs.

4.1 HYDROMODELING ANALYSIS

The SFL study incorporated existing and future forcing and potential future climate change to perform statistical analyses and numerical hydrodynamic modeling for the region. The statistical analyses resulted in stillwater level elevations as average recurrence intervals (ARI) for a 100 percent flood (one year flood), 50 percent flood (two year flood), 20 percent flood (five year flood), ten percent flood (ten year flood), five percent flood (20 year flood), two percent flood (50 year flood), one percent flood (100 year flood), 0.50 percent flood (200 year flood), 0.20 percent flood (500 year flood), and 0.10 percent flood (1,000 year flood) for different confidence limits. The numerical modeling study was performed using the two-dimensional hydrodynamic model ADCIRC and the two-dimensional spectral wave model SWAN. The ADCIRC model is a coastal circulation and storm surge model that uses the finite element method to solve the reformulated, depth-averaged shallow water equations. The model is run on a triangulated mesh with elevations derived from a seamless bathymetric/topographic digital elevation model (DEM) that includes both offshore and overland areas. The triangulated format of the mesh allows variation in the element size, so the study area can have a high concentration of nodes while fewer nodes (with higher element areas) can be placed farther away to make the mesh size more efficient without compromising accuracy (FEMA, 2015). The SWAN model runs on the same triangulated mesh that is used with the ADCIRC model. During the model simulations, the water levels from ADCIRC are fed into the SWAN model at 15 minute interval (of model time). The SWAN model computes the wind driven development of the storm waves, the propagation of the waves over the model domain, and the wave radiation stress gradients where the waves break close to the shore. In turn, the ADCIRC component is informed of the computed radiation stress gradients at the completion of each SWAN component time step. This information is used by the ADCIRC component to adjust the nearshore water levels for the wave driven setdown and setup in the zone of breaking waves near the shoreline. This process continues for the duration of the wind and pressure forcing from the meteorological input files. The model was validated with historic tide gage, high water mark, and wave buoy data.

4.2 RELATIVE SEA LEVEL RISE EFFECTS ON STRUCTURE HEIGHTS

Many CSRM project designs in the past typically took into consideration the effects of coastal forces from waves, tides, currents, and storm surges. However, many in the past have not taken into consideration the effects of sea level rise on a coastal structure. In recent years, as sea level rise and climate change become apparent, the impacts of existing structures now show the

repercussions of not including the sea level. The rise in the sea level could potentially change the effects of coastal forces, due to the change in the water depths. Knowing the future coastal conditions of an area, engineers should design to include future potential impacts on coastal structures. Incorporating the effects of sea level rise in the initial design could also reduce the risk of failure in the future and reduce changing or making major adjustments for the structure in the future.

4.3 VERTICAL CONTROLS AND DATUMS

The horizontal datum for this study is tied to the State Plane Coordinate System using the North American Datum of 1983 (NAD83, Florida East, 0901). Distances are in feet by horizontal measurement. Coordinates are Florida East Zone. The vertical datum for this study is tied to the North American Vertical Datum of 1988 (NAVD88), a requirement of ER 1110-2-8160 and elevations are in feet.

CHAPTER 5 ECONOMIC APPLICATION

5.1 GEOGRAPHIC DATA

The study area includes all land and water resources reasonably deemed to be within the vicinity of the Florida Keys. Due to the vast range of elevation levels, storm wave heights, and varied land use, the study area of Monroe County is divided into 34 model areas (MAs) to facilitate initial economic analysis of the project alternatives using the USACE Generation 2 Coastal Risk Model (G2CRM).

5.2 STRUCTURE INVENTORY AND VALUATION

Parcel information was provided by Monroe County to assist with characterizing residential and nonresidential structures for the economic analysis. Data included addresses, property class description, property use, dwelling year built, dwelling condition/grade, crawl code, number units, number of floors, etc. With the building footprints provided by the County, property class descriptions and Google Maps were used to classify buildings into damage categories and occupancy types. First floor elevation assumptions were based on foundation type and verified with elevation certificates if available for a structure. Property class descriptions and Google Earth were used to classify buildings into damage categories and occupancy types. In rare cases, for attributes that contained no information, National Structure Inventory 2.0 data was used to fill those gaps. The team utilized 2019 RSMeans cost per square footage estimator to derive depreciated replacement values of all structures. The depreciated replacement value captures the cost of reconstructing the structure and doesn't not account for land valuation.

5.3 VEHICLE DATA

Physical flood damage reduction benefits include the decrease in potential damages to residential, commercial, industrial or public structures and their contents. Damages to associated vehicles and reduction in emergency services were not evaluated due to the nonstructural solution which would not reduce damage to vehicles.

5.4 EMERGENCY COST ESTIMATES

In addition to structure damage, a flooded community typically incurs a variety of other flood related costs including debris removal. The cost of the debris removal can vary according to the residential or nonresidential occupancy type of the structure. The content-related debris include white goods (refrigerators, stoves, dishwashers, etc.), electronics, and hazardous waste (paints, oil, household chemicals, poisons, etc.).

Interviews were conducted with experts in the fields of debris collection, processing, and disposal following Hurricanes Katrina and Rita. The experts were asked to provide a minimum, most likely, and maximum estimate for the cleanup costs associated with the two feet, five feet, and 12 feet depths of flooding. A prototypical structure size in square feet was used for the residential occupancy categories and for the nonresidential occupancy categories. The experts were asked to estimate the percentage of the total cleanup caused by floodwater and to exclude any cleanup that was required by high winds.

5.5 TRANSPORTATION

Roadway flooding is a common occurrence within portions of the County. Flooding causes residents and travelers to move their vehicles to higher ground or parking garages, travel alternate routes or risk losing their vehicle. However, vehicles were not included in the G2CRM model. Additional travel time incurred by using alternate routes to avoid flooded roads was not included in this analysis, but this additional benefit will be evaluated in the next phase of study during the feasibility level design, specifically to determine if there would be additional benefit generated by the proposed U.S. Route 1 shoreline stabilization measures.

5.6 STAGE-DAMAGE FUNCTIONS

Various depth damage functions (DDFs) were considered for use in the study. Residential and Non-residential depth-percent damage relationships are sourced from (1) the North Atlantic Coast Comprehensive Study (NACCS) Physical Depth-Damage Function Summary Report and (2) the revised 2013 Expert Elicitation draft report completed by the USACE Institute of Water Resources (IWR). Various flood depth-damage functions were used with respect to structure characteristics. These DDFs are assumed to be representative of the structures in the floodplain. Given the high amount of multi-family condominiums in the study area, combined with the salt-water environment associated with the location, the DDFs established within the NACCS Physical Depth Damage Function Summary Report were determined to be appropriate for use in the study. The NACCS curves were used to model damages for all residential structures and the majority of nonresidential structures, unless curves for more specific non-residential structure types were developed as part of the Nonresidential Flood DDFs derived from Expert Elicitation Report in 2013. These curves were used in lieu of the NACCS curves for non-residential inundation to more closely match specific non-residential occupancy types within the structure inventory.

5.7 STAGE-PROBABILITY DATA

Stage-probability relationships were provided for the existing (2030) without project condition and future without (2079) project conditions. Water surface profiles were provided for nine annual chance expedience (ACE) events: 50 percent (two year), 20 percent (five year), ten percent (ten year), five percent (20 year), two percent (50 year), one percent (100 year), 0.5 percent (200 year), 0.2 percent (500 year), and 0.1 percent (1,000 year). The without project water surface profiles were based on 34 save points published on the Coastal Hazards System. The mean sea level trend of 0.0126 feet per year (Vaca Key, FL) was used as the sea level change rate.

5.8 ADDITIONAL ECONOMIC CONSIDERATIONS

5.8.1 Residual Damage

Nonstructural and structural measures reduce flood risk and damage to buildings. No measure, except acquisition and removal, can eliminate all risk. Floodwalls, tide gates, structure elevation and floodproofing can be overtopped by a flood event or fail. Some measures don’t address nuisance or sunny day flooding. The risk that remains after a measure is implemented is the

residual risk. Residual risk can be reduced by implementing multiple layers of protection, such as flood insurance, higher floodplain standards, evacuation, stormwater infrastructure investment, NNBFs, etc. The purchase of flood insurance can reduce financial risk to a property owner should flooding occur. Higher floodplain standards, including freeboard, reduce the exposure of structures to flooding and the vulnerability of the community. Improved stormwater infrastructure can increase capacity of the system and reduce risk of flooding to roads and buildings. NNBFs can reduce impervious surfaces and improve infiltration, thereby reducing runoff.

5.8.2 Gross Regional Output, Employment, and Earned Income Impacted

Regional Economic Development (RED) will be evaluated on the TSP during the next phase of this study. The RED analysis measures the dependence between industries and workers in an economy. In other words, if a government agency invests in a certain area, how will the regional economy respond? The calculation is performed by a model developed by IWR, Michigan State University and the Louis Berger Group. Further detail on the RED analysis can be found in Appendix C.

CHAPTER 6 MANAGEMENT MEASURES AND FORMULATION OF ALTERNATIVES

6.1 PLAN FORMULATION STRATEGY

Due to the large geographic extent of the study area and the fact that coastal storm risk is relatively high across the majority of the Florida Keys, three plan formulation strategies were developed by the PDT to assist in the identification of vulnerable areas and the development of alternative plans that would meet the study's planning objectives. The objectives for this study were created to address the coastal storm risk problems identified during the scoping phase of the study, considering the limitations of the study authority, and were used to evaluate and compare the risk reduction each alternative would be expected to generate. The planning objectives include:

1. Reduce the risk of damage to U.S. Route 1 caused by wave action and erosion associated with coastal storms in the Florida Keys over the 50 year period of analysis.
2. Reduce the risk of damage to critical infrastructure caused by storm surge inundation associated with coastal storms in the Florida Keys over the 50 year period of analysis.
3. Reduce the risk of damage to development (residential and non-residential structures) caused by storm surge inundation associated with coastal storms in the Florida Keys over the 50 year period of analysis.
4. Reduce the risk to human life, health, and safety to the population in the Florida Keys that is caused by the inundation of development and critical infrastructure and the reduced evacuation efficiency that is associated with coastal storm events over the 50 year period of analysis.

These objectives were created to address the problems (Section 3.1 of this report) that the PDT and NFS identified as significant factors contributing to coastal storm risk in the Florida Keys. Because there are many measures could address each of these objectives at a multitude of different locations across the large study area, the PDT decided to address the different types of coastal storm risk captured in objectives one, two, and three by developing the following three plan formulation strategies:

- Reduce coastal storm risk along the U.S. Route 1 corridor. This includes reducing damage to the roadway that is caused by wave action and erosion and potentially also reducing damage to any other infrastructure that is located immediately along U.S. Route 1 should it be located in an area where a measure is recommended to prevent damage to the roadway. The goal of this strategy is to reduce risk of damage to the singular evacuation route from the Keys to the mainland and maintain connectivity between the islands. Alternatives formulated under this strategy meet both the first and fourth planning objectives.
- Reduce coastal storm risk to critical infrastructure. This includes reducing damage caused by inundation associated with coastal storm events to critical infrastructure including emergency services (fire, police, EMS), key utilities (communications, power, water, wastewater/sewer), emergency shelters, etc. The goal of this strategy is to reduce risk to human life and safety by reducing coastal storm damage to critical infrastructure that is necessary to maintain public safety and human health. Alternatives formulated under this strategy meet both the second and fourth planning objectives.
- Reduce coastal storm risk to development. The goal of this strategy is to reduce damage caused by inundation associated with coastal storm events to vulnerable residential and

non-residential structures to reduce the impact of coastal storms on the national, regional, and local economies. Alternatives formulated under this strategy meet both the third and fourth planning objectives.

In formulating alternative plans using these three plan formulation strategies, measures were combined to develop a plan for each strategy, so that the resulting array of alternatives included a variety of unique plans that provided varying types and amounts of coastal storm risk reduction to the Florida Keys. When the array of alternatives includes a range of plans that address each of the coastal storm risk drivers individually and in different combinations, the NFS is also provided with good information that can be used to select a Locally Preferred Plan (LPP), if desired, that prioritizes one or more of their primary concerns.

6.2 MEASURES FOR COASTAL STORM RISK MANAGEMENT

A suite of structural, nonstructural, and NNBF measures were identified to possibly be effective in reducing coastal storm risk in the Florida Keys. The suite of measures also included feedback gathered during a charette that was held in the Keys on 14 November 2018 with the NFS, relevant state and Federal agencies, and other key stakeholders.

6.2.1 STRUCTURAL MEASURES

Structural measures focus on reducing the probability of coastal storm damage by limiting the amount of storm surge, erosion, wave action, etc. that affects an area or structure that is at risk. A variety of structural measures were considered in this study. These measures are defined and described below.

Breakwaters

In general, breakwaters are structures designed to reduce risk to shorelines, beaches, or harbor areas from the impacts of wave action thereby reducing shoreline erosion and storm damage. Breakwaters, usually constructed in combination with beach restoration, are appropriate for implementation on beaches as a stabilization measure. Breakwaters are usually rubble-mound structures built roughly parallel to the shoreline at some distance in relatively shallow water in order to maximize amount of risk reduction they provide and to optimize their efficiency at reducing erosion. The dissipation of wave energy usually allows sand to accumulate behind the breakwater, which may further reduce risk the shoreline. In some cases the beach “salient” formed by the accretion effect connects to the breakwater thus forming a “tombolo.”

Shoreline Stabilization

Revetments are onshore structures with the principal function of reducing the impacts to the shoreline from erosion and typically utilizes stone, concrete, or asphalt to armor sloping natural shoreline profiles. They consist of an armor layer, filter layer(s), and toe protection. The armor layer may be a mass of stone or concrete rubble. The filter assures drainage and retention of the underlying soil. Filter-type structures such as stone revetments are preferable where groundwater is part of the erosion process.

Sea Walls/Floodwalls

Floodwalls are structures used to reduce risk in relatively small areas or areas with limited

space for coastal storm risk management against lower levels of flooding and are usually constructed from concrete. Unlike wider, more stable levees, walls require significant reinforcement and anchoring construction to prevent collapse from hydrostatic pressure. The significant amounts of steel sheeting and/or reinforced concrete used in constructing a typical wall make the feature extremely heavy. Because construction may occur on soft organic soil, pile reinforcement may be required under the base of the wall. The combination of steel sheeting, reinforcement, concrete, and pile support make a floodwall a much more costly structural risk management measure than a similar length and height levee.

Levees

Levees are embankments constructed along a waterfront to prevent flooding in relatively large areas. They are typically constructed by compacting soil into a large berm that is wide at the base and tapers toward the top. Grass or some other type of non-woody vegetation is usually planted on the levee to add stability to the structure. If a levee is located in an erosive shoreline environment, revetments may be needed on the waterfront side to reduce impacts from erosion, or in cases of extreme conditions, the levee face may be constructed entirely of rock. Levees may be constructed in urban areas; however, large tracts of real estate are usually required due to the levee width and required setbacks. The height and width usually limit access to the water for recreation and commercial activities, and like floodwalls, impact the viewshed of coastal properties. Structural measures, such as floodwalls and levees tend to trap rainfall runoff associated with storms on the landward side, so gravity outlets are installed along the length of the structure. In cases where significant runoff may be trapped behind the structure, ponding areas and pump stations are required.

Storm Surge Barriers

Storm surge barriers reduce risk from storm surge flooding and waves. In most cases, the barrier consists of a series of movable gates that stay open under normal conditions but are closed when storm surge is expected to exceed a certain predetermined level. Storm surge barriers are often chosen as a preferred alternative to closing off waterways completely and may also reduce the required length of flood risk management measures adjacent to and/or behind the barriers. Storm surge barriers range in scale from small/local gates reducing risk to a small coastal inlet to very large barrier systems that are designed to reduce risk to a large estuary or bay and consist of a series of coastal dikes, gates, and in some cases navigation locks. Both are usually combined with other coastal storm risk reduction measures such as levees or floodwalls.

Small Scale Ring Walls

Ring walls are small floodwalls that are constructed around a particular structure or group of structures to reduce damage from storm surge. The maximum height considered for ring walls is 6 feet due to engineering and building access constraints.

Canal Improvements

This measure would include improvements to the hundreds of residential canals throughout the study area, to include hardening/protection of the shorelines, dredging and debris removal, or filling as appropriate. The non-Federal sponsor requested that this measure be considered,

particularly to determine if debris removal and/or deepening the canals would reduce storm surge impacts on structures adjacent to the canals.

Beachfill and Dunes

Beach restoration, also commonly referred to as beach nourishment or beachfill, typically includes the placement of sand fill to either replace eroded sand or increase the size (width and/or height) of an existing beach, including both the beach berm and dunes. Material similar to the natural sand is artificially placed on the eroded part of the beach. Beachfill designs must also consider the quantity of sand and frequency of renourishments that are required to maintain the design berm and dune over the life of the project. There are many other site specific design criteria that must be considered during detailed beach restoration design: identification of onshore or offshore sources of compatible sediment, beachfill tapers, dune crest alignment, etc. Beachfill alone does not alter preexisting shoreline erosion rates. Generally, it is assumed that shoreline erosion will continue at the same rate with a beachfill project as before the project was constructed. Typically, background erosion is caused by a deficit in sediment budget. Beachfill projects typically experience additional erosion from “spreading out” or diffusion of sand resulting from the shoreline anomaly or “bump” created by the beachfill. Diffusion losses are function of the longshore length of the beachfill, cross-shore width of the beachfill, and wave climate (diffusivity). The rate of diffusion is particularly sensitive to the longshore length of the beachfill project. Shorter projects will generally experience a much higher rate of diffusion than longer projects.

6.2.2 NONSTRUCTURAL MEASURES

Nonstructural 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 differ from Structural measures in that they focus on reducing the consequences of flooding instead of focusing on reducing the probability of flooding. A variety of nonstructural measures were considered in this study. These measures are defined and described below.

Acquisition (buyouts)

Buildings may be removed from vulnerable areas by acquisition (buyout), subsequent demolition, and relocation of the residents. Property acquisition and structure removal are usually associated with frequently damaged structures. Implementation of other measures such as elevation or floodproofing may be effective, but if a structure is subject to repeated storm damage, acquisition may represent the best alternative to eliminating risks to the property and residents. The property that remains once the structure has been acquired and demolished must remain undeveloped in perpetuity. Acquisition is limited to residential structures and residents of structures will be relocated to equivalent homes in areas that are less vulnerable to coastal storm surge flooding.

Elevation

Elevation of structures is limited to residential structures. Whether a structure may be elevated depends on a number of factors including the foundation type, size of the structure, condition, etc. Elevating a home so that the finished floor is at a height where coastal storm surge flooding reduces the likelihood that the structure and/or content will be damaged.

Dry/Wet Floodproofing

Dry floodproofing involves sealing flood prone structures from water with door and window barriers, small scale rapid deployable floodwalls, or sealants. Dry floodproofing is generally feasible up to three feet. Wet floodproofing does not prevent water from entering the structure, but moves or protects damageable items from the water so that once the surge recedes, the damage to the structure and contents is greatly reduced. Floodproofing is only recommended for non-residential structures, such as commercial buildings and critical infrastructure that cannot be elevated due to their large size.

Warning Systems

Despite improved tracking and forecasting techniques, the uncertainty associated with the size of a storm, the path, or its duration necessitate that warnings be issued as early as possible. There are early warning systems in place currently and these would be continued by the NFS and other state and federal agencies.

Emergency Planning

Emergency and evacuation planning is imperative for areas with limited access, such barrier islands, high density housing areas, elderly population centers, cultural resources, and areas with limited transportation options. The NFS currently has an emergency plan and will continue to engage in emergency planning in the future.

Land Use Planning

Land use planning reduces development in flood prone areas through the use of zoning laws and other policies. The NFS has taken steps to contain growth with the ROGO policy and other zoning and planning actions that will continue in the future.

6.2.3 NATURAL AND NATURE-BASED FEATURES

NNBFs consist of various habitat types that have been shown to reduce the impacts of coastal storms by reducing storm surge, wave energy, and/or erosion. A variety of natural and nature based features (NNBF) were considered in this study. These measures are defined and described below.

Beachfill and Dunes

Beachfill is also considered by USACE to be a structural measure. Please refer to section 6.2.1 of this report for a description of this measure.

Mangrove Restoration/Creation

Mangrove restoration would restore mangroves where they were historically present and/or the site conditions are conducive to their survival (water depth, bottom conditions, etc.). Research has shown that areas located behind mangroves sustain less coastal storm damage than those areas without mangroves.

Reef Habitat Restoration/Creation

Reefs enhance resilience of coastal areas by reducing wave energy that degrades the shoreline. In the Florida Keys, coral reef is the predominant reef type and the world's third largest coral reef is located approximately three miles off the Atlantic coast of the study area.

SAV Restoration/Creation

This measure includes the restoration of submerged aquatic vegetation (SAV) in areas where it was historically present and the site conditions are conducive to their survival (water depth, bottom conditions, etc.). SAV has been shown to provide some wave attenuation and sediment stabilization.

Living Shorelines

Living shorelines represent a shoreline management option that combines various erosion control methods and/or structures while restoring or preserving natural shoreline vegetation communities and enhancing resiliency. They are natural landscape features that function primarily under normal tidal range conditions and provide a varied mix of habitat such as: shallow water, intertidal, beach, marsh or dune. They provide some wave reduction benefit under high water and storm conditions. A typical living shoreline is relatively narrow, and they have been promoted in embayments and other lower energy areas to replace or enhance revetments, bulkheads, and other hard shoreline stabilization structures. An essential component of a living shoreline is the rock structure (breakwater/sill) that is constructed offshore and parallel to the shoreline to reduce wave energy that would impact the wetland area and cause erosion of the substrate and damage the tidal plants.

Drainage Improvements/Water Storage Features

Drainage improvements and water storage features include measures that would increase the efficiency and/or storage of water. Usually, this measure is used to address flooding from precipitation in areas behind a large structure such as a floodwall. USACE policy prohibits feasibility studies from recommending improvements to general stormwater systems, unless it is to mitigate for the effects of a structure such as a floodwall or surge barrier that is included in the recommended plan.

6.3 SCREENING OF MEASURES

The suite of CSRM measures was initially screened qualitatively using the following criteria:

- Does the measure provide a relative measure of coastal storm risk reduction that would meet one or more of the study objectives?
- Is the measure technically feasible considering the study area characteristics?
- Is the measure sustainable and an economically efficient method of coastal storm risk reduction for the Florida Keys?

In the first iteration of the planning process, parametric cost estimates and preliminary structure damage benefits were used to determine whether some measures were economically efficient methods of coastal storm risk reduction.

In subsequent iterations of the planning process, new analysis was completed and measures were screened further using the same criteria, but with more detailed and/or quantitative assessments such as G2CRM results and refined cost estimates.

6.3.1 Structural Measures Screening

It became clear very early on in the study that the study area conditions would limit the applicability of most structural measures, especially the large-scale ones such as sea walls and surge barriers. The Florida Keys are a unique study area and the very characteristics that increase the area's vulnerability to coastal storms are also what limit the application of many risk reduction measures that are used in other coastal communities. Most coastal communities in the U.S., even those in southern Florida, have a defined coastline where coastal storms make landfall and then coastal risk gradually decreases moving inland away from the coast. As an archipelago situated between the Atlantic Ocean and Gulf of Mexico, the Keys have omnidirectional risk. Coastal storms can and do make landfall from any direction and the Islands are so small that there is effectively not a shoreline where efforts can be concentrated to create a single line of protection with an inland area to retreat to behind that line of protection. Most structural measures are designed to reduce storm surge and wave energy from one direction, so that there is an area behind that measure with significantly reduced risk. However, in the Keys, there is effectively no way to reduce risk to an area behind a wall or surge barrier without encircling an entire island. Considering this and also the porous limestone geology in the Keys, all structural measures were screened from consideration except for shoreline stabilization. Detailed rationale for the screening of structural measures is provided below.

Breakwaters

Breakwaters are usually rock structures that are constructed just offshore from sandy beaches to reduce wave energy on the coastline and prevent erosion of the beach. When the PDT evaluated the applicability of breakwaters in the study area, the engineering team did not identify any areas where constructing new breakwaters would be feasible from an engineering standpoint and there was also significant structure damage identified that could be used as economic benefit needed to generate a positive BCR needed to justify their construction. This is because there are not many sandy beaches in the Keys where the measure could be considered, and in the areas where there is sandy beach, revetment or nonstructural measures would be much more cost effective methods in reducing coastal storm risk. Breakwaters require a larger quantity of rock to construct vs. revetment which is located on the shoreline and in the Keys, there are very high mitigation costs associated with constructing anything in the water. More information on sites where breakwaters were considered is included in Appendix A, Plan Formulation. For these reasons, breakwaters were screened from further consideration.

Shoreline Stabilization

Shoreline stabilization, in this case, rock revetment, was initially recommended for 15 locations along U.S. Route 1 to reduce erosion and/or washout of the roadway due to the wave energy from coastal storm events. Engineering PDT members initially identified the 15 locations for shoreline stabilization based on a review of aerial imagery to identify areas where the shoreline looked to be encroaching on the road, there was less than 100 linear feet of land from the edge of the roadway to the water, and there was evidence of a high wave energy and/or erosion. These 15 areas were then evaluated based on a cost and benefit analysis, environmental impact analysis, and also coordinated with FDOT. This evaluation and coordination, resulted in

screening eight of these initial 15 areas out. The designs of 7 remaining areas were also revised following this coordination and two of these were combined into one new larger area. More information on the revetment areas is included in Appendix A, Plan Formulation. Ultimately, six revetment areas were carried forward and are included in the TSP.

Roadway Elevation

This measure would increase the road elevation to allow vehicles access to and from impacted areas during a storm event. In the study area, elevation was considered along Route 1 to maintain the ability to travel on the route even with some storm surge from a coastal storm. However, such a significant portion of the roadway would be inundated a significant amount during a storm event, that maintaining travel along the entire length of U.S. ROUTE 1 during a major coastal storm event is not feasible due to the extensive road elevation that would be needed to gain even a low level of benefit. Engineering PDT members identified the following reasons why extensive roadway elevation is not a feasible or cost effective measure:

- Roadway sections would require increased transitions from side streets to tie into the elevated road. An increase of five inches equates to an approximate length increase of 21 feet to transition to the existing grade of the side street. Retaining walls may be required to tie into the right-of-way or other fixed object such as a building, fence, or wall.
- Roadway sections will either require increasing the slope from the edge of pavement to the existing right-of-way or maintaining the typical section on either side of the roadway which more than likely will encroach beyond the right-of-way line. The net result would be that property owners would be impacted by the loss of land area and property value. The cost of compensating these land owners to acquire the real estate needed would increase the already high cost of the road elevation itself.

The PDT concluded that while it was not feasible or cost effective to prevent inundation to U.S. ROUTE 1, risk can be reduced in sections of the roadway that are at risk to washout or erosion/land loss effects can be reduced with shoreline stabilization, which has been included in the array of alternatives. Road elevation was screened from further consideration.

Canal Improvements

This measure would include improvements to the residential canals throughout the study area, to include hardening/protection of the shorelines, dredging and debris removal, or filling as appropriate. This measure was requested by the NFS because the County is currently evaluating some improvements to these residential canals themselves to remove debris resulting from Hurricane Irma. Canal improvements were considered but were screened from further consideration by the PDT for the following reasons:

- Coastal engineers have established that there would not be a measurable reduction in storm surge or wave action during a significant coastal storm event gained by improving these small canals.
- If there is not a measurable reduction in the effects of coastal storms that would meet the study objective of reducing damage in the study area, there would be no way to quantify an economic benefit to justify the cost of improvements to the canals

Sea Walls and Flood Walls

This measure would include traditional, large scale sea or flood walls that would serve as a barrier to coastal storm surge and wave action to reduce damage to the structures behind them. Sea Walls were screened from further consideration for the following reasons:

- For a sea wall to be constructed in a coastal setting, there must be higher ground to tie the end of the wall in. In the Keys, the terrain is flat and there are not locations where there is high ground to end a wall structure. This would require a ring wall to be constructed on every single Island of the Keys. This is not acceptable from a cost or lifestyle standpoint for residents and tourists in the Keys.
- Existing walls were considered for elevation and/or improvement, such as the one south of the airport. However, due to the flat and low elevation of the islands, a partial wall would not further reduce impacts from coastal storms since storm surge would intrude into the area behind the wall from the unprotected areas.

Levees

This measure is similar to sea walls and flood walls in the method and level of risk reduction. However, levees require a large footprint because unlike walls, they are constructed from earthen fill and require a trapezoidal design. Levees were screened from further consideration for the following reasons:

- The area needed to construct a levee is not available in a fully developed coastal urban environment like the Keys.
- Similar to a sea wall, for a levee to be constructed in a coastal setting, there must be higher ground to tie the end of the structure in. In the Keys, the terrain is flat and there are not locations where there is high ground to end a levee structure. This would require a ring levee to be constructed on every single Island of the Keys. This is not acceptable from a cost or lifestyle standpoint for residents and tourists in the Keys.

Storm Surge Barriers

Storm surge barriers are some sort of gate or closure across an inlet or other body of water that prevent storm surge and waves from affecting areas in the vicinity of that water body. This measure is typically coupled with some type of seawall, floodwall, or levee or must be able to tie into higher ground to provide temporary or as needed protection for geographic gaps and inlets. Surge barriers were considered across the study area, specifically on the canal that runs through the middle of Key West. However, there is no high ground in the vicinity where a surge barrier can be tied in and seawalls/floodwalls and levees were screened from consideration. Without anything to tie a surge barrier into, constructing one would be ineffective because storm surge would rise over the shoreline next to the inlet and flood the structures there even if the canal itself was blocked off with a surge barrier. Surge barriers were screened from further consideration.

Small Scale Floodwalls (Ring Walls)

Although not realistic for all of the structures in the Florida Keys, ring walls were considered for critical infrastructure. However, engineering analysis showed that due to the limestone geology in the Keys, T-walls would be required instead of I-walls. T-walls are much more expensive to construct than I-walls and would not be economically justified. Ring walls were screened from further consideration.

Beachfill and Dunes

Beachfill was initially considered across the entire study area. The PDT looked specifically at areas that have existing sandy shoreline, which would suggest that beachfill is a sustainable measure there. Preliminary structure damage was also incorporated in the consideration of beachfill areas and only areas where structures were experiencing damage were considered. Private property also had to be considered. In some of the areas considered for beachfill, the beaches are privately owned and do not have public access amenities that are required for USACE to recommend a beachfill project, such as established beach access locations and adequate public parking facilities. After reviewing potential sites across the study area, the only area identified as a location where beachfill would be feasible considering these engineering, economic, and public access criteria is the southern shoreline of Key West, from the edge of Naval Air Station Truman Annex eastward to the groin at the end of Smathers Beach. This segment of shoreline does not include the shoreline in front of the Key West Airport. This is because there appears to be a large longshore sediment transport in the area that would supply sand naturally in front of the Key West Airport. To sustain the artificial beach, approximately nine coastal structures (groins, breakwaters, etc.) would be needed. The existing bulkhead should function as a shoreline stabilization project in this location. The width of the road and bulkhead will dissipate the wave energy before it gets to the airport. Beaches in front of seawalls tend to erode a faster rate than shoreline with just beaches, especially in areas where there are a large longshore sediment transport, due to the wave reflection at walls reflecting back on the beaches. In some areas like this, the anticipated time of renourishment is cut in half (in other words effectively doubling the sand renourishment required). In summary, constructing a beach in front of the seawall near the airport in Key West would be extremely costly and not reduce damage to the airport beyond the existing seawall's function.

Additionally, while the stretch of shoreline from edge of Naval Air Station Truman Annex eastward to the groin at the end of Smathers Beach did meet the initial three screening criteria, additional analysis was completed on this area to assess the economic feasibility due to the high cost of beachfill in the Florida Keys. When the PDT searched for data needed to develop an initial cost estimate for beachfill in the study area, they were informed that there was just a beachfill project completed in Key West in 2018 (non-USACE/Federal). The material for this project had to be truck hauled from an upland sand source near Lake Okeechobee and the cost per cubic yard of beach quality sand was $76 per cubic yard (CY). This is significantly higher than the cost of beach quality sand in other coastal areas such as the northeast, so alternative sources of sand were researched to ensure that there are not less costly options. After additional research, no additional sources of sand were found that had the quantity and/or quality of sand needed for less than $76/CY. Other sources studied included using dredge material from Key West Harbor and other navigation channels in the study area vicinity, barging

sand from the Bahamas, and barging sand from an offshore BOEM borrow site in the Gulf of Mexico off the coast of Naples, FL.

The PDT also completed an initial benefits analysis which was compared to the cost of beachfill in the Truman Annex to Smathers Beach area and found that there would not be enough structure damage or recreation benefit to support beachfill at the cost of $76/CY. This analysis is explained in Appendix A, Plan Formulation. The benefit cost analysis supported the rationale to screen out beachfill from further consideration in this study not just in this area of Key West, but throughout the study area.

Table 6-1 shows the summary of structural measures screening. Red shaded rows indicate measures that were screened from further consideration.

Table 6-1: Summary of Structural Measures Screening

Measure	Measure Type	Notes	Carried Forward?
Breakwaters	Structural	Meets objective #1, but screened out due to high cost and environmental impacts and shoreline revetment can accomplish same risk reduction to U.S. ROUTE 1 for lower cost and less environmental impact, does not reduce damage to structures due to surge inundation per objectives #2 and #3	N
Shoreline Stabilization	Structural	Meets objective #1, includes armoring of shoreline with revetment structures, most relevant to U.S. ROUTE 1 damage reduction	Y
Canal Improvements	Structural	Does not meet objectives, includes shoreline stabilization, debris removal, and dredging or filling as appropriate but these would not reduce inundation of structures or erosion/wave damage to U.S. ROUTE 1	N
Sea Walls	Structural	Would meet objectives #1-4, but screened out due to engineering limitations including low elevation with no high ground to tie wall into, porous limestone geology, and extensive shoreline length which would be cost prohibitive and cause shoreline access issues.	N

Measure	Measure Type	Notes	Carried Forward?
Floodwalls	Structural	Meets objectives #1-4, but screened out due to engineering limitations including low elevation with no high ground to tie wall into, porous limestone geology, and extensive shoreline length which would be cost prohibitive and cause shoreline access issues.	N
Levees	Structural	Meets objectives #1-4, but screened out due to engineering limitations including low elevation with no high ground to tie levee into, porous limestone geology, and extensive shoreline length which would be cost prohibitive and cause shoreline access issues.	N
Small Scale Ring Walls	Structural	Meets objectives #2-4, but screened out due to geological constraints that require T walls which have a much higher cost and would not be efficient on a structure by structure basis	N
Storm Surge Barriers	Structural	Meets objectives #2-4, but screened out due to flat topography and low elevation that does not provide high ground for surge barrier tie into	N
Beachfill/Dunes	Structural/NNBF	Meets objectives #1-4, but screened out due to extremely high cost of procuring beach quality sand ($76/CY) which makes the measure not cost effective in reducing damage to structures	N

6.3.2 Nonstructural Measures Screening

Unlike structural measures, nonstructural measures are applicable across the entire study area and they were all carried forward and included in the array of alternatives. Details on each measure are provided below (see Table 6-2).

Acquisition (buyouts)

This measure considers acquisition of property facing a serious threat from coastal storms. Those who own property would relocate to a low-risk area with little threat of damage from flooding. Property to be acquired would not be able to be developed in the future. Acquisition was carried forward to be included in the array of alternatives.

Structure Elevation

In addition to acquisition, elevation was also examined. Elevation would involve raising homes to a level above design flood elevation at which they would no longer face a threat from coastal storm surge. Due to height restrictions from wind, elevation may not be an option for certain structure types such as mobile homes. Elevation of structures was carried forward to be included in the array of alternatives.

Dry/Wet Floodproofing

Dry floodproofing includes sealing all openings below a certain elevation to prevent floodwaters from entering a structure. The maximum height a structure can be dry floodproofed is three feet above ground elevation due to engineering constraints. Structure owners would have to place the barriers prior to a storm, but, once placed, damages could be reduced significantly. Wet floodproofing is a strategy where uninhabited spaced of a structure are intentionally allowed to flood. This strategy helps reduce structural damage that can result from the pressure of the floodwaters. To be implemented, structures need to have space below the flood elevation to be sacrificed, such as a basement or crawl space. This limits the number of structures where this strategy could be applied, but it could be effective for a number of structures. Florida State building code does not allow wet floodproofing in most coastal areas, so only dry floodproofing was carried forward to be included in the array of alternatives. It is important to note that due to engineering constraints, the maximum height of dry floodproofing is three feet above ground level.

Warning Systems

Warning systems increase limit damages of an event due to increased preparedness. Although Monroe County already has a warning system, modifications could improve the functionality of the system. Warning Systems were carried forward to be included in the array of alternatives.

Emergency Planning

Planning for an emergency decreases the impact it has on a community. This measure will likely include the development of a Flood Emergency Preparedness Plan (FERP) to examine risks, current actions, and proposed actions. The measure was carried forward to capture any improvements that could be made for the region's emergency planning.

Land Use Planning

Land use planning strategies ensure communities are not continuing to place structures in danger and utilizing the protections that are in place. Land use planning is vital to the success of the entire plan moving forward and was carried forward.

Table 6-2 shows the summary of nonstructural measures screening. All nonstructural measures were carried forward for further consideration.

Table 6-2: Summary of Nonstructural Measures Screening

Measure	Measure Type	Notes	Carried Forward?
Buyout/ Acquisition	Nonstructural	Meets objectives #2-4	Y
Elevation	Nonstructural	Meets objectives #3 and #4, only residential structures can be elevated	Y
Dry/Wet Floodproofing	Nonstructural	Meets objectives #2-4, only dry floodproofing is carried forward for critical infrastructure and non-residential structures	Y
Warning Systems	Nonstructural	Meets objective #4, would be implemented by the NFS and other state and local entities as appropriate	Y
Emergency Planning	Nonstructural	Meets objective #4, would be implemented by the NFS and other state and local entities as appropriate	Y
Land Use Planning	Nonstructural	Meets objectives #2-4, would be implemented by the NFS and other state and local entities as appropriate	Y

6.3.3 Natural and Nature Based Measures Screening

The study area is extremely rich in unique environmental resources and the team recognized early on in the study that it would be important to incorporate NNBF measures to full extent possible in this study. However, recognizing that the study authority does not include ecosystem restoration, NNBF measures must be considered and screened based on the same criteria that structural and nonstructural measures were with the understanding that they must provide coastal storm risk reduction that can be quantified in terms of net NED benefit. There is inherent value provided by all of the different NNBF measures in any coastal system, but there were only two NNBF measures, mangrove restoration and living shorelines, that were determined to provide a measurable contribution to CSRM in the Keys. Detailed rationale for the screening of NNBF measures is provided below.

Beachfill and Dunes

Beachfill is considered to be both a structural measure and NNBF. The rationale provided for

beachfill and dunes in the structural measures section also applies to this measure as a NNBF because NNBF measures must be economically justified according to the same policy requirements as structural and nonstructural measures. Per the rationale in section 6.3.1, this measure was screened from further consideration.

Mangrove Restoration/Creation

Mangroves have been shown to reduce storm surge and wave action during coastal storm events, which is the reason why damage is less in areas where they are present. Several mangrove restoration locations were initially identified and considered; however none were deemed suitable because they would have displaced other existing aquatic resources and/or other waterway uses, or otherwise were not appropriate habitat. .

Reef Habitat Restoration/Creation

Coral reef restoration was considered in the study area. The third largest coral reef in the world is located about three miles off the Atlantic coast of the Keys, so there is no doubt that the study area vicinity would support coral reef habitat. However, "Altering the seabed, or placing or abandoning any structure on the seabed" is prohibited in the Florida Keys National Marine Sanctuary (FLKNMS). A new artificial coral reef would be classified as a structure that would need to be a permitted by the FKNMS and there is considerable risk that a permit would not be granted. The predominance of deep water large reef tracts (and the best likely potential sites for success) are outside the Designated FKNMS Management Areas. These deep water coral reefs are more than three miles from the Florida Keys and PDT engineers have established that at such a distance, there would not be a significant, measurable reduction in coastal storm effects such as storm surge and wave action that would inflict damage on developed areas. Additionally, while it is true that a small amount of wave attenuation and reduced damages could be attributed to the installation of new coral reefs in these areas, the propagation of coral reefs is an expensive and lengthy process. This means that it would take a significant portion of the period of analysis to begin accruing economic benefits from this measure, making it likely that it would not be economically justified. Armoring the shoreline with revetment would be more cost effective and likely more effective in reducing wave damage on the study area. Reef restoration has been screened from further consideration.

SAV Restoration/Creation

Upon research into the reduction in storm surge and/or wave energy on coastal infrastructure, it has been established that SAV does not provide reductions significant enough to justify the cost of restoration. SAV restoration has been screened from further consideration.

Living Shorelines

Living shorelines are a type of shoreline stabilization that include more natural features in addition to rock and other hard materials. In this study, living shorelines were considered in areas that are identified for shoreline stabilization along Route 1. However none of the six proposed revetments would be compatible with living shorelines, except for the one at Long Key; but this area is needed for the required replacement and replanting of upland beach vegetation.

Drainage Improvements/Water Storage Features

USACE policy prohibits feasibility studies from recommending improvements to general storm water systems, unless it is to mitigate for the effects of a structure such as a floodwall or surge barrier that is included in the recommended plan. Because floodwalls, seawalls, levees, and surge barriers have been screened from further consideration in this study, this measure must be screened as well. The PDT did consider the possibility of storing storm surge water, but due to the high levels of surge expected with a storm event in the Keys, it would not be possible to have a measureable reduction in the effect of surge on the Keys by storage features. This measure has been screened from further consideration.

Table 6-3 shows the summary of NNBF screening. Red shaded rows indicate measures that were screened from further consideration.

Table 6-3: Summary of NNBF Screening

Measure	Measure Type	Notes	Carried Forward?
Beachfill/Dunes	Structural/NNBF	Meets objectives #1-4, but screened out due to extremely high cost of procuring beach quality sand ($76/CY) which makes the measure not cost effective in reducing damage to structures	N
Mangrove Restoration/Creation	NNBF	Contributes to, but does not completely meet objectives #1-4, no locations were identified where habitat is suitable and where NNBFs would be a compatible with surroundings	N
Reef Habitat Restoration/Creation	NNBF	Contributes to, but does not completely meet objectives #1 and #4, but artificial reefs are not approved by the FKNMS and natural reef is too far offshore to provide measurable CSRM benefit to infrastructure at risk to wave/erosion damage	N
SAV Restoration/Creation	NNBF	Does not meet objectives, not effective in providing a measureable reduction in surge and/or waves	N

Measure	Measure Type	Notes	Carried Forward?
Living Shorelines	NNBF	Contributes to, but does not entirely meet objectives #1 and #4, were considered however, no locations where the habitat is suitable adjacent to proposed revetments were identified	N
Drainage Improvements/Water Storage Features	NNBF	Contributes to, but does not entirely meet objectives #2-4, not technically feasible for CSRM benefit, sunny day flooding and storm water management are NFS responsibility	N

It is important to note that NNBF were screened initially based on the three criteria used for all measures and mangrove restoration and living shoreline initially were carried forward for further analysis. NNBFs and living shorelines must not displace other important aquatic resources, such as existing seagrass beds, hardbottom, or wetlands, which would themselves have to be mitigated if impacted. It is also not expected that the addition of NNBFs would have altered the benefits or costs of any plan significantly enough to affect plan formulation and the selection of a TSP. At this time, no feasible NNBFs have been identified. If additional potential sites are identified, this could be considered prior to the Agency Decision Milestone as part of the optimization of the TSP.

6.4 FORMULATION OF ALTERNATIVES

Measures carried forward after screening were combined using the three plan formulation strategies described in Section 6.1 to develop an array of alternatives. Different combinations of the measures included in those first three alternatives were then combined to develop alternatives four, five, six, and seven. The no action alternative will also be evaluated and is the basis by which all other alternatives are compared. The array of alternatives is shown in Table 6-4 and described in detail below.

Table 6-4: Array of Alternatives

Alternative	Description	Measures	Objectives Met
1	U.S. Route 1 Corridor	Shoreline stabilization (revetment),	1 and 4
2	Critical Infrastructure	Floodproofing	2 and 4
3	Development	Floodproofing, elevation, and acquisition	3 and 4
4	Combo Alts 1 + 2	Shoreline stabilization (revetment), floodproofing	1, 2, and 4
5	Combo Alts 1 + 3	Shoreline stabilization (revetment), floodproofing, elevation, and acquisition	1, 3, and 4
6	Combo Alts 2 + 3	Floodproofing, elevation, and acquisition	2, 3, and 4
7	Combo Alts 1 + 2 + 3	Shoreline stabilization (revetment), floodproofing, elevation, and acquisition	1, 2, 3, and 4 (all objectives met)
8	No Action	N/A	N/A

6.4.1 Alternative 1, U.S. Route 1 Corridor

This alternative was designed to address the first planning objective. U.S. Route 1 is the only roadway that connects all of the Florida Keys to each other and then to the Florida mainland. Considering the extent of expected storm surge during a hurricane or other significant storm event and that structural measures such as road elevation and sea walls were screened and not carried forward to be included in alternatives, there is no practical way to prevent the entire length of U.S. Route 1 from being inundated by surge from a coastal storm event. Therefore, plan formulation for U.S. Route 1 focused on measures that would maintain the road structure as much as possible even if inundated by surge so that once a storm has passed, the roadway would likely remain intact. The only structural measure carried forward was shoreline stabilization. Rock revetment structures were designed for six at risk areas along U.S. Route 1 to reduce damage to the roadway by stabilizing the shoreline and reducing the risk of washout due to wave action and erosion. Appendix A, Plan Formulation, provides more detail on how the six shoreline stabilization areas were identified. Locations of the six revetment sites included in

this alternative are shown in Figures 6-1 through 6-3.

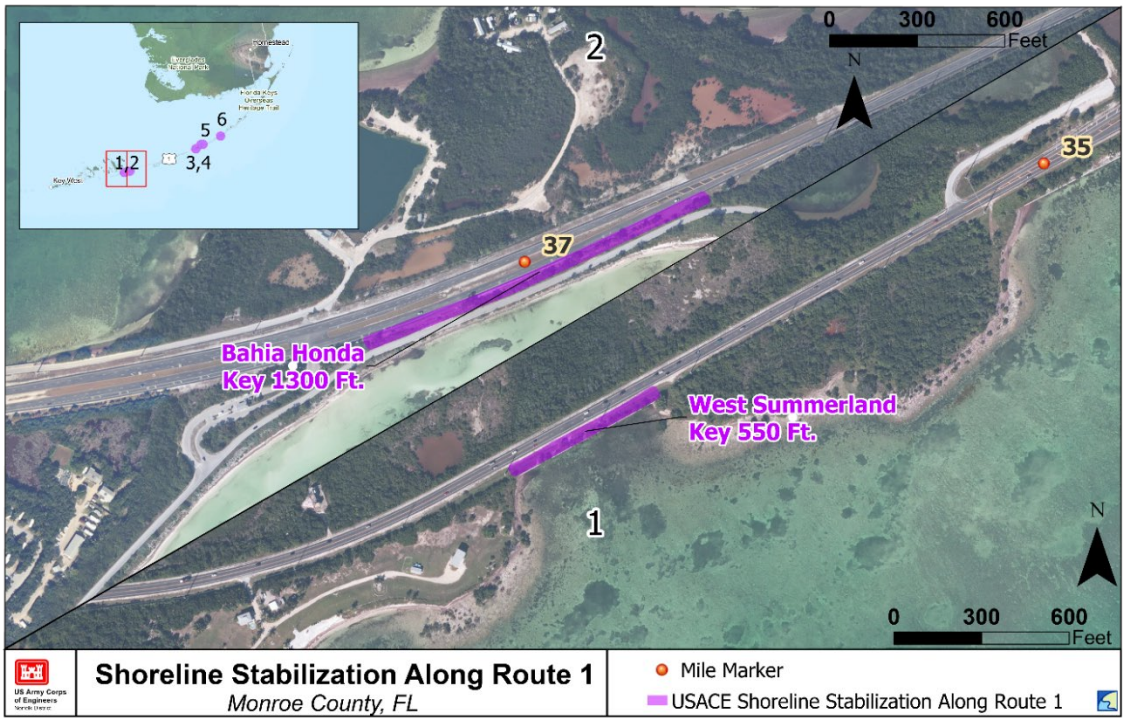

Figure 6-1: Shoreline Stabilization Areas 1 and 2

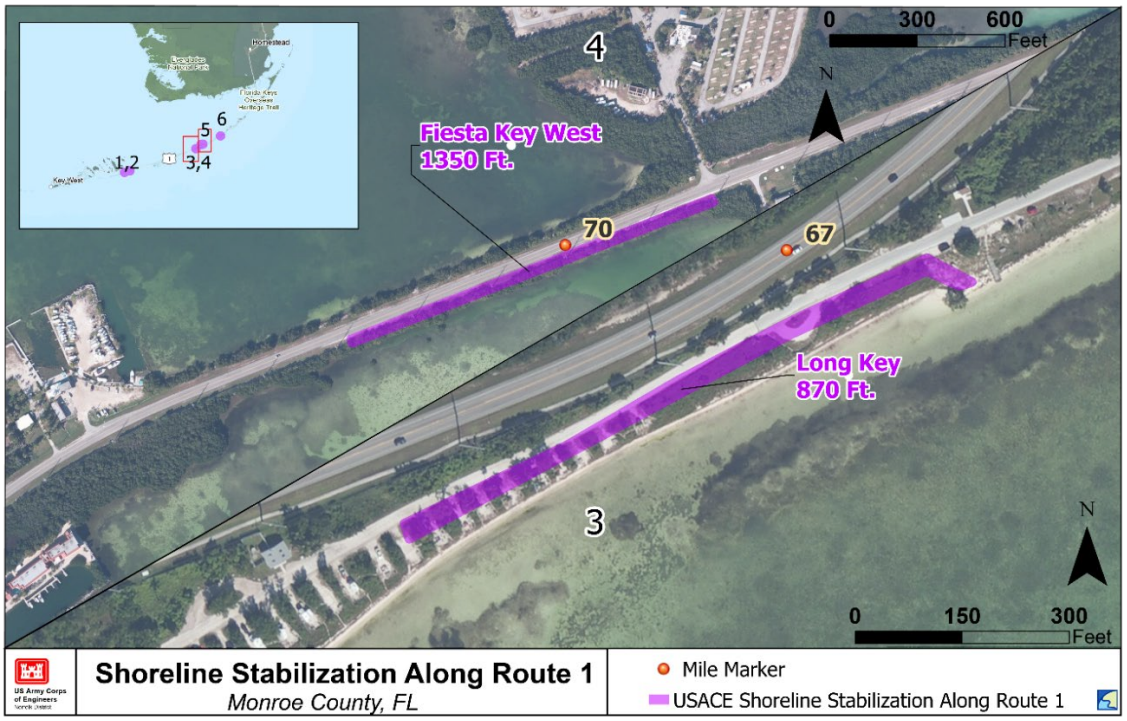

Figure 6-2: Shoreline Stabilization Areas 3 and 4

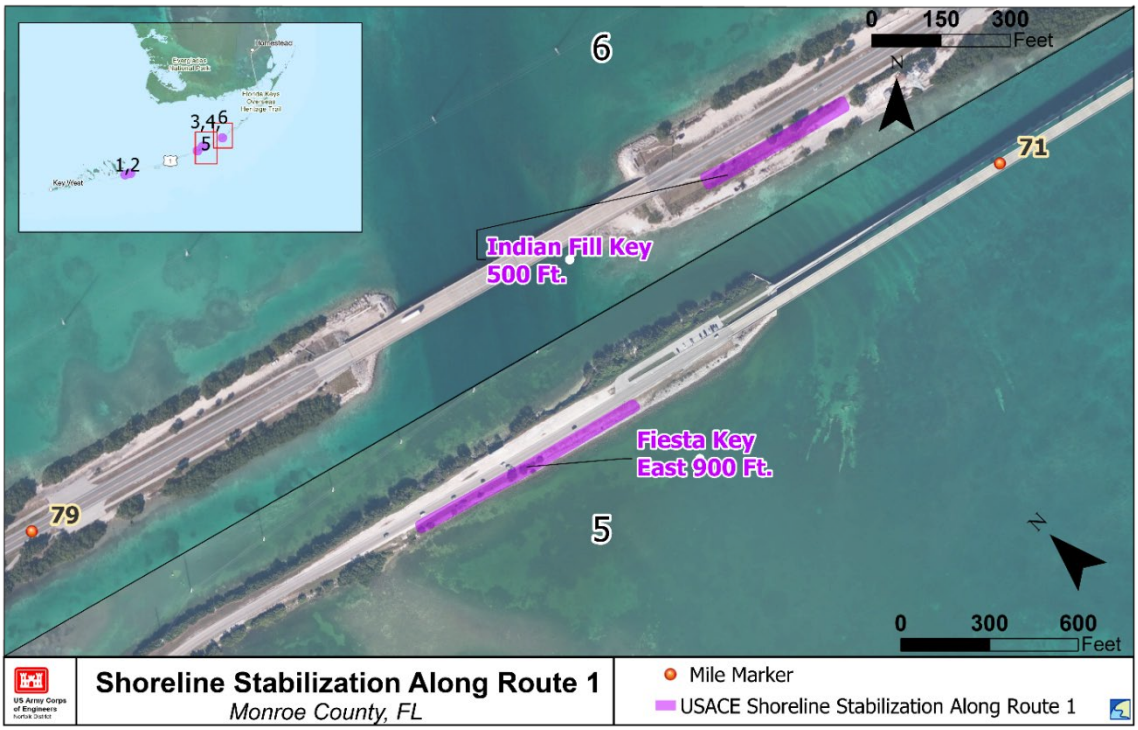

Figure 6-3: Shoreline Stabilization Areas 5 and 6

6.4.2 Alternative 2, Critical Infrastructure

This alternative was designed to address the second planning objective. The only measures carried forward that would reduce damage to any structure vulnerable to storm surge flooding, critical or not, are nonstructural. Considering the size of critical infrastructure buildings does not allow them to be elevated and they would not be acquired because they are necessary and must remain in place, the only nonstructural measure appropriate for critical infrastructure would be floodproofing. There are engineering and safety restrictions that limit floodproofing to a maximum of three feet above ground level, which may leave some structures vulnerable to damage from storm surge that exceeds three feet. However, floodproofing is still expected to reduce a significant amount of vulnerability and damage to critical infrastructure in the study area. A list of critical infrastructure was provided by the non-Federal sponsor and the following critical infrastructure types were evaluated using the economic model:

- Potable Water Pumping Stations
- Wastewater Facility
- Emergency Operations Center (EOC) Facilities
- Health care
- Schools
- Fire Stations
- Police Stations

- Airports

There were 47 critical infrastructure structures with a positive BCR for floodproofing. These structures will be dry floodproofed up to the maximum of three feet above ground level as required to reduce damage to the structure and contents due to coastal storm surge.

6.4.3 Alternative 3, Development

This alternative was designed to address the third planning objective. The only measures carried forward that would reduce storm damage to structures in the study area that are vulnerable to storm surge flooding are nonstructural. All nonstructural measures were carried forward from measure screening, however the PDT focused on elevation, floodproofing, and acquisition of structures experiencing damage over the 50 year period of analysis. The water level that was used for the evaluation of nonstructural measures varied across the study area in order to accurately reflect the variation in water levels that can be expected from coastal storm events in different locations throughout the study area. USACE policy requires that alternatives must reasonably maximize NED benefit. To determine the water level that would reasonably maximize NED for each model area, the amount (dollar value) of expected structure damage was compared to the water level that generated that damage. The water level where structure damage only increased at a rate of five percent was used for evaluation of nonstructural measures. Due to the variation in water levels in different locations in the study area, the water levels used for nonstructural measure evaluation ranged from 10 to 15 feet NAVD88. This method established a design water surface elevation that is representative of the hydraulic conditions in each area and would be expected to reasonably maximize NED benefit per ER 1105-2-100. Elevation of residential structures is limited to a maximum of 12 feet above ground level. Non-residential structures were evaluated to determine if floodproofing up to a maximum allowed height of three feet above ground level would reduce damage to the structure and contents.

Economic model results indicated that approximately 3,800 nonresidential structures had a positive BCR for floodproofing, approximately 7,100 residential structures had a positive BCR for elevation, and approximately 300 residential structures had a positive BCR for acquisition. Residential structures are eligible for acquisition and included in the TSP only if they were estimated to experience significant damage over the 50 year period of analysis, the value of which exceeds the cost to acquire the property and if acquisition is a more cost effective measure than elevation of that particular structure. While the cost to elevate a structure is generally lower than the cost to acquire a structure, the 12 foot maximum height for elevation creates a situation for some structures where there is remaining damage at water levels above that maximum elevation height that cannot be mitigated. However, if a structure is acquired, all estimated future damage is mitigated. So in some cases, there is actually greater economic benefit (reduced structure damage) remaining for acquisition after implementation cost is considered when compared to elevation of the same structure. Appendix G of this report, the Nonstructural Implementation Plan, includes additional information on the recommended nonstructural measures.

6.4.4 Alternative 4, U.S. Route 1 and Critical Infrastructure

This alternative is a combination of the U.S. Route 1 shoreline stabilization plan (alternative 1) and the critical infrastructure identified for floodproofing (alternative 2). This alternative meets the first, second, and fourth planning objectives.

6.4.5 Alternative 5, U.S. Route 1 and Development

This alternative is a combination of the U.S. Route 1 shoreline stabilization plan (alternative 1) and the structures identified for either floodproofing, elevation, or acquisition (alternative 3). This alternative meets the first, third, and fourth planning objectives.

6.4.6 Alternative 6, Critical Infrastructure and Development

This alternative is a combination of the critical infrastructure identified for floodproofing (alternative 2) and the structures identified for either floodproofing, elevation, or acquisition (alternative 3). This alternative meets the second, third, and fourth planning objectives.

6.4.7 Alternative 7, U.S. Route 1, Critical Infrastructure, and Development

This alternative is a combination of all economically justified measures included in alternatives 1, 2, and 3. It would reduce coastal storm risk to U.S. Route 1, critical infrastructure, and residential and commercial structures that are damaged by coastal storms. This alternative meets all of the planning objectives.

6.4.8 Alternative 8, No Action

The no action plan assumes that no action would be taken by USACE as a result of this study and is effectively the future without project condition. This is the alternative/condition by which all other alternatives are compared.

6.5 EVALUATION AND COMPARISON OF ALTERNATIVES

While there is significant emphasis on NED for the authorization and ultimately construction of a project, there are four accounts established by the Economic and Environmental Principles for Water and Related Land Resources Implementation Studies that are used to facilitate evaluation and display of effects of alternative plans. The NED account as described above is the basis for justification of federal interest, but there are additional accounts that also have a material bearing on the decision making process.

- The national economic development (NED) account displays changes in the economic value of the national output of goods and services.
- The environmental quality (EQ) account displays non-monetary effects on significant natural and cultural resources.
- The regional economic development (RED) account registers changes in the distribution of regional economic activity 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.
- The other social effects (OSE) account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

The study area includes all of the Florida Keys. Every structure in the study area was evaluated as part of either the critical infrastructure or development alternative. Economic modeling was completed using G2CRM to determine which of the approximately 47,000 structures in the structure inventory are expected to be damaged, for the without project scenario and with the alternatives considered, over the 50 year period of analysis. Each of the six U.S. ROUTE 1 segments where revetment is proposed were also evaluated to estimate damage expected to the roadway in the without and with project scenarios. Because the alternatives were evaluated in this way, alternatives one, two, and three become the separable elements of alternatives four, five, six, and seven. In ER 1105-2-100, a separable element is defined as any part of a project which has separately assigned benefits and costs, and which can be implemented as a separate action. Although the combination alternatives contain elements that are considered separable in terms of economic benefits and costs, there is significantly more risk reduction provided by plans that address more than one aspect of coastal storm risk, especially in terms of other social effects.

6.5.1 National Economic Development

Each of the alternatives were evaluated and compared to determine the NED benefit generated.

U.S. Route 1

Table 6-5 shows the economic evaluation for Alternative 1, U.S. Route 1 shoreline stabilization. It is important to note that while the six shoreline stabilization areas were evaluated separately in the economic model, they will be economically justified as one system with a combined BCR. This reflects the fact that U.S. Route 1 is the only roadway in and out of the Keys, so the areas should be considered dependent on each other in order for the project to be complete. The BCR for this alternative is currently less than 1.0, which is required in order to be considering a viable alternative. However, the traffic benefits analysis has still not been completed and is not included in the economic summary shown in Table 6-5. Considering there are not usually alternative vehicle traffic routes if U.S. Route 1 is not available for vehicle travel, it is expected that there should be some traffic benefit that will increase the BCR for this alternative once that analysis has been completed. This alternative is also expected to reduce life risk, especially the risk associated with evacuation. It is also important to include this alternative for further refinement as the study progresses because it reduces damage to the singular evacuation route from the Florida Keys to mainland Florida.

Table 6-5: Economic Evaluation for Alternative 1, U.S. Route 1

Economic Evaluation	**Total**
Revetment First Cost	$15,688,000
IDC	$71,000
Total Investment Cost	$617,000
Capital Recovery Factor at 2.75%	3.7%
Average Annual O&M	$301,000
Total Average Annual Cost	$918,000
Total PV Benefits for the Revetment	$7,225,000
Average Annual Benefits	$268,000
Benefit to Cost Ratio	**0.29**
Total Annual Net Benefits	**-$650,000**

(1) Interest rate: 2.75%
(2) Estimates rounded
(3) Assumed O&M annual costs are $5,000. Reconstruction costs are estimated to be 10% of the initial first cost and will occur every five years in the period of analysis.

Critical Infrastructure

Table 6-6 shows the economic evaluation for Alternative 2, critical infrastructure.

Table 6-6: Economic Evaluation for Alternative 2, Critical Infrastructure

Economic Evaluation	**Total**
Number of CI Eligible for Floodproofing	47
Floodproofing First Cost	$17,204,000
IDC	$58,000
Total Investment Cost	$675,000
Capital Recovery Factor at 2.75%	3.7%
Total Average Annual Cost	$675,000
Total PV Benefits for CI Floodproofing	$180,641,000
Average Annual Benefits	$6,691,000
Benefit to Cost Ratio	**9.91**
Total Annual Net Benefits	**$6,016,000**
(1) Interest rate: 2.75% (2) Estimates rounded	

Development

Table 6-7 shows the economic evaluation for the nonstructural measures included in Alternative 3, development.

Table 6-7: Economic Evaluation for Alternative 3, Development

Economic Evaluation	**Total**
Number of Structures Eligible for Acquisition	300
Number of Structures Eligible for Elevation	7,100
Number of Structures Eligible for Floodproofing	3,800
Total First Cost	$5,504,459,000
IDC	$18,715,000
Total Investment Cost	$216,110,000
Capital Recovery Factor at 2.75%	3.7%
Total Average Annual Cost	$216,110,000
Total PV Benefits for Acquisition	$9,641,359,000
Average Annual Benefits	$357,125,000
Benefit to Cost Ratio	**1.65**
Total Annual Net Benefits	**$141,015,000**
(1) Interest rate: 2.75% (2) Estimates rounded	

NED Comparison of Alternatives

Table 6-8 shows the economic evaluation for all eight alternatives. Alternative 6 and Alternative 7 provide almost the same amount of annual net benefit. Alternative 7 reasonably maximizes net NED benefit as required by ER 1105-2-100 and is also a more comprehensive plan that also reduces risk to U.S. Route 1 which generates more OSE benefit and specifically, life safety benefits than Alternative 6 at a cost that is higher by a negligible amount. It is also important to reiterate that NED benefit generated by the U.S. Route 1 shoreline stabilization component of the plan is expected to increase when a vehicle traffic benefit analysis is completed in the next phase of study.

Table 6-8: Economic Comparison of Alternative Plans

Cost Item	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Total First Cost	15,688	17,204	5,504,459	32,892	5,520,147	5,521,663	5,537,351
Interest During Construction	71	58	18,715	130	18,787	18,774	18,844
Annualized Investment Cost	617	675	216,110	1,292	216,727	216,786	217,402
Annualized O&M Cost	301	0	0	301	301	0	301
Total Average Annualized Cost	918	675	216,110	1,593	217,028	216,785	217,703
PV Damages FWOP	9,067	537,245	19,712,524	546,312	19,721,591	20,249,769	20,258,836
PV Damages FWP	1,842	356,605	10,071,164	358,447	10,073,007	10,427,769	10,429,611
Present Value Benefit	7,225	180,641	9,641,359	187,865	9,648,584	9,822,000	9,829,225
Total Average Annual Benefits	268	6,691	357,125	6,959	357,393	363,816	364,084
Benefit-Cost Ratio	**0.29**	**9.91**	**1.65**	**4.37**	**1.65**	**1.68**	**1.67**
Net Remaining Benefits	**(650)**	**6,016**	**141,015**	**5,366**	**140,365**	**147,031**	**146,381**

(1) Interest rate: 2.75%
(2) Estimates rounded
(3) All numbers in thousands

6.5.2 Other Social Effects

The PDT evaluated the seven alternatives based on OSE metrics. 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). This method uses a -3 to 3 scale with -3 representing significant negative effects and 3 representing significant beneficial effects. Zero is negligible effects or no impact. The one and two rankings indicate minor and moderate effects in either the negative or positive direction. Per this IWR handbook methodology, the score is an assessment of the relative impact an alternative would have on a particular metric in relation to the without project condition which the same as the no action alternative (alternative 8). The assessment is made from an overall planning perspective and does not necessarily reflect impacts to individuals or small groups. For detailed descriptions of each metric used to evaluate OSE, please refer to Appendix A, Plan Formulation. Results of the OSE analysis are shown in Table 6-9.

Table 6-9: Results of OSE Analysis

Factor	Metric	Alt 1 U.S. ROUTE 1	Alt 2 CI	Alt 3 Development	Alt 4 Combo Alts 1+2	Alt 5 Combo Alts 1+3	Alt 6 Combo Alts 2+3	Alt 7 Combo Alts 1+2+3
Health and Safety	Human Health	1	3	3	3	3	3	3
	Life Safety	2	3	3	3	3	3	3
Economic Vitality	Business Climate	1	1	1	1	1	2	2
	Tourism Revenue	1	0	1	1	1	1	1
	Real Estate Values	0	0	1	0	1	1	1
Social Connectedness	Community Cohesion	0	0	1	0	1	2	2
	Local/Cultural Identity	0	1	1	1	1	1	1
Resiliency (4 USACE Resilience Principles)	Prepare	2	2	3	2	3	3	3
	Absorb	2	2	3	2	3	3	3
	Recover	2	2	3	2	3	3	3
	Adapt	1	1	2	2	2	2	3
Environmental Justice	Socially Vulnerable Populations	0	1	3	1	3	3	3
Recreation	Recreational Opportunities	-1	0	0	-1	0	0	-1
	Total Score	11	16	25	17	25	27	27

The results of the OSE analysis show that overall, all seven alternatives have a positive effect on OSE metrics. Only the plans that include U.S. Route 1 shoreline stabilization have a negative effect on OSE, and that is only a minor negative effect on the recreational opportunities metric. This minor effect is due to the fact that two of the six U.S. Route 1 revetments are located near state parks and the parks have indicated some concern on how these structures would impact recreation at the park. However, the PDT does not expect these two revetments to pose more than a minor impact on recreation at the parks, which is why the score of -1 was assigned for that metric for all alternatives that include the U.S. Route 1 shoreline stabilization.

Another trend observed in the results of the OSE analysis is that alternative 3, development centers, and the combination plans that include the nonstructural measures of alternative 3 had the highest scores of all the alternatives. This level of OSE benefit is consistent with the level of risk reduction that can be expected from a plan that includes nonstructural measures for approximately 10,350 structures, which is about one fifth of the total number of structures in the Keys.

6.5.3 Regional Economic Development

In addition to NED, RED will also be considered in the evaluation and comparison of alternatives. The specific input-output model used in this analysis is RECONS (Regional Economic System). RECONS uses industry multipliers derived from the commercial input-output model IMPLAN to estimate the effects that spending on USACE projects has on a regional economy. “Output” is the sum total of transactions that take place as a result of the project, including both value added and intermediate goods purchased in the economy. “Labor Income” includes all forms of employment income, including employee compensation (wages and benefits) and proprietor income. “Gross Regional Product” is the value-added output of the study regions. This metric captures all final goods and services produced in the study areas because of the project’s existence. Appendix C, Economics, includes more detailed information on RED and RECONS. A RED analysis will be completed using RECONS prior to the ADM and the results will be included in the final report. Because the TSP is the most comprehensive plan considered and will likely generate the most RED benefit of all the alternatives, RED impacts are not expected to change the TSP. However, the results can be useful for the sponsor and local stakeholders to understand how the TSP may affect the regional economy.

6.5.4 Environmental Quality

The EQ account has been addressed in Chapter 8 of this report, which discusses environmental consequences associated with each of the alternatives. The environmental impacts do not differ significantly enough between the alternatives that it impacts plan selection.

CHAPTER 7 TENTATIVELY SELECTED PLAN

This study considered a range of nonstructural and structural measures to reduce the risk of storm damage in the study area. Planning objectives were identified based on the problems, needs, and opportunities, as well as existing physical and environmental conditions present in the study area. Alternatives must contribute to NED by reducing the risk of damage caused by coastal storm surge within the study area, consistent with the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

Through an iterative planning process, potential coastal storm risk management measures were identified, evaluated, and screened. Those remaining were combined into different coastal storm risk management alternatives that composed an array of eight alternatives. Based on an evaluation of the costs and benefits of the array of alternatives, including potential environmental impacts, Alternative 7, U.S. Route 1, Critical Infrastructure, and Development Centers, was identified as the Tentatively Selected Plan (TSP).

7.1 DESCRIPTION OF THE TENTATIVELY SELECTED PLAN

The tentatively selected plan is Alternative 7, which includes measures to reduce risk to U.S. Route 1, critical infrastructure, and development centers. This alternative is the most comprehensive plan in the focused array of alternatives and it addresses all three of the plan formulation strategies and addresses the most planning objectives for the study while reasonably maximizing NED benefits as compared to the cost to implement the plan. Based on the current economic analysis as summarized in Chapter 6 of this report, Alternative 7 has been identified as the NED plan.

7.2 TENTATIVELY SELECTED PLAN ECONOMICS

NED benefits were evaluated using G2CRM as documented in Chapter 5 of this report and Appendix C, Economics. Nonstructural costs were developed using information from FEMA and nonstructural projects recently completed in southern Florida and Monroe County. Structural costs were developed based on an initial ten percent design to inform construction, associated real estate, and environmental mitigation costs. An abbreviated risk analysis was completed in January 2020 and was used to determine the contingency applied to the estimated nonstructural and structural costs. Table 7-1 below shows the results of the cost and benefits analysis for the TSP.

Table 7-1: TSP Cost and Benefit Analysis

TSP Economic Summary	**Total**
TSP Total First Cost	$5,537,351,000
IDC	$18,844,000
Total Investment Cost	$217,402,000
Capital Recovery Factor at 2.75%	3.7%
Average Annual O&M	$301,000
Total Average Annual Cost	$217,703,000
Total PV Benefits	$9,829,225,000
Average Annual Benefits	$364,084,000
Benefit to Cost Ratio	**1.67**
Total Annual Net Benefits	**$146,381,000**
(1) Interest rate: 2.75% (2) Estimates rounded	

7.3 OPTIMIZATION OF THE TENTATIVELY SELECTED PLAN

The USACE SMART Planning process, as described and shown in section 1.5 of this report, emphasizes that study teams should use a reasonable level of detail to collect data and model alternatives to analyze and evaluate effectiveness in order to identify a TSP. The PDT has completed the evaluation and comparison of a focused array of distinctly different strategies for achieving the water resources objectives in the study area and identified a TSP to carry forward. At this point in the study, the TSP has been characterized to a level of detail consistent with an approximately ten percent level of design for structural and nonstructural measures. This integrated draft feasibility report and EIS documents the analysis that led to the selection of the TSP to a level of detail required for the release for concurrent public, technical, legal, and policy review and independent external peer review (IEPR).

The PDT has also identified additional analysis that is needed following the release of the draft report to develop sufficient cost and design information for the final feasibility-level analysis and feasibility report/EIS. The Feasibility Level Design of the agency recommended plan occurs after the Agency Decision Meeting. This phase of the study includes development of the Final Draft Report and additional design of the recommended plan, approximately 35 percent, to reduce risk and uncertainty with cost data, engineering effectiveness, environmental impacts,

and economic benefits.
During feasibility level design, the designs, cost estimates, and benefit analysis will be refined for both structural and nonstructural measures included in the TSP. Risk and uncertainty will also be evaluated to determine ranges of economic benefits and costs and project performance in order to meet the requirements of ER 1105-2-101, Risk Assessment for Flood Risk Management Studies, which was recently updated to apply to CSRM studies. ER 1105-2-101 also requires that potential life loss should be assessed using accepted USACE methods and tools. During feasibility level design, the USACE life safety model HEC-LifeSim 2.0 will be used to inform the life safety effects of the TSP on the study area. Section 7.7.2 of this report provides more detail on the life safety impacts associated with the TSP.

Before the ADM, a sensitivity analysis will be completed to assess performance of the TSP under SLR projections other than the USACE high projection that was considered in the evaluation of the alternatives. The TSP will be evaluated at the USACE Low, USACE Intermediate, and NOAA High SLR projections for the Florida Keys to determine how each scenario affects plan performance. In addition, the TSP will be evaluated for a period of 100 years to determine project performance over a 100 year period (vs. the 50 year period of analysis required for plan formulation purposes) at the USACE High rate of SLR. This additional analysis will be used to improve the resiliency analysis presented in the final report and describe how the TSP would perform under different SLR scenarios.

Following the completion of this study and authorization of the recommended plan, the project will continue to the preconstruction engineering and design (PED) phase where a more detailed analysis will be completed in order to develop plans and specifications needed to construct the project.

7.3.1 Nonstructural

In addition to the additional analyses that will be completed on the entire TSP, there are tasks that will be completed on only the nonstructural measures included in the TSP. The results of these analyses will be included in the final report.

- Refine the TSP as needed to ensure compliance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 requirements can be met for the 300 structures recommended for acquisition. The limited housing stock and other unique local conditions in the Keys may affect the ability to provide comparable housing for relocation as required for acquisition of structures.
- FL State building code restrictions will be reviewed and incorporated into the TSP as appropriate (e.g. provisions for maximum structure height limit) with consideration of exceptions available in municipalities. The nonstructural analysis supporting the TSP selection does account for the restriction of dry floodproofing in V Zones as identified in the current FEMA Flood Insurance Rate Map (FIRM).
- Structures identified for elevation or acquisition should be grouped per PB 2019-03. This may lead to either a reduction in the total number of structures or in the addition of new structures if needed to ensure that the nonstructural plan considers neighborhood

cohesion and a logical grouping strategy for structures recommended for elevation and acquisition in the TSP.

- A sensitivity analysis will be completed for different design water levels above and below the water level that was used for the evaluation and selection of the TSP in each model area. The PDT is considering the comparison of project benefits at one or two feet higher and lower for this analysis to confirm that the current design water level is where NED benefit is reasonably maximized for nonstructural measures. This analysis will be completed in addition to the SLR sensitivity analysis that will be completed for the entire TSP to assess performance at the low and intermediate SLR projections.
- A sensitivity analysis will be completed to determine how different participation rates affect the cost and NED benefit for the recommended elevation and floodproofing measures included in the TSP.
- A cost schedule risk analysis will be completed to determine what risk based contingency should be used for the nonstructural cost estimate.

7.3.2 Structural (U.S. Route 1 Shoreline Stabilization)

In addition to the additional analyses that will be completed on the entire TSP, there are tasks that will be completed on only the structural measures, or U.S. Route 1 shoreline stabilization, included in the TSP. The results of these analyses will be included in the final report.

- Additional NED benefit categories will be evaluated and incorporated into the TSP as appropriate/applicable. The PDT is specifically interested in determining whether vehicle traffic benefits can be attributed to the U.S. Route 1 shoreline stabilization.
- A cost schedule risk analysis will be completed to determine what risk based contingency should be used for the structural cost estimate.

7.4 RESILIENCY, SUSTAINABILITY, AND ADAPTABILITY

This section has been prepared to address how the TSP contributes to the resiliency, how it affects the sustainability, and how it may be adapted to continue to perform under changed future conditions in the Florida Keys.

7.4.1 Resiliency

Resiliency is defined in the February 2013 USACE-NOAA Infrastructures Systems Rebuilding Principles white paper as the ability to adapt to changing conditions and withstand, and rapidly recover from disruption due to emergencies. The USACE Climate Change Adaptation Goal is to minimize impacts from climate change and maximize resiliency in the coastal landscape. The 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.

Anticipate

The TSP for the Florida Keys project anticipates the effects of sea level rise in water surface elevations that were evaluated. Other future conditions and land use and development trends have been anticipated through the review of existing information and studies completed by Monroe County and other stakeholders.

Prepare

Monroe County currently implements various floodplain management, zoning, and city planning strategies that consider relative sea level rise and in addition to maintaining the current risk reduction efforts, is also preparing for changing future conditions. The implementation of the TSP will enhance that preparedness.

Respond

This study considers critical infrastructure in order to improve the ability for the Florida Keys to respond to coastal storm risk by reducing risk to the structures supporting emergency services, hospitals, schools (storm shelters), potable water infrastructure, etc.

Adapt

One of the planning objectives of this study is to improve the resiliency of the Florida Keys to impacts from coastal storms. All of the TSP features will improve the resiliency of the Keys, particularly with future sea level rise taken into account. Generally speaking, the project will reduce the average annual damages to infrastructure from coastal storms. Nonstructural measures for critical infrastructure will enable the Keys to maintain and more quickly recover services deemed critical to the functioning of the Keys. The project is complemented by projects and efforts incorporated by Monroe County and other stakeholders. Every project has its limitations and the TSP is no different. However, the local economy will see improvements to economic resiliency through the reduction in damages and disruptions from coastal storms.

7.4.2 Sustainability

Sustainability is defined in the February 2013 USACE-NOAA Infrastructures Systems Rebuilding Principles white paper as the ability to continue (in existence or a certain state, or in force or intensity), without interruption or diminution. The TSP is expected to sustain performance over the 50 year period of analysis that was evaluated. This is mostly due to the consideration of sea level change over that period, as sea level change is the biggest known source of uncertainty that would affect project performance in the future. However, by incorporating the high rate of sea level change in the formulation and design of measures included in the TSP, that uncertainty is greatly reduced and the TSP is expected to generate NED benefits as estimated by the economic analysis.

7.4.3 Adaptability

Adaptability is defined as the quality of being able to adjust to new conditions or the capacity to be modified for a new use or purpose. The USACE Climate Change Adaptation Goal is to minimize impacts from climate change and maximize resiliency in the coastal landscape. The current ten percent design of the TSP takes into consideration the effects of sea level rise at the projected USACE high rate. Figure 7-1 shows inundation at the 12 foot water level that is a reasonable estimate for the assessment of nonstructural measures plus the addition of SLR that is expected by 2079 under the USACE high projection. During the feasibility level analysis and plan optimization, a sensitivity analysis will be completed on the TSP to determine how different rates of sea level rise, including the USACE Low, USACE Intermediate, and NOAA High, affect project performance.

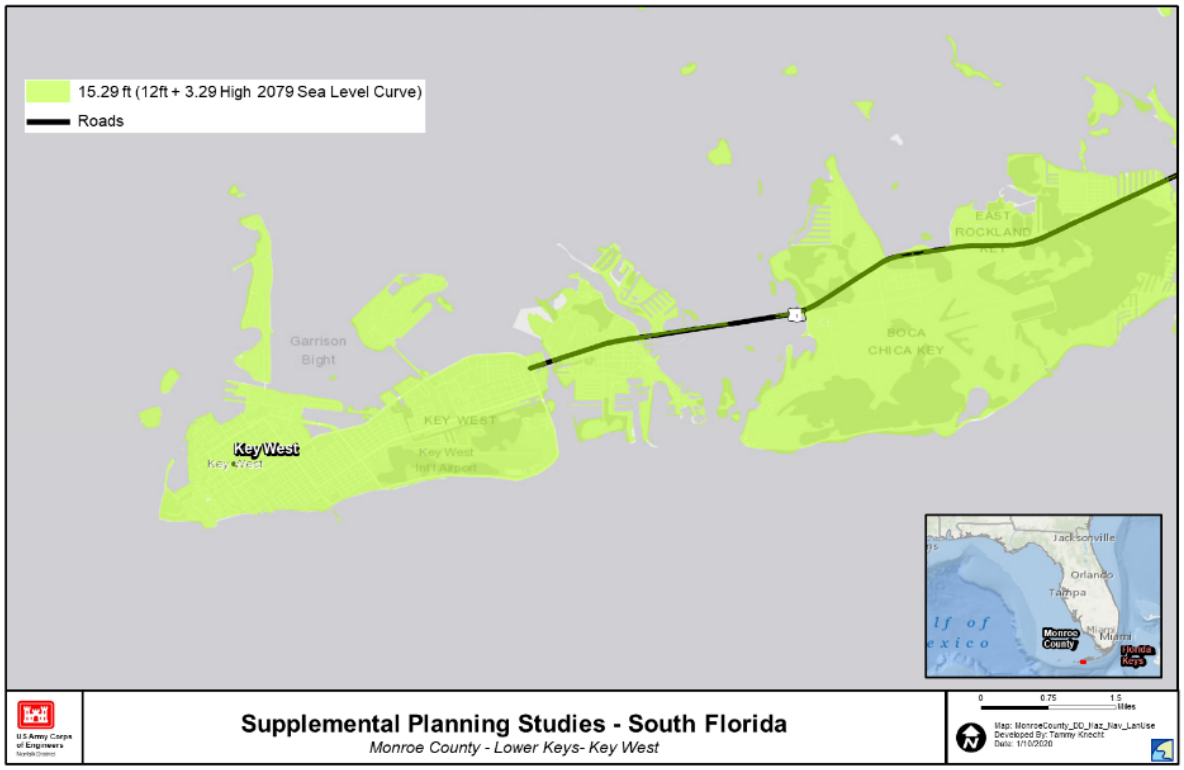

Figure 7-1: Showing inundation at the 12 foot water level

Although USACE evaluates the performance of Civil Works projects over a 50 year design life, projects should also take into consideration how and if the design can adapt to the effects of sea level rise and climate change 100 years after the project is constructed. During the feasibility level analysis and plan optimization, the ability of the project to adapt into the future will be assessed through the analysis of project performance considering projected sea level rise out to 2129.

7.5 IMPLEMENTATION OF THE SELECTED PLAN

The TSP as described in this report is estimated to be at a ten percent design level and is based upon current information and the best available estimates into future conditions in the study area. Therefore, modifications to design and operations are likely during later stages of project design and construction to ensure that the project considers any unforeseen changes in the existing or future conditions that have occurred since the completion of this feasibility study and report. Modifications may require new investigation into environmental and social impacts. There are also some analyses that have been deferred to or must occur during the PED phase:

- Detailed cultural resources surveys
- Review of conditions that may have changed since the completion of the feasibility study that would affect the design of structural or number of structures recommended for nonstructural measures

- Detailed assessment of structures identified for nonstructural measures, including but not limited to surveys, structural assessments, etc.

The non-federal sponsor is required to obtain the lands, easements, rights of way, and disposal areas (LERRDs) required to implement any civil works project. This includes the real estate needed to construct structural measures, and also the acquisition of the residential structures that have been recommended for acquisition. USACE policy (Planning Bulletin 2019-03) requires the use of eminent domain to be retained, if necessary, for acquisition, relocation, and evacuation if such nonstructural features are included in the recommended plan. Under this policy, homeowners will first be offered fair market value plus relocation assistance if their home has been recommended for acquisition in the authorized project. However, if any homeowners decline that initial offer, acquisition would then be implemented through the use of eminent domain. Monroe County does not support mandatory acquisition and will not agree to participate in a plan that includes mandatory acquisition that would be implemented through the use of eminent domain. The County has submitted a formal request for a waiver from the current policy that requires mandatory participation in acquisition, and if that request is not approved, would request a Locally Preferred Plan (LPP) that does not include acquisition. Participation in elevation and floodproofing, if recommended in the authorized plan, is voluntary. More detailed information on the implementation of nonstructural measures is included in Appendix G, Nonstructural Implementation Plan.

The non-federal sponsor will also continue to pursue the various resilience initiatives discussed in section 1.8 of this report as well as new opportunities that become available to them in the future that would reduce coastal storm risk in the Florida Keys. Monroe County is currently working to identify county roadway locations that should be elevated and/or improved to reduce the impacts of sea level rise. The county is also currently executing a grant to elevate homes that were damaged by Hurricane Irma and also is working to use the Hazard Mitigation grant program to elevate and acquire homes that are at risk to inundation caused by coastal storm events. Because this is ongoing work that will continue after this study has been completed, it will be important to reassess the existing condition in terms of road infrastructure and the structure inventory during PED to ensure that the recommended plan accounts for any changes to the development in the Keys that may have occurred after the study ended. It is expected that the number of structures included in the nonstructural recommendation may be slightly reduced to account for improvements made under other grant programs that were not completed at the time of this study. In addition, county roadway improvements, or lack thereof, may also change the number of structures recommended for nonstructural measures.

7.6 EXECUTIVE ORDER 11988 AND PUBLIC LAW 113-2 CONSIDERATIONS

This study has considered the requirements of EO 11988, Flood Plain Management and PL 113-2, the Disaster Relief Appropriations Act of 2013. Specifically, this section of the report addresses:

- The Water Resources Council Floodplain Management implementing guidelines for EO

11988;

- The specific requirements necessary to demonstrate that the project is economically justified, technically feasible, and environmentally acceptable, per PL 113-2.

Executive Order 11988 requires federal agencies avoid, to the extent possible, the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in USACE ER 1165-2-26, requires an eight step process that agencies should carry out as part of their decision making on projects that have potential impacts to, or are within the floodplain. The eight steps and project-specific responses to them are summarized below.

1. Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year). The proposed action is within the base floodplain. However, the project is designed to reduce damages to existing infrastructure.

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 flood plain. Chapter 6 discusses the process of screening and analyzing both measures and alternatives. Nonstructural, structural, and NNBF measures were all considered in the process.

3. If the action must be in the floodplain, advise the general public in the affected area and obtain their views and comments. An EIS is being developed and NEPA procedures are being followed concurrently with the study. During this process, local stakeholders and the general public have been afforded the opportunity to review and comment on the study recommendations.

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 anticipated impacts and environmental compliance associated with the Recommended Plan are summarized in Chapters 8 and 9. The project is not expected to alter or impact the natural or beneficial floodplain values.

5. If the action is likely to induce development in the base floodplain, determine if a practicable non-floodplain alternative for the development exists. The project provides benefits primarily for existing and previously approved development, and is not likely to induce significant

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 project is not expected to induce development in the floodplain. In areas where the project may impact the natural or beneficial floodplain values, environmental mitigation is planned. Chapter 6 of this report summarizes the alternative identification, screening, and selection process. The no action alternative was included in the plan formulation process.

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 Draft Integrated Feasibility Report and Environmental Impact Statement will be provided for public review. Public meetings will also be scheduled during the public review period. Each comment received will be addressed and, if appropriate, incorporated into the Final Report. A record of all comments received will also be included in Appendix D.

8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order. The TSP is the most responsive to all of the study objectives and the most consistent with the executive order.

7.7 RISK AND UNCERTAINTY

All CSRM projects comprise different risk management alternatives represented by the tradeoffs among engineering performance, project cost, economic and environmental resilience, and life loss consequences. These increments contain differences in damage reduced, residual risk, local and federal project cost, impacts to the environment, and life loss. The PDT has completed the analysis used to select the TSP so that all of these tradeoffs in order to identify a plan that reduces risk and also considers other conditions appropriately. Throughout the study and project implementation, the PDT will communicate with the non-Federal sponsor, local residents, and stakeholders so they understand these tradeoffs and can participate fully in informing the decision-making process.

7.7.1 Project Performance

In estimating the future conditions for any study, there is inherent uncertainty in the characterization of the future without project and future without project conditions. The goal of the feasibility study is to reduce the level of uncertainty surrounding the selection of and performance of the TSP to a level where there is reasonable certainty that the best plan has been selected and a tolerable level of risk associated with that plan. By accounting for changes in conditions using the best available projections and data, the team has identified the plan that reasonably maximizes NED benefits and expects that plan to provide the anticipated level of risk reduction. During the feasibility level analysis and optimization, the PDT will complete the

analysis needed to present the estimate of net NED benefits and BCRs both as an expected (mean) value and on a probabilistic basis. Cost estimates include risk based contingency that has been developed using an Abbreviated Risk Analysis. Key risks that affect the estimated cost of nonstructural measures are the volatile nature of the real estate market over time and the uncertainty surrounding participation rate. For structural measures, it is the cost of environmental mitigation and the cost to transport materials down to the Keys. The probability that net benefits are positive and that the B/C ratio is at or above 1.0 will also be presented per ER 1105-2-101, Risk Assessment for Flood Risk Management Studies. A sensitivity analysis will also be completed using different participation rates for floodproofing and elevation.
The TSP is expected to significantly reduce coastal storm risk throughout the Florida Keys however, this study did not formulate plans to address the impacts of general sea level rise that is often referred to as “sunny day flooding,” precipitation, or the direct effects of wind associated with coastal storms. Due to these and other limitations of the study, no one project or action that is proposed, evaluated, adopted, and implemented can completely eliminate or mitigate coastal storm risks. Thus, with any CSRM project, there will be some amount of residual risk that remains once the project has been implemented. The TSP is comprised of mostly nonstructural measures, which means that while economic damage will be substantially reduced to both residential and nonresidential structures, the project does not reduce risk to the roadway and utility systems that support those structures. The TSP does include shoreline stabilization to reduce damage to U.S. Route 1, however, these measures will not prevent storm surge from flooding the roadway during a coastal storm event. The shoreline stabilization areas were designed to retain the shoreline and roadway to the extent possible even if they should be inundated during a coastal storm event so that once the surge recedes, the roadway should have sustained far less damage than if the measure was not implemented there.

There is also residual risk in that the maximum height a residential structure can be elevated is 12 feet above ground level and the maximum height a nonresidential structure can be floodproofed is three feet above ground level. The range of water levels used for the evaluation of nonstructural measures was 10-15 feet because that is the water level where economic model results indicated the majority of structure damage was occurring, however, the same model out did also show damage occurring to some structures at water levels higher than the design water level. There is residual risk then posed even to structures that receive a nonstructural measure in that water levels would likely exceed the water level evaluated in this study during coastal storm events of higher magnitudes.

Considering the maximum height a nonresidential structure can be floodproofed is three feet above ground level, sea level change alone may begin to approach the limit of some floodproofing where the ground elevation is very low. Due to the engineering and safety requirements that limit dry floodproofing to three feet, there are critical infrastructure and non-residential buildings that may still be vulnerable to damage due to storm events that generate surge higher than the maximum floodproofing height. Due to building code restrictions on floodproofing in the Florida Keys, nonresidential structures located in V zones as specified by FIRM are cannot be floodproofed and these structures will remain at risk to inundation as they were not included in the floodproofing recommendation in the TSP. Additionally, there were

approximately 11,000 total structures identified for some type of nonstructural measure, which accounts for less than a quarter of all structures in the Keys.

7.7.2 Life Risk

In conjunction with Planning Bulletin 2019-04 “Life Risk” the FL Keys CSRM Study is evaluating life safety risk using HEC-LifeSim 2.0. HEC-LifeSim 2.0 is the state-of-the-art consequences tool developed by USACE for evaluating life loss. Of particular interest to the FL Keys CSRM Study is LifeSim’s ability to simulate evacuation. As recently as 2017, the Florida Keys were ordered to evacuate in anticipation of Hurricane Irma making landfall. While most of the population at risk complied with the mandatory evacuation order, those who didn’t were forced to evacuate southwest along the Keys towards Key West. The value of evaluating evacuation effectiveness and subsequently simulating evacuation is that it will help identify possible improvements in emergency planning to support the non-structural measures recommended in the TSP. No project, structural or nonstructural would eliminate the need for evacuation from the Keys during major coastal storm events, but the goal is to use lessons learned from simulating evacuation in LifeSim to improve emergency preparedness and protective action response. The input parameters for warning and evacuation for the existing condition will consider the Hurricane Irma evacuation response and warning issuance timing.

The amount of life loss associated with coastal storm events in the Keys will be evaluated both on roads and in structures for the existing and future with project condition. For example, a nonstructural measure that raises structures is expected to provide a reduction in the risk of life loss when compared to the future condition without the TSP because the new first floor elevations will be at a height above the level of inundation that would be expected with many coastal storm events. Raised structures allow people exposed to a storm (population at risk (PAR) = population at risk exposed to flooding in a structure, in a vehicle, or out in the open) in a structure to reach a higher elevation, which may reduce the number of people that are likely to end up in a high hazard condition where they are exposed to flood characteristics associated with the highest rate of mortality.

While the TSP will not eliminate all life risk associated with coastal storms in the Florida Keys, the TSP is expected to reduce the risk of life loss as compared to what it would be in the future without the project. The lessons learned from simulating evacuation and the life loss analysis in both the existing and future with project conditions will allow the team to determine what level of life safety risk reduction is provided by the TSP. Results from HEC-LifeSim will be completed prior to the ADM and documented in the final integrated feasibility report and EIS.

7.8 LOCALLY PREFERRED PLAN

Monroe County does not support mandatory acquisition of structures in the Florida Keys per the current USACE policy that requires that eminent domain be used if necessary to implement acquisition if it is included in the recommended plan. Monroe County has requested a waiver to the current USACE policy that requires mandatory implementation of acquisition in a formal letter that was submitted to the Norfolk District in April 2020. This letter is included in Appendix

H of this report. Policy requests of this kind must be transmitted through USACE Headquarters to the ASA(CW) for approval. There is currently no estimated timeframe for a decision to be made by the ASA(CW) regarding this request.

While Monroe County does not support mandatory acquisition, they do support the recommendation of acquisition as long as it is on a voluntary basis similar to floodproofing and elevation. At the time of this draft report, Monroe County had not chosen to move forward with a locally preferred plan (LPP) because they would like to see whether their request for a waiver to the mandatory acquisition policy is granted which would mean the acquisition included in the TSP could be implemented on a voluntary basis. However, if their request is denied, Monroe County would not support the NED plan if it includes acquisition if it must be implemented under the current policy for mandatory participation and would instead opt to move forward with a LPP that does not include acquisition.

Monroe County would still like to reduce coastal storm risk to the full possible extent with a LPP, so the approximately 300 structures recommended for acquisition in the NED plan would be considered for elevation instead. In an LPP that only considers elevation and floodproofing, 225 of the approximately 300 structures that were identified for acquisition in the NED plan would meet the criteria for elevation and have a positive BCR for elevation. This elevation and floodproofing only LPP would include a total of approximately 7,300 elevations and the same number of structures recommended for floodproofing as in the NED plan, which is 3,800. The U.S. Route 1 revetment would also be included in the LPP in addition to the nonstructural plan, as it is in the NED Plan. The resulting LPP would essentially be the same as Alternative 7, which is the current NED Plan and TSP, but with all eligible residential structures recommended for elevation instead of a mix of elevation and some acquisition. Table 7-2 shows the economic summary of this LPP.

Table 7-2: Locally Preferred Plan Economics

Economic Evaluation	**Total**
Number of Structures for Acquisition	0
Number of Structures to Elevate	7,349
Number of Structures to Floodproof	3,805
Number of CI to Floodproof	47
Total Number of Structures	11,201
Total First Cost[1]	$3,616,987,000
IDC	$22,619,000
Total Investment Cost	$283,326,000
Capital Recovery Factor at 2.75%	3.7%
Total Average Annual Cost	$142,272,000
Total Average Annual Benefits	$350,719,000
Benefit to Cost Ratio	**2.47**
Total Annual Net Benefits	**$208,447,000**

(3) Total first cost estimate includes the cost of the revetment ($15,688,000)
(4) Interest rate: 2.75%
(5) Estimates rounded

The LPP as described in this section would have very similar plan effects as the TSP for the four accounts including NED, RED, OSE, and EQ. As shown in Table 7-2, the economics of the LPP are very similar to the TSP and the cost is slightly lower than the cost of the TSP, so the 65/35 cost share would also apply to the LPP. RED effects would be virtually the same as the TSP and so would OSE.

With respect to Environmental Quality effects and the effect determination pursuant to NEPA, converting mandatory residence acquisitions to elevations would reduce effect levels for land use, socioeconomics, and environmental justice from significant to minor adverse and beneficial effects. Some residents may not wish to relocate and therefore, would not experience the adverse effects of being required to abandon their current homes permanently. They also would not experience the temporary adverse effect of moving, which can be burdensome for disadvantaged populations. In addition, there would be no permanent disruption of community cohesion. However, residences would still qualify for the optional beneficial effects of residence elevations. Chapter 8 of this report summarizes the impacts expected from the alternatives considered in this study, including the TSP. Chapter 9 discusses compliance with Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations.

CHAPTER 8 ENVIRONMENTAL CONSEQUENCES*

8.1 SUMMARY OF IMPACTS

A summary and comparison of resource impacts for the final array of project alternatives is provided in Table 8-1. This chapter provides a baseline for the impact analysis by presenting an overview of the existing conditions for each resource.

All of the alternatives involve either structural improvements to U.S. Route 1, nonstructural improvements to critical infrastructure, nonstructural improvements to development centers, or varying combinations of two or all three of these. For this analysis, the alternatives were grouped into four alternatives: Alternative 1 (Structural Measures Only for the U.S. Route 1 Corridor); Alternative 6 (Nonstructural Measures Only for both Critical Infrastructure and Development Centers); Alternative 7, a combination of Alternatives 1 and 6, which encompasses all structural and nonstructural measures; and Alternative 8, the No Action/Future Without Project Alternative.

A detailed analysis of potential impacts for each of the final array of project alternatives for each resource area is provided in this chapter following the summary of impacts description as well.

Table 8-1: Summary of Impacts for the Final Array of Project Alternatives

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Land Use	Direct and indirect, temporary and permanent adverse effects on land use that are minor to moderate. Permanent moderate adverse effects related to impacts along Long Key State Park shoreline near campground facility. Temporary, direct and indirect minor adverse effects.	Significant, permanent effects on land use. These effects include both adverse and beneficial effects, for approximately 300 residences affected by relocation, depending on perspective. Significant beneficial effects for those receiving elevations or floodproofing. Temporary, direct and indirect minor adverse effects.	Significant, adverse and beneficial permanent effects on land use, due to acquisition/relocation, and floodproofing. Direct and indirect, temporary and permanent adverse effects on land use along Long Key State Park shoreline near campground facility.	No direct or indirect effects. However, there is the potential for greater coastal storm damage to U.S. Route 1 and buildings within existing development centers.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Socioeconomics	Potentially significant permanent benefit in the form of a more resilient U.S. Route 1. Minor temporary beneficial effect resulting from temporary construction jobs.	Significant, permanent effects on socioeconomics. These effects include both adverse and beneficial effects, both for those relocated, depending on perspective. Could disrupt communities and affect Environmental Justice communities. However, it would also allow those affected by repetitive damage the benefit of relocating to comparable areas less subject to flood damage associated with coastal storms. Significant beneficial effects for those receiving elevations or floodproofing. Temporary, direct and indirect minor adverse effects.	Significant, permanent effects on socioeconomics. These effects include both adverse and beneficial effects, both for those relocated, depending on perspective. Significant beneficial effects for those receiving elevations or floodproofing. Potentially significant permanent benefit in the form of a more resilient U.S. Route 1. Minor temporary beneficial effect resulting from temporary construction jobs.	Potentially significant permanent and temporary adverse effect. Risk to people, property, and the economy of the Florida Keys would continue to increase as climate change is expected to result in more frequent and powerful Atlantic hurricanes, and sea level rise make their floods more damaging.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Transportation	Permanent direct and indirect moderately beneficial effects, through the protection of vulnerable sections of U.S. Route 1 from erosional damage due to coastal storms. Minor temporary impacts during construction.	Permanent, moderately beneficial effects, because flood warning systems and emergency planning would help residents evacuate more effectively, orderly, and safely, reducing direct impacts on the traveling public. Land use planning would reduce the future number of evacuees on the transportation network prior to and during storm events.	Permanent, moderately beneficial direct and indirect effects, through the protection of vulnerable sections of U.S. Route 1, and through flood warning systems, emergency planning, and land use planning.	Moderate indirect temporary adverse effect, due to increased vulnerability of U.S. Route 1, the evacuation route, to more frequent storm damage.
Navigation	Temporary adverse effects on navigation near Indian Key would be negligible to minor.	No effect.	Temporary adverse effects on navigation near Indian Key would be negligible to minor.	No effect.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Geology, Topography, and Soils	Minor adverse effects to soils during construction; a strict erosion and sediment control plan would reduce those impacts. There would be permanent minor beneficial effects on soils, as the revetment locations would be more stable and would no longer erode.	Minor adverse effects to soils during construction; a strict erosion and sediment control plan would reduce those impacts.	Minor adverse effects to soils during construction; a strict erosion and sediment control plan would reduce those impacts. There would be permanent minor beneficial effects on soils, as the revetment locations would be more stable and would no longer erode.	Minor adverse indirect effect due to increased erosion of soils.
Hydrology, Hydraulics, and Bathymetry	Minor permanent adverse indirect effect for revetment at Long Key State Park due to potential for deflection of wave energy	No effect	Minor permanent adverse indirect effect for revetment at Long Key State Park due to potential for deflection of wave energy	Minor adverse indirect effect due to increased erosion of soils and sea level rise
Water Quality	Negligible to minor indirect permanent adverse effects due to minor wetland impact, and negligible temporary adverse effects.	No direct or indirect, temporary or permanent adverse effects.	Negligible to minor indirect permanent adverse effects due to minor wetland impact, and negligible temporary adverse effects.	No effect

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Floodplains	Negligible to minor, adverse temporary impacts and accounted for during design and construction	Significant and beneficial short-term and long-term due to protection of structures in the floodplain. Also, acquisition, demolition, and removal of structures that suffer recurring damage can provide additional flood storage. No nonstructural measures would be conducted in the CBRA.	Significant and beneficial short-term and long-term due to protection of structures in the floodplain. Also, acquisition, demolition, and removal of structures that suffer recurring damage can provide additional flood storage.	No direct effect, however structures in floodplains would continue to suffer storm damage and more frequent flooding due to sea level rise and climate change.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Beaches and Terrestrial Habitat	An estimated 15,000 square feet of beach and vegetated dune land will be permanently modified for the installation of the revetment at Long Key State Park. This impact would be minor to moderate, because it would be mitigated with a planting plan. Otherwise, minor permanent and temporary direct impacts on low-quality terrestrial habitat. Long-term predicted loss and/or retreat of beaches and terrestrial habitat landward, due to sea level rise.	Negligible permanent and negligible to minor direct temporary adverse impacts, because land disturbance for this alternative would be limited to modification of existing buildings. Long-term predicted loss and/or retreat of beaches and terrestrial habitat landward, due to sea level rise.	An estimated 15,000 square feet of beach and vegetated dune land will be permanently modified for the installation of the revetment at Long Key State Park. This impact would be minor to moderate, because it would be mitigated with a planting plan. Otherwise, minor permanent and temporary direct impacts on low-quality terrestrial habitat. Long-term predicted loss and/or retreat of beaches and terrestrial habitat landward, due to sea level rise.	No direct or indirect effect, other than the long-term predicted loss and/or retreat of beaches and terrestrial habitat landward, due to sea level rise.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Wetlands	Direct, permanent adverse impacts on approximately 10,250 square feet of sea purslane and sea oxeye-dominated herbaceous wetlands, and 100-200 square feet of scrub/shrub wetlands. Permanent wetland impacts would be mitigated, and thus would be minor. Negligible to minor temporary wetland impacts are expected to occur, as it is the intention to utilize nonwetland areas for construction access and staging. If any wetland areas are disturbed during construction, they areas would be restored after construction. Long-term predicted loss and/or retreat of wetlands landward, due to sea level rise.	Negligible direct or indirect effect, other than the long-term predicted loss and/or retreat of wetlands landward, due to sea level rise.	Direct, permanent adverse impacts on approximately 10,250 square feet of sea purslane and sea oxeye-dominated herbaceous wetlands, and 100-200 square feet of scrub/shrub wetlands. Permanent wetland impacts would be mitigated, and thus would be minor. Negligible to minor temporary wetland impacts are expected to occur, as it is the intention to utilize nonwetland areas for construction access and staging. If any wetland areas are disturbed during construction, they areas would be restored after construction. Long-term predicted loss and/or retreat of wetlands landward, due to sea level rise.	No direct or indirect effect, other than the long-term predicted loss and/or retreat of wetlands landward, due to sea level rise.
Benthics and Submerged Aquatic Vegetation	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Fish and Fishery Resources	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Special Status Species and Critical Habitat	Moderate to potentially significant permanent adverse effects on loggerhead sea turtles, American crocodile, roseate terns, red knot, piping plover, and Cape Sable thoroughwort. Modifications of up to 0.5 acre of American crocodile critical habitat, 0.5 acre of Cape Sable thoroughwort critical habitat, and 0.25 acre of loggerhead sea turtle critical habitat, in known turtle nesting areas. There would be no effect on marine mammals. Otherwise, expected adverse effects due to climate change. Coordination with USFWS is ongoing. No effects to species under the purview of the NOAA PRD as no structures or construction would be in the water.	No direct or indirect effect other than adverse effects due to climate change.	Moderate to potentially significant permanent adverse effects on loggerhead sea turtles, American crocodile, roseate terns, red knot, piping plover, and Cape Sable thoroughwort. Modifications of up to 0.5 acre of American crocodile critical habitat, 0.5 acre of Cape Sable thoroughwort critical habitat, and 0.25 acre of loggerhead sea turtle critical habitat, in known turtle nesting areas. There would be no effect on marine mammals. Otherwise, expected adverse effects due to climate change. Coordination with USFWS is ongoing. No effects to species under the purview of the NOAA PRD as no structures or construction would be in the water.	No direct or indirect effect other than adverse effects due to climate change.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Wildlife	Direct and indirect, temporary and permanent, minor to moderate adverse impacts on wildlife, from the permanent alteration of habitat and shorebird and migratory bird foraging and loafing area by the Long Key revetment footprint. Temporary indirect and direct adverse effects; disturbance during construction would cause wildlife to avoid the areas. Other expected adverse effects due to climate change.	Negligible temporary or permanent adverse impacts to wildlife species; land disturbance for this alternative would be limited to modification of existing buildings. Wildlife would likely avoid the area during construction. Other expected adverse effects due to climate change.	Direct and indirect, temporary and permanent, minor to moderate adverse impacts on wildlife, from the permanent alteration of habitat and shorebird and migratory bird foraging and loafing area by the Long Key revetment footprint. Temporary indirect and direct adverse effects; disturbance during construction would cause wildlife to avoid the areas. Other expected adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Cultural Resources	Potential indirect and direct, temporary and permanent adverse effects on two recorded sites; however National Register of Historic Places eligibility has not yet been determined for either site. Coordination is ongoing.	Significant permanent adverse effects to any NRHP eligible buildings; these impacts would be primarily in the NRHP-listed Key West Historic District. The most severe adverse effects would be from acquisition, Elevating any NRHP-eligible structure would be an adverse effect. These should be avoided if practicable. A Programmatic Agreement has been drafted to address impacts and mitigation.	Significant permanent adverse effects to any NRHP eligible buildings; these impacts would be primarily in the NRHP-listed Key West Historic District. Potential indirect and direct, temporary and permanent adverse effects on two recorded sites; however National Register of Historic Places eligibility has not yet been determined for either site. A Programmatic Agreement has been drafted to address impacts and mitigation.	No direct or indirect effect, other than adverse effects due to climate change. Historic buildings would continue to be exposed to flood risk.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Recreational Resources	Direct and indirect temporary and permanent impacts on recreation that are minor to moderate. Temporary, direct and indirect, adverse effects on use of sections of the Overseas Trail, the public pier at Fiesta Key, Long Key State Park campground roadway, and Indian Key Fill beach access area, during an approximately 4-5 month construction window. However, permanent, beneficial effect due to erosion protection. Permanent adverse effect on approximately 1,500 linear feet of Long Key beach.	No direct or indirect permanent impacts on any known recreational facilities. Potentially negligible to minor, temporary adverse effect during construction.	Direct and indirect temporary and permanent impacts on recreation that are minor to moderate. Temporary, direct and indirect, adverse effects on use of sections of the Overseas Trail, the public pier at Fiesta Key, Long Key State Park campground roadway, and Indian Key Fill beach access area, during an approximately 4-5 month construction window. However, permanent, beneficial effect due to erosion protection. Permanent adverse effect on approximately 1,500 linear feet of Long Key beach.	No direct or indirect effect, other than adverse effects due to climate change.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Visual Resources	Direct temporary and permanent minor adverse effects	Direct minor temporary and permanent adverse effects. Also, potentially beneficial effects. Building elevations will change appearances and viewshed, and acquisition areas will be converted to open space.	Direct minor temporary and permanent adverse effects. Also, potentially beneficial effects. Building elevations will change appearances and viewshed, and acquisition areas will be converted to open space.	No direct or indirect effect
Hazardous, Toxic, Radioactive Waste (HTRW)	No direct or indirect effect.	Negligible adverse permanent and minor adverse temporary impacts. Phase 1 Environmental Site Assessment needed for demolition or elevation of any affected structure constructed prior to 1978. If any such contaminants are found, lawful demolition, removal, and disposal of such wastes would be followed.	Negligible adverse permanent and minor adverse temporary impacts. Phase 1 Environmental Site Assessment needed for demolition or elevation of any affected structure constructed prior to 1978. If any such contaminants are found, lawful demolition, removal, and disposal of such wastes would be followed.	No direct or indirect effect.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Safety	Permanent direct and indirect beneficial effects for safety, through the protection from erosional damage of U.S. Route 1, the only land evacuation route from the Keys. However, all other effects from climate change would still be expected.	Permanent direct and indirect beneficial effects. Relocation of residents from repetitive loss areas Land use planning, flood warning systems, and emergency planning would also help residents prevent damage, and evacuate more effectively. However, all other effects from climate change would still be expected.	Permanent direct and indirect beneficial effects for safety, through the combined protection from erosional damage of U.S. Route 1, relocation of residents from repetitive loss areas, better land use planning, flood warning systems, and emergency planning. However, all other effects from climate change would still be expected.	No direct or indirect effects. However, increased vulnerability coastal storm damage caused by climate change can lead to damaged evacuation route, stranded residents, and damaged buildings.
Utilities	Potential for minor permanent and temporary direct effects. Utility impacts would be thoroughly vetted and coordination would occur as the design process continues. Temporary, minor disruptions of service would be avoided.	Potential for minor permanent and temporary direct effects. Utility impacts would be thoroughly vetted and coordination would occur as the design process continues. Temporary, minor disruptions of service would be avoided.	Potential for minor permanent and temporary direct effects. Utility impacts would be thoroughly vetted and coordination would occur as the design process continues. Temporary, minor disruptions of service would be avoided.	No direct or indirect effects. However, climate change would continue to pose a threat to utility infrastructure.
Air Quality	Minor, temporary impacts during construction.	Minor, temporary impacts during construction.	Minor, temporary impacts during construction.	No direct or indirect effect.
Noise	Minor, temporary impacts during construction.	Minor, temporary impacts during construction.	Minor, temporary impacts during construction.	No direct or indirect effect.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, TSP (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Climate Change	Negligible effect on climate change due to temporary greenhouse gas emissions. However, there would be permanent beneficial effects for resiliency and adaptation to climate change.	Negligible effect on climate change due to temporary greenhouse gas emissions. However, there would be permanent beneficial effects for resiliency and adaptation to climate change.	Negligible effect on climate change due to temporary greenhouse gas emissions. However, there would be permanent beneficial effects for resiliency and adaptation to climate change.	No direct or indirect impacts would occur. However, the cumulative effects of climate change would still occur. Significant, permanent adverse effects due to damages to buildings, roadways, and environments due to sea level rise and coastal storms would be expected to continue and increase.

8.2 LAND USE

8.2.1 Alternative 1: Structural Only Alternative (Revetments Only)

Land Use for this alternative consists of uses compatible with areas within 100 feet of the U.S. Route 1 highway corridor. These uses are transportation and recreation. Effects on those resources are mentioned below, but discussed in greater detail in those sections of this chapter. This alternative affects four recreational facilities: the U.S. Route 1 Overseas Trail, Bahia Honda State Park, Long Key State Park, and a public pier at Fiesta Key. These land uses are mentioned below, but covered in greater detail in the Recreation section of this chapter. There are no residential, commercial, or institutional land uses within the ROI for this alternative, so these land uses would not be affected.

Overseas Trail along West Summerland Key, Bahia Honda Key, Fiesta Key East, Fiesta Key West, and Indian Key Fill

The Overseas Trail is in close proximity to all of the proposed revetment locations, except for the one in Long Key State Park. The proposed revetments cannot permanently displace any sections of the trail, and therefore would have no direct, permanent adverse impact or conversion of land use of the Overseas Trail itself. However, sections of the trail will likely have to be closed during the construction window at these three locations, which is expected to take

approximately four to five months at each location. Once construction is complete, the revetments would provide added permanent erosion protection for the trails and the roadway itself.

West Summerland Key

The proposed revetment at this location would be placed largely in an area that is currently vegetated herbaceous wetlands. This effect is discussed in the Wetlands section of this chapter. This area, which is between an existing concrete floodwall and the Overseas Trail, does not appear to have an active land use.

Long Key State Park

The proposed revetment, to be approximately 1,500 linear feet, is planned on a very narrow vegetated beach, upslope of MHW and parallel to the Park's campground access road. Installing a permanent revetment at this location would have a temporary and permanent direct and indirect adverse effect on this park. Areas that are currently open for wading, swimming, walking, bird watching, and other passive uses would have more limited access with a permanent revetment structure in place. In addition, construction staging area stretches across the park access roadway to the campground, which would require its temporary closure for four to five months. This would be a direct, temporary moderate impact, and a direct, permanent moderate land use impact on Long Key State Park. A permit from the FDEP Division of Parks and Recreation (DPR) would be required for the temporary and permanent revetment encroachment.

Public Pier at Fiesta Key East

Between mile markers 70 and 71, across U.S. Route 1 from the Fiesta Key East revetment, there is a long public pier. Once a bridge trestle for U.S. Route 1, it now parallels U.S. Route 1 to the north. The pier is used mostly for fishing, but also sightseeing, photography, bird watching, walking, and other passive uses. There is a large public parking area adjacent to it, and this area would be used for construction staging. There would be no indirect or direct permanent impact on recreation here, because the area where the revetment itself will be placed is not used for recreation. However, construction would require the temporary closure of the pier for approximately four to five months. There is no other such pier nearby for use as an alternative; therefore, this would have a direct, temporary minor to moderate effect on recreational land use.

Indian Key Fill

This location, while not a "facility," is owned by both DPR and FDOT and currently used by the public for recreation. This alternative would have a direct and indirect, minor temporary impact on recreational land use during construction. However, the embankment on which the revetment will be constructed is not conducive to recreational use, so the revetment would have no direct or indirect permanent adverse effect on land use.

In order to construct the revetments on DPR or FDOT land, Monroe County must go through authorization processes. For DPR, including both parkland and Overseas Trail easement, there

is an application process in which the applicant must submit a completed questionnaire that includes an accurate aerial map of the proposed easement area(s) and a sketch and legal description of the easement area(s), to the park managers' and district offices for review and DPR comment; and upon receipt of all comments, DRP's managing agency review letter will be provided. After that, the applicants submit a completed easement application, including the DPR letter, to the Division of State Lands/DSL, which has the responsibility of reviewing and issuing easements. For acquisition of an easement from FDOT, the County must first receive a formal written request from a department head or director. Any request to surplus property or convey property rights has to be routed to the different units within FDOT for comment. Once comments are given, the request is presented to the Right of Way Department Manager and the Transportation Director, who would make the final determination whether to grant the request or not. FDOT would also need an adopted resolution stating the public purpose need of the request prior to executing the easement.

Overall, Alternative 1 would have direct and indirect, temporary and permanent adverse effects on land use that are minor to moderate.

8.2.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves construction on existing upland structures, demolition of structures to be acquired, and construction access and staging for both. Construction staging areas would be directly co-located with the affected structures.

Acquisition

Approximately 300 residences would be subject to mandatory acquisition and relocation. These would be for residences at various locations throughout the Keys, but only affects residences that have suffered repetitive losses due to storm and/or flooding damage, and for which a cost-benefit analysis has determined that these buyouts are a benefit to the government as opposed to providing recurring governmental aid. These residents would be compensated for their property and would be given relocation aid, subject to the Uniform Relocation Act. This alternative would require mandatory relocation of those residents, some of whom may not wish to leave. However, depending on perspective, acquisition of repetitive losses and aid for residents in finding new residences less subject to damage could also be a beneficial effect, as some residents may welcome the opportunity to relocate. For those locations subject to acquisition, the land use would be permanently converted from a residence to open space.

Elevation and Floodproofing

Approximately 7,100 residences would be eligible for elevation or raising of their homes. Elevation of structures would apply only to residences, and would therefore have no temporary or permanent effect on land use. Floodproofing treatments would be done for approximately 3,800 commercial and critical infrastructure facilities. In these locations, the land use would not change. The Proposed Action would result in fewer coastal storm damages to structures.

For these reasons, this alternative would have direct, potentially significant, permanent effects on land use. These effects include both adverse and beneficial effects. For those residents not wishing to relocate, this would be a permanent significant adverse effect on their land use. Otherwise, there would be beneficial permanent effects for elevated and floodproofed structures, and residents relocated to areas less susceptible to damage, in the form of improved coastal storm resilience. There would also be indirect permanent and beneficial land use effects due to increased open space to absorb coastal flooding. Temporary, indirect and direct adverse effects would result from construction noise and presence and use of heavy equipment in residential and commercial land use areas.

8.2.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The effects of this alternative would be a combination of those described above under Alternatives 1 and 6. The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, this alternative would have direct, potentially significant, permanent effects on land use. These effects include both adverse and beneficial effects. There would be temporary, indirect and direct adverse effects from construction noise and presence and use of heavy equipment in residential and commercial land use areas.

8.2.4 Alternative 8: No Action and Future Without Project

The No Action Alternative and Future Without Project would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No direct effects on land use would occur from the Proposed Action; however, there is the potential for greater coastal storm damage to U.S. Route 1 and buildings within existing development centers without Proposed Action.

8.2.5 Best Management Practices to Avoid and Minimize Impacts on Land Use for Alternative 7

1) Coordination with all affected residents and businesses will be conducted by the County and USACE.
2) All laws and regulations pertaining to relocation and compensation would be adhered to.
3) For public safety, the shoreline areas that are under construction and their staging areas will be closed to the public.
4) Staging areas will be the minimum necessary to construct the project, and construction will be completed as soon as practicable.
5) Further coordination will be conducted with DPR in the PED phase, to avoid and minimize conflicts with the park and Overseas Trail operations. All required permits would be obtained.
6) The timing of the work will be coordinated with the County and FDOT to avoid and minimize conflicts with planned or ongoing County projects.

8.3 SOCIOECONOMICS

8.3.1 Alternative 1: Structural Only Alternative (Revetments Only)

Alternative 1 would improve socioeconomic resilience, the ability of the population to resume commerce after a coastal storm, by helping to keep U.S. Route 1 passable after a storm. This would be a permanent, moderate benefit, as U.S. Route 1 is the backbone of land transport in the Florida Keys. Construction of the revetments would temporarily support jobs locally, or bring workers into the Florida Keys, resulting in a negligible to minor economic benefit. Construction access and operations may be somewhat disruptive to residences and businesses, but should have a negligible to minor adverse effect on the overall socioeconomics within the Florida Keys.

8.3.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves construction on existing upland structures, demolition of structures to be acquired, and construction access and staging for both. Construction staging areas would be directly co-located with the affected structures.

In residential areas, nonstructural measures can keep people away from damaging and dangerous floodwaters, but they come with serious social costs.

Acquisition

Approximately 300 residences would be subject to mandatory acquisition and relocation. This would be for residences at various locations throughout the Keys and therefore would not disrupt whole communities. This measure only affects residences that have suffered losses due to storm and/or flooding damage, and for which a cost-benefit analysis has determined that these buyouts are a benefit to the government as opposed to providing recurring governmental aid. This alternative would require mandatory permanent relocation of those residents, through eminent domain if necessary; and some residents may not wish to be relocated. Buyouts and relocations also could present special hardships to the elderly, handicapped, minority, or low-income people, for whom moving may be more burdensome, and relocation options may be more limited. Acquisition and relocation could cause individuals to have to miss days of work during the process, which could adversely affect their families' income.

However, acquisition of heavily damaged homes and aid for residents in finding new residences less subject to damage is also a beneficial effect, as some residents may welcome the opportunity to relocate and suffer fewer long-term repetitive losses. All residents subject to mandatory acquisition would be provided with assistance required to find a comparable residence, and would be given relocation aid, subject to the Uniform Relocation Act (URA). This Act, which is discussed further in the Real Estate Plan Appendix, Appendix F, also has guidelines on distances away from places of employment that residents could be relocated, which would help minimize effects on socioeconomics.

Elevation and Floodproofing

Approximately 7,100 residences located throughout the Keys would be eligible for elevation or raising of homes. Elevation of structures would apply only to residences, would be voluntary for

property owners, and would have a beneficial effect on socioeconomics in the form of less damage from coastal flood risk damage. However, structural elevations may cause daily inconvenience to all, and special hardships to the elderly and handicapped. Floodproofing treatments would be done for approximately 3,800 nonresidential structures. For elevation, temporary relocation and/or restriction of use by residents and businesses would be likely during construction. Because elevations and floodproofing are voluntary, property owners would not receive relocation aid; however tenants occupying affected residents would be eligible for the aid under the URA, as described in the Real Estate Plan Appendix, Appendix F.

Overall, this alternative would have direct, potentially significant, permanent effects on socioeconomics. These effects include both adverse and beneficial effects. For those residents not wishing to relocate, this would be a permanent significant adverse effect.

Compliance with Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations is discussed further in Section 9.21.

Otherwise, there would be beneficial permanent effects for elevated and floodproofed structures, and residents relocated to areas less susceptible to damage, in the form of improved coastal storm resilience. The Proposed Action would result in fewer coastal storm damages to structures and an overall improvement of socioeconomic resilience, through the ability of the population to resume normal life after a coastal storm, by keeping infrastructure functional for longer. This would be a significant benefit as critical infrastructure includes utilities, emergency services, and other essential elements of daily life.

Temporary, indirect and direct adverse effects would result from construction noise and presence and use of heavy equipment in residential and commercial structures. There would also be temporary minor to moderate adverse effects due to the challenges of relocation and moving, as well as effects due to restricted use of individual residences and businesses during construction. A beneficial temporary socioeconomic effect would be that additional construction work would support jobs locally, or bring workers into the Florida Keys, resulting in a negligible to minor economic benefit.

8.3.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The effects of this alternative would be a combination of those described above under Alternatives 1 and 6. The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, this alternative would have direct, potentially significant, permanent effects on socioeconomics. These effects include both significant adverse and beneficial effects. Acquisition and relocation also could present special hardships to the elderly, handicapped, minority, or low-income people, for whom moving may be more burdensome, and relocation options may be more limited. Acquisition and relocation could cause individuals to have to miss days of work during the process, which could adversely affect their families' income.

However, acquisition of homes vulnerable to damage and aid for residents in finding new residences less subject to damage is also a beneficial effect, as some residents may welcome the opportunity to relocate and suffer fewer long-term repetitive losses. For elevation, temporary

relocation and/or restriction of use by residents and businesses would be likely during construction. Because elevation and floodproofing are voluntary, property owners would not receive relocation aid; however tenants occupying affected residents would be eligible for the aid under the URA, as described in the Real Estate Plan Appendix, Appendix F. Temporary, indirect and direct adverse effects would result from construction noise and presence and use of heavy equipment in residential and commercial structures and at the revetment locations.

8.3.4 Alternative 8: No Action and Future Without Project

The No Action Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No residents would be relocated or structures modified. Risk to people, property, and the economy of the Florida Keys would continue to increase as climate change is expected to result in more frequent and powerful Atlantic hurricanes, and sea level rise make their floods more damaging.

8.3.5 Best Management Practices to Avoid and Minimize Impacts on Socioeconomics for Alternative 7

1) Strict adherence to the URA.
2) Minimize adverse effects on socioeconomics through regular communication and coordination with affected residents.
3) Attempt to accommodate the citizens of the Florida Keys, particularly the elderly, disabled, minority, and low-income residents, to the extent reasonable and practicable and in accordance with law and regulation.

8.4 TRANSPORTATION

8.4.1 Alternative 1: Structural Only Alternative (Revetments Only)

For this alternative, the identified locations along U.S. Route 1 that have less than 100 feet of land between the road footprint and the shoreline, and are not already being stabilized by others, will be stabilized with revetments. Due to the proximity of the revetments to U.S. Route 1, it is possible that temporary lane closures or restrictions on U.S. Route 1 may necessary during the four to five month construction window at each revetment location. Also, heavy equipment will need to enter and exit US Route 1 to travel to and from staging and equipment storage areas. These effects could cause direct and indirect minor, temporary adverse effects due to travel delays. However, if all safety regulations are followed during construction, there would be negligible adverse effects on transportation safety for construction workers and the public.

There would be permanent direct and indirect beneficial effects for transportation, that are minor to moderate, through the protection of vulnerable sections of U.S. Route 1 from erosional damage due to coastal storms and SLR. This is crucial, as U.S. Route 1 is both the only transportation network connecting all of the inhabited Florida Keys and the only land evacuation route from the Keys.

8.4.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves temporary construction on existing structures, demolition of structures to be acquired, and construction access for both. Staging areas would not directly affect roadways, however, heavy equipment entering and exiting the transportation network could cause temporary, indirect negligible to minor travel delays. During construction, if all safety regulations are followed, there would be negligible temporary adverse effects on transportation safety.

Flood warning systems and emergency planning would also help residents make preparations to prevent damage, and/or evacuate more effectively, orderly, and safely, reducing direct impacts on the traveling public. Land use planning would reduce temporary and permanent adverse transportation impacts by reducing the future number of residents needing to evacuate on the transportation network prior to and during storm events.

8.4.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, there would be indirect and direct temporary adverse effects that are minor. There would be indirect and direct, permanent beneficial effects on U.S. Route 1 and the travelling public.

8.4.4 Alternative 8: No Action and Future Without Project

The No Action Alternative and Future Without Project would mean not implementing an alternative. No temporary or permanent impacts to safety would occur, due to any alternative. However, the Keys are located in a low-lying region, which makes them vulnerable to increased frequency of unsafe flooding conditions and damage. This can lead to various potentially dangerous conditions such as flooded or damaged evacuation route, and stranded residents. Therefore, this alternative would result in indirect and direct, temporary and permanent, adverse effects that are minor to moderate.

8.4.5 Best Management Practices to Avoid and Minimize Impacts on Transportation for Alternative 7

1) Prior to construction, a transportation plan would be developed by USACE and approved by FDOT and the County for any temporary impacts on traffic.

2) Prior to construction, schedules would be coordinated with FDOT and the County to prevent conflicts with other construction schedules affecting the transportation network.

3) Construction workers would be required to follow the Occupational Safety and Health Act (OSHA) regulations.

4) Public access would be prohibited in construction zones.

8.5 NAVIGATION

8.5.1 Alternative 1: Structural Only Alternative (Revetments Only)

For this alternative, there would be no temporary or permanent in-water impacts. Therefore, there would be no permanent adverse impacts on navigation.

Construction access and staging would occur from the land side rather than from the water. Construction will require staging of heavy equipment in areas near the water, for approximately four to five months near each revetment location. During construction, these areas would be closed to the public for safety reasons. There are no public boating launches, aids to navigation, or buoys located in the near vicinity of any of the proposed revetments or staging areas; however, there are nearshore areas where navigation access for small craft such as canoes or kayaks could occur, and it is possible that some people may access the water directly off the shorelines. For this reason, temporary adverse effects on navigation would be negligible to minor. Recreational effects are discussed more in the Recreation Resources section of this chapter.

8.5.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves only construction on existing upland structures, demolition of structures to be acquired, and construction access and staging for both. Construction staging areas would be directly co-located with the affected structures. There would be no in-water effects, and no temporary or permanent adverse effects on navigation would occur.

8.5.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. There would be no permanent adverse effects, and negligible to minor temporary adverse effects on navigation.

8.5.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No effects on navigation would occur.

8.5.5 Best Management Practices to Avoid and Minimize Impacts on Navigation for Alternative 7

For navigational safety, the shoreline areas that are under construction and their staging areas will be closed to the public.

8.6 GEOLOGY, TOPOGRAPHY, AND SOILS

8.6.1 Alternative 1: Structural Only Alternative (Revetments Only)

For this alternative, embankments would be graded and filled with core stone and covered with rock, to produce to a more stable slope. Soils would be permanently covered by the new revetments. There would be minor adverse effects to soils during construction; a strict erosion and sediment control plan would reduce those impacts. There would be permanent beneficial effects on soils and topography, as the revetment areas would be more stable and would no longer erode. There would be negligible effects on the geology within the ROI.

8.6.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves construction on existing structures, demolition of structures to be acquired, and construction access for both. This would require the temporary use of heavy equipment. Demolition may also require some regrading of the affected areas following construction, to produce a more stable landscape. There would be minor adverse effects to soils during construction; a strict erosion and sediment control plan would reduce those impacts. There could be permanent beneficial effects on soils and topography as a result of demolition; these areas would be stabilized and seeded following construction. There would be negligible effects on the geology within the ROI.

8.6.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, temporary minor adverse impacts and beneficial permanent effects would be expected for topography and soils, and negligible impacts on geology.

8.6.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent impacts to topography, soils, or geology would occur.

8.6.5 Best Management Practices to Avoid and Minimize Impacts on Geology, Topography, and Soils for Alternative 7

1) Strict erosion and sediment control measures should be employed during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version).

2) Following construction, disturbed areas would be seeded and stabilized in accordance with state requirements.

8.7 HYDROLOGY, HYDRAULICS (H&H) AND BATHYMETRY

8.7.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment, the watershed within the ROI contains benthic habitats that include beaches, sandflats and mudlflats, hardbottom, corals, seagrass beds; and red mangrove habitat. Like all shorelines, these areas regularly experience erosive forces.

Originally, the proposed revetments would have directly and adversely impacted sandflats, mudflats, hardbottom, and red mangroves. However, upon further consideration of the existing site conditions and proposed stabilization to be constructed by others, it was determined that it is practicable to construct the revetment footprints upslope of MHW for all revetments, including upslope of the existing mangrove wetlands at Fiesta Key East and West, and Indian Fill Key. Embankments would be graded as needed, filled with core stone, and covered with rock, to produce to a more stable slope. Soils would be permanently covered by the new revetments. Strict erosion and sediment control measures will be adhered to during construction. None of the six revetments would have temporary or permanent direct adverse effects on bathymetry.

Although revetments are effective means of stabilizing shorelines, sometimes revetments placed nearshore and/or channelward of MHW can indirectly contribute to minor erosion in adjacent areas by deflecting wave energy. As per Florida Statute Title XI Section 161.052, the beaches at Bahia Honda and Long Key State Parks fall under the jurisdiction of the State of Florida's Coastal Construction Control Line (CCCL) Program, because each is located along a state-designated "Critically Eroding Beach." The CCCL program regulates structures and activities which can cause beach erosion, destabilize dunes, damage upland properties, or interfere with public access. For critically eroding beaches in the Florida Keys, coastal construction is prohibited within 50 feet of the line of mean high water except by waiver or variance of the 50-foot setback requirements pursuant to Section 161.052, F.S (FDEP 2020c).

The proposed revetment at Bahia Honda has been moved upslope, directly adjacent to U.S. Route 1 and the Overseas Trail. It is within approximately 30-40 feet of the MHW line; however, it is unclear whether or not a permit would be required, because the Section 161.052 also states, "The setback requirements as defined herein shall not apply to any riparian coastal locations fronting the Atlantic Ocean or Gulf of Mexico which have vegetation-type nonsandy shores." The proposed revetment footprint would be placed in a grassed roadside that includes a treeline. However, a revetment along a roadway embankment would not be expected to have a negligible to minor permanent adverse effect on erosive, hydrodynamics along the beach.

The revetment at Long Key State Park will be placed adjacent to the MHW line, on a sand-based beach substrate that also contains upland herbaceous beach vegetation. This location would definitely be subject to CCCL requirements, and a permit or waiver will be required from FDEP in order to construct the revetment. While revetments along shorelines protect them from erosion, they can also deflect wave energy to other shorelines in the vicinity. For this reason, the revetment at Long Key State Park is likely to have indirect temporary and permanent minor adverse effects on H & H.

8.7.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Because there are no in-water or nearshore impacts associated with this alternative, this alternative will have no effect on H & H, or bathymetry.

8.7.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. This alternative would have no direct or indirect adverse effect on bathymetry, but could have indirect temporary and permanent minor adverse effects on H & H, due to wave energy deflection of the revetment near the beach.

8.7.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would not implement a build alternative to mitigate against coastal storm risk. For this alternative, the areas not protected would continue to experience SLR, coastal storms, and higher tides, which could result in minor adverse effects on H & H due to continuing erosion of the banks, shorelines, and beaches.

8.7.5 Best Management Practices to Avoid and Minimize Impacts on H & H and bathymetry for Alternative 7

1) Strict erosion and sediment control measures will be adhered to during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version).
2) All required state and local permits pertaining to the CCCL program would be obtained, and the conditions would be adhered to.
3) Following construction, disturbed areas would be seeded and stabilized in accordance with state requirements.

8.8 SURFACE WATERS, GROUNDWATER, AND WATER QUALITY

8.8.1 Alternative 1: Structural Only Alternative (Revetments Only)

All revetments have been relocated upslope of the mean high water line. Only the revetment at West Summerland Key will entail wetland impacts behind a sea wall, landward of the MHW line. A Section 401 Clean Water Act permit and mitigation will be required for those impacts. However, it should be noted that wetlands are covered in a separate section of this document.

Other than these wetlands, no surface waters will be directly or permanently impacted by this alternative. Because these impacts are landward of MHW, no permit from the FKNMS would be required.

Implementation of Alternative 1 also would require temporary construction access. Access would be expected to be from existing roads and staging areas; no access from the water is expected to occur. Some grading would be required to install the riprap. During construction, as well as for any subsequent periodic maintenance and repairs, strict erosion and sediment

control measures would be employed to prevent sedimentation and turbidity in adjacent waterways.

Negligible to minor indirect permanent adverse effects due to minor wetland impact, and negligible temporary adverse effects to surface waters, groundwater, or water quality would occur as a result of this alternative.

8.8.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

No direct surface water, groundwater, or water quality impacts would occur as a result of implementation of Alternative 6, because land disturbance for this alternative would be limited to modification of existing buildings. If acquisition of homes at risk to coastal flooding occurred, impacts to water quality have the potential to be moderately beneficial and permanent, because as structures are demolished and removed, these land areas could revert to wetlands.

Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, as repairs will be needed over time.

No direct or indirect permanent adverse effects to surface waters, groundwater, or water quality would occur as a result of this alternative.

8.8.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Negligible to minor indirect permanent adverse effects due to minor wetland impact, and negligible temporary adverse effects to surface waters, groundwater, or water quality would occur as a result of this alternative.

8.8.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent water quality impacts would occur. However, climate change would continue to cause sea level rise, warmer waters, ocean acidification, etc.

8.8.5 Best Management Practices to Avoid and Minimize Impacts on Water Quality for Alternative 7

1) Strict erosion and sediment control measures should be employed during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version).
2) USACE will apply for the appropriate permits under CWA 401 and 402 during the PED phase when more details on the project design are available. All permit conditions will be followed.
3) Proactive stormwater management via increased engineering (silt fences, etc.) and administrative controls (site stormwater inspections, permitting, BMPs) would provide additional assurance that potential impacts (runoff, contaminant transport,

sedimentation, etc.) to the marine environment from land-disturbing activities would be minimized.

8.9 FLOOD PLAINS

8.9.1 Alternative 1: Structural Only Alternative (Revetments Only)

As a major transportation route for the community, the revetments along U.S. Route 1 are expected to provide major effects that are beneficial and permanent with regards to daily travel and hurricane evacuation, unless the measures fail or the design flood level is exceeded. As the main road out of the Florida Keys, it is important to have a reliable evacuation route to get people out of area in advance of a storm event. Road closures during construction could disrupt travel plans for citizens or emergency personnel, which could be negligible to moderate, adverse temporary impacts.

Impacts to the environment and flood plain areas, including wetlands, upland areas, natural drainage features, utilities, existing structures, etc. will generally be within the footprint of project. Recognizing the value of existing wetlands, the revetment footprints were shifted upslope. Avoidance and minimization efforts are expected to result in wetland impacts only at West Summerland Key, which would be result in minor, adverse permanent impacts to wetlands. Impacts to natural drainage and utilities will be negligible to minor, adverse temporary impacts and accounted for during design and construction.

None of the structural measures would be within the Coastal Resource Barrier Act (CRBA) designated unit maps; therefore no coordination would be required under this Act.

8.9.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Use of non-structural flood mitigation measures for critical infrastructure, dry and wet flood proofing, will provide beneficial, permanent, and major impacts with flooding, unless the measures fail or the design flood level is exceeded. Protecting critical infrastructure will help communities be more resilient and sustainable after a flood event occurs. However, if the mitigation measures fail or the flood level exceeds the design, although temporary, the impacts could be adverse and major for a community to recover after a flood event, especially if there are back-to-back flood events. The flooding of critical infrastructure could cause damage to the structure and its contents and depending the type of facility, could cause harm to the environment. Although temporary, the level of flooding could cause the impacts to range from negligible to major. Regarding life-safety issues, if non-structural measures are used, people should not be in a critical facility during a flood event, just in case it does become flooded. Before a flood event, items should be elevated or relocated to avoid possible flood damage.

The following non-structural measures are being used for residential or commercial structures:

Elevation – elevation is only applied to residential structures. FEMA recognizes elevation as a way to reduce flood insurance premiums. If a structure is located within the FEMA one percent annual chance flood plain, in general, the higher the lowest rated floor is above the one percent

annual chance flood elevation, the less expensive the flood insurance will be.

Acquisition – acquisition is only being applied to residential structures. By purchasing property and demolishing a structure, the need for flood insurance is permanently eliminated. The community agrees never to develop the property, except for acceptable uses within a flood plain.

Dry Floodproofing – dry floodproofing applies only to commercial structures. FEMA only recognizes floodproofing of commercial structures to reduce flood insurance premiums, but not for residential structures. A floodproofed building has been designed and constructed to be watertight, substantially impermeable to floodwaters, up to a recommended depth of three feet for conventional built structures. Closure panels are used at openings and a sump pump and drain system installed. To receive an insurance rating based on the one percent annual chance flood, the building must be flood proofed to an elevation at least one foot above the one percent annual chance flood. Insurance premiums will be lower if floodproofing exceeds this requirement.

Nonstructural measures will help keep neighborhoods and communities sustainable and resilient after a flood, where a structure could possibly stay flood-free during its design life which is a beneficial and major impact. However, if the mitigation measure fails or the flood level exceeds the design, although temporary, the impacts could be adverse and major for a community, family, or business to get back to normal after a flood event, especially if there are back-to-back flood events. The flooding could cause damage to the structure and its contents and depending on the type of facility, could cause harm to the environment. Although temporary, the level of flooding could cause the impacts to range from negligible to major. Any property that becomes permanent open space due to acquisition will be a beneficial aspect of the project, usually targeted for repetitive loss structures, where flood damage will never occur and the open space can be used for an acceptable use in a flood plain. With nonstructural measures, Monroe County should inform citizens on the need to evacuate in the event of a flood, to protect themselves and not to put first responders in danger as well, which should be addressed in the USACE required Flood Plain Management Plan.

If an existing structure does not meet FEMA's regulations, in general with respect to the building's finished floor elevation and the effective one percent annual chance flood elevation, and has been substantially improved, as may apply with a nonstructural measure such as elevation, then the structure will need to be brought into compliance with FEMA and Monroe County's flood plain regulations. A Substantially Improved Building is a building that has undergone reconstruction, rehabilitation, addition, or other improvement, the cost of which equals or exceeds 50 percent of the market value of the building before the "start of construction" of the improvement. This term does not include a building that has undergone reconstruction, rehabilitation, addition, or other improvement related to:

1. Any project or improvement of a building to correct existing violations of a State or local health, sanitary, or safety code specifications that have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions; or

2. Any alteration of a "historic building," provided that the alteration will not preclude the structure's continued designation as a "historic building."

Designated historical structures can use any type of non-structural measure to reduce flood damage, as long as it maintains its historical status, including being exempt from FEMA's Substantial Improvement regulations. However, the structure is still rated for flood insurance according to its lowest rated floor elevation. If the structure loses its historical status, then it will have to comply with FEMA and Monroe County's flood plain regulations.

None of the nonstructural measures would be located within designated CBRA unit maps; therefore no coordination under this Act would be required.

Nonstructural projects are small in scale such that any adverse impacts due to construction would be localized to each structure and will be temporary and negligible to minor. Erosion and sediment control measures should be implemented during construction activities, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013, (or most recent version).

8.9.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, any adverse impacts due to construction would be localized to each structure and will be temporary and negligible to minor. Adverse impacts to natural drainage and utilities also will be negligible to minor, and temporary.

8.9.4 Alternative 8: No Action and Future Without Project

Alternative 8, the No Action and Future Without Project Alternative, would involve no action from USACE to mitigate against coastal storm risk. Monroe County would continue addressing current flooding issues and those in the future. Flooding is a temporary condition, where the impacts are generally adverse, from negligible to major, depending on the level flooding. From previous storm events, the community has experience in dealing with nuisance type flooding to more severe flooding. With ongoing and continued relative sea level rise and possible climate change, where there may be an increase in storm frequency, storm surge flooding, and rainfall, the communities will need to continue flood mitigation activities in order to protect people, property, and the environment. Although many of the communities participate in FEMA's Community Rating System, with the number of structures located in the flood plain and mitigation projects currently identified in their Local Mitigation Strategy, and competition for available limited funding, it will continue to be a struggle to fund and complete many of the projects.

8.9.5 Best Management Practices to Avoid and Minimize Impacts on Flood Plains for Alternative 7

Specific examples of best management practices to avoid and minimize impacts on flood plains include:

1) Community officials should have a continuous outreach and education plan in place for citizens to understand the types of flooding, flood mitigation activities, design limitations,

impacts, and their role if given instructions from local officials. Citizens come and go and people forget about past flood events or are not aware of the possible flooding.

2) Community officials should have a continuous outreach and education plan in place for local staff to understand the flood types, flood mitigation activities, operations and maintenance, design limitations, impacts, and their role in protecting citizens. Local staff come and go and people forget about past flood events or are not aware of the possible flooding.

3) Considering how vulnerable Monroe County is to flooding, community officials to should encourage flood insurance, even if it is not required. Federal flood insurance is based on the one percent annual chance flood, but floods greater have and will occur in the future.

8.10 BEACHES AND TERRESTRIAL HABITAT

8.10.1 Alternative 1: Structural Only Alternative (Revetments Only)

With the exception of Long Key, the six proposed locations for the revetments currently provide limited beach or terrestrial habitat.

West Summerland Key
This revetment site includes approximately 10,725 square feet of wetland impacts; this is discussed in the Wetland section of this chapter. Some of the vegetation to be cleared is dead but standing mangroves.

Bahia Honda
In order to avoid beach impacts, the Bahia Honda Key revetment was originally planned along the beach, but was shifted upslope to a grassed and treeline area between the Park fence line and U.S. Route 1 and the Overseas Trail. Its staging area will be located on uplands elsewhere, away from the beach. A thin treeline along the road will be the only affected permanently affected vegetation community.

Fiesta Key East and Indian Key Fill
The proposed revetment is located on an eroded or grassed roadside and trail side slopes, and therefore, lack a vegetative community.

Fiesta Key West
The proposed revetment also immediately adjacent to the road and trail, and is in very close proximity to mangrove and buttonwood mixed wetlands immediately downslope. However; the revetment will be built upslope of those wetlands and therefore, they will not be permanently impacted.

Long Key
The Long Key revetment location is along the beach. An estimated 15,000 square feet of land will be permanently modified for the installation of the revetment, and much of this area is vegetated with herbaceous and scrubby shoreline species. The wrackline debris would also be

permanently displaced; it would fall along the revetment rather than along a beach, making it less useable for foraging or loafing habitat. There will be approximately 1.25 acre of temporary impacts for staging and construction access that would be restored following construction.

Pursuant to Section 161.053 Florida Statutes (F.S.), CCCL is defined as the demarcation on the beach and dune system subject to severe fluctuations based on a 100-year storm event. It establishes the landward limit of jurisdiction of the FDEP along sandy beaches of the State along the Gulf of Mexico, the Atlantic Ocean, and the Straits of Florida. On sandy beach areas where no CCCL, has been established, such as the Florida Keys, coastal construction is prohibited within 50 feet of the line of MHW unless authorized by waiver or variance of the setback requirements pursuant to Section 161.052, F.S. The statute states that unless expressly authorized by the permit, native coastal vegetation destroyed during construction should be replaced.

DPR expressed concerns about the beach impacts in their comments to USACE. This is more fully discussed in the Recreation section of this chapter, but specifically, DPR indicated that it prefers no hard structures in the Long Key State Park, and that a planting plan is being developed for this area. However, if agreeable to the Park, its planting plan could be supplemented with a USACE upland dune vegetation mitigation plan to replace the impacted dune vegetation. This also is discussed more in the mitigation plan section of the Environmental Appendix.

This alternative would result in indirect and direct, temporary and permanent, adverse impacts on the beach and its vegetation that are minor to moderate. Similarly, localized maintenance and repairs will be needed over time, and would also involve temporary construction impacts. Also, suitable beach foraging areas will remain outside of the revetment footprint and area to be affected by construction noise and disturbance. USACE would follow best management practices. In addition, continued beach erosion and sea level rise throughout the Keys would be expected to occur.

8.10.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Negligible permanent and negligible to minor temporary adverse impacts to beaches and/or terrestrial vegetation are expected to result from implementation of Alternative 6, because land disturbance for this alternative would be limited to modification of existing buildings. Where buyouts or acquisition of homes and/or businesses at risk to coastal flooding occur, impacts on vegetation have the potential to be moderately beneficial and permanent, because as structures are demolished, these land area could revert to naturalized areas.

Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads, but some minor clearing of vegetation may be needed for construction access. Similarly, localized maintenance, as repairs will be needed over

time. In addition, continued beach erosion and sea level rise throughout the Keys would be expected to occur.

8.10.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, this alternative would result in indirect and direct, temporary and permanent, adverse impacts on the beach and its vegetation that are minor to moderate. The effects would be minimized through a replanting plan and the other Best Management Practices described in Section 8.10.5.

8.10.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action to mitigate against coastal storm risk. No temporary or permanent impacts to beaches and terrestrial vegetation would occur. However, continued beach erosion and sea level rise would be expected to occur.

8.10.5 Best Management Practices to Avoid and Minimize Impacts on Beaches and Upland Vegetation for Alternative 7

1) Buffers of at least 10 meters (approximately 30 feet) should be maintained around sensitive plants.
2) Strict erosion and sediment control measures should be employed during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version).
3) Planting native vegetative seed mixes on disturbed land after construction is complete.
4) Vegetated dune impacts would be mitigated elsewhere with plantings, and would be coordinated with Long Key State Park to complement its proposed planting plan.
5) The following standard BMPs for to prevent the spread of invasive species will be followed:
    a. Prior to the commencement of work, an invasive species prevention plan will be developed. It shall identify specific transfer prevention procedures and equipment cleaning sites.
    b. Sightings of any invasive species shall be included in a preconstruction report. Any subsequent sighting of invasive species shall be reported within 24 hours of siting. The reporting shall include date, time, location (latitude and longitude), photographs, environmental conditions, circumstances surrounding sighting disposition/behavior of the species, and any other notable observations. Reports shall be provided to the Jacksonville District Planning Division, Environmental Branch.
    c. All equipment would be thoroughly cleaned prior to and following work on the project site to ensure that materials including soil, vegetative matter, eggs, seeds, and other debris are not transported to other sites.
    d. Prevention protocols will also apply to clothing and personal protective equipment.

8.11 WETLANDS

8.11.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment, the ROI contains many areas of mangrove and mixed mangrove and buttonwood wetland communities, as well as patches of herbaceous wetlands dominated by sea purslane and sea oxeye further upslope.

Originally, the proposed revetments combined would have impacted over an acre of wetland communities. Mangrove and/or buttonwood wetlands are present in the vicinity of the revetments at the West Summerland Key, Fiesta Key West, Fiesta Key East, and Indian Key Fill. However, recognizing the value of these wetlands, the revetment footprints were shifted upslope. Avoidance and minimization efforts are expected to result in wetland impacts at only one of the revetment locations.

It should be noted that at this early stage, a jurisdictional determination (JD) to identify waters of the U.S., including wetlands, has not been conducted. Instead, wetlands were spot-checked in the field. Aerial maps and National Wetland Inventory (NWI) maps were also checked to determine an estimate. As project plans and impact areas are finalized, a JD will be undertaken pursuant to the 1987 Wetland Delineation Manual and the Atlantic and Gulf Coast Regional Supplement, to ascertain the actual footprint of jurisdictional wetlands impacted by the project. This will be done in the PED phase.

West Summerland Key

Minor, adverse permanent impacts to wetlands will occur as a result of implementation of Alternative 1. An estimated 10,250 square feet of sea purslane and sea oxeye-dominated herbaceous wetland community behind an existing concrete seawall will be displaced for the installation of the revetment. There are also several dead mangrove and/or buttonwood individuals and an estimated 100-200 square feet of live ones in this wetland area. However, these likely can be avoided by designing the revetments to avoid them (Figure 8-1).

Figure 8-1: Wetlands to be impacted at West Summerland Key.

The USACE is required to avoid, minimize, and mitigate impacts to wetlands, pursuant to Section 401 and 404 of the Clean Water Act and 33 C.F.R. 336(c)(4) and 33 C.F.R. 320.4(b) and Executive Order 11990, Protection of Wetlands. The mitigation would be in-kind replacement, near the impact site. The Uniform Mitigation Assessment Methodology (UMAM), is being utilized to determine to wetland mitigation would be required. Mitigation within the watershed, and preferably near the impact, would be completed. The Environmental Mitigation Plan is found in the Environmental Appendix.

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas. Similarly, localized maintenance, as repairs will be needed over time. However, negligible to minor temporary wetland impacts are expected to occur, as it is the intention to utilize nonwetland areas for construction access and staging. If wetland areas are disturbed for access, the areas would be restored after construction.

It can also be expected that due to natural causes such as sea level rise, erosion would continue to occur, and shoreline wetlands could therefore be eroded and/or migrate further inland.

8.11.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Negligible temporary or permanent adverse impacts to wetland resources are expected to result from implementation of Alternative 6 because land disturbance for this alternative would be limited to modification of existing buildings. If acquisition of homes at risk to coastal flooding

occurred, impacts to wetland resources have the potential to be moderately beneficial and permanent, because as structures are demolished, these land area could revert to wetlands.

Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, as repairs will be needed over time.

It can also be expected that due to natural causes such as sea level rise, erosion would continue to occur and shoreline wetlands could therefore be eroded and/or migrate further inland.

8.11.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, because the wetlands impacts will be minimized and mitigated in accordance with the Best Management Practices described in Section 8.11.5, minor, adverse permanent impacts to wetlands would occur as a result of implementation of this alternative. Negligible to minor temporary wetland impacts are expected to occur.

8.11.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action beyond any current or planned future actions to mitigate against coastal storm risk. However, it can be expected that due to natural causes such as sea level rise, erosion would continue to occur, and shoreline wetlands could therefore be eroded and/or migrate further inland.

8.11.5 Best Management Practices to Avoid and Minimize Impacts on Wetlands for Alternative 7

1) Revetments are designed to provide for a one-foot buffer off of any mangrove and/or buttonwood wetlands.
2) Unavoidable wetland impacts will be mitigated according to the UMAM. The Environmental Mitigation Plan is found in the Environmental Appendix.
3) Strict erosion and sediment control measures should be employed during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version), as well as the conditions of any permits issued for the project
4) All wetlands permit conditions will be adhered to.
5) The Standard BMPs for invasive species as described under Section 8.10 will be followed.

8.12 BENTHICS AND SUBMERGED AQUATIC VEGETATION

8.12.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment section of this report, the watershed within the ROI contains benthic habitats that include beaches, sandflats and mudlflats, hardbottom, corals, seagrass beds; and red mangrove habitat.

It was determined that it is practicable to construct the revetment footprints upslope of mean high water and all benthic and SAV habitat. In addition, strict erosion and sediment control measures will be adhered to during construction. Therefore, there will be no effect on these resources.

However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, benthic communities and SAV could become stressed over the next 50 years, as is discussed in the Cumulative Effects section.

8.12.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Because there are no in-water impacts associated with this alternative, it will have no effect on benthic or SAV resources.

However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, benthic communities and SAV could become stressed over the next 50 years, as is discussed in the Cumulative Effects section.

8.12.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are the same as described under Alternatives 1 and 6 above: no effect due to this Alternative, but expected adverse effects due to sea level rise and climate change.

8.12.4 Alternative 8: No Action and Future Without Project

This alternative would have no effect on benthic or SAV resources. However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, benthic communities and SAV could become stressed over the next 50 years, as is discussed later in the Cumulative Effects section.

8.13 FISH AND FISHERY RESOURCES

8.13.1 Alternative 1: Structural Only Alternative (Revetments Only)

Because no subaqueous habitat channelward of MHW will be impacted, and strict erosion and sediment control measures will be adhered to during construction, there will be no effect on fish or fishery resources. However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, fish and fishery resources could become stressed over the next 50 years, as is discussed in the Cumulative Effects section.

8.13.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Because no subaqueous habitat channelward of MHW will be impacted, there will be no effect on fish or fishery resources. However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, fish and fishery resources could become stressed over the next 50 years, as is discussed in the Cumulative Effects section.

8.13.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are the same as described under Alternatives 1 and 6 above: no effect due to this Alternative, but expected adverse effects due to sea level rise and climate change.

8.13.4 Alternative 8: No Action and Future Without Project

This alternative would have no effect on fish or fishery resources. However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, fish and fishery resources could become stressed over the next 50 years.

8.14 THREATENED AND ENDANGERED SPECIES

8.14.1 Alternative 1: Structural Only Alternative (Revetments Only)

The ROI contains nesting, migratory, breeding, foraging, and overwintering habitat for numerous threatened and endangered species. In addition, there are designated critical habitats for the loggerhead sea turtle, the piping plover, the American crocodile, the Cape Sable thoroughwort, the West Indian manatee, staghorn coral and elkhorn coral.

Originally, the proposed revetments combined would have impacted approximately 19 acres (11 temporary and 9 perpetual) of critical habitat for threatened and endangered species and had in water impacts to additional threatened and endangered species within the ROI. These resources and habitats are present in the vicinity of the revetments at all locations. However, recognizing the value of these resources, the revetment footprints were shifted upslope to eliminate in water impacts. Impacts to in water species and critical habitat for West Indian manatee, elkhorn coral, and staghorn coral are no longer expected. With the modifications, the revetments are expected to impact approximately 7.5 acres (5.5 temporary and 2 permanent) total of critical habitat for piping plover, loggerhead sea turtle, American crocodile, and Cape Sable thoroughwort.

West Summerland Key

Minor, adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1. An estimated 660 square feet of land will be modified for the installation of the

revetment. There are no anticipated impacts to critical habitat on West Summerland Key. The Cape Sable thoroughwort was historically found throughout the Keys, however the current range within the ROI is only expected to occur on Long Key (USFWS 2019). Historically, loggerhead sea turtles nested on West Summerland Key in 1991 and 1995. However, there have been no documented nests at the site since 1995. Green, hawksbill, Kemp's ridley, and leatherback sea turtles are not known to nest on West Summerland Key. American crocodiles and alligators may find the habitat suitable for nesting. However, the revetment is proposed behind an existing seawall which would prevent access from potential nesting reptiles. The main impacts expected to occur on West Summerland Key are impacts to migratory birds. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Some impacts to breeding and nesting roseate terns could be mitigated by avoiding construction during nesting season. Revetments have the potential to modify the intertidal feeding areas for various seabirds (Dugan and Hubbard 2006), however, the revetment is proposed behind an existing seawall and no intertidal impacts are expected to occur. The permanent footprint of the revetment would permanently alter the site.

Implementation of Alternative 1 also would require temporary construction access (Figure 8-2). This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. There would also be localized maintenance, as repairs will be needed over time.

Figure 8-2: West Summerland Key revetment location.

Fiesta Key East

Minor, adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1. An estimated 11,700 square feet of land will be modified for the installation of the revetment (Figure 8-3). There will be permanent adverse modifications of up to 0.5 acre and temporary adverse modifications of up to 1.25 acre of American crocodile critical habitat on Fiesta Key East. Historically, loggerhead, green, hawksbill, Kemp's ridley, and leatherback sea turtles are not documented to nest on Fiesta Key East. American crocodiles and alligators may find the habitat suitable for nesting. However, the revetment is proposed behind an existing rip rap revetment which would prevent access from potential nesting reptiles. The main impacts expected to occur on Fiesta Key East are impacts to migratory birds and the permanent alteration of up to 0.5 acre of critical habitat for American crocodile. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Some impacts to breeding and nesting roseate terns could be mitigated by avoiding construction during nesting season. Revetments have the potential to modify the intertidal feeding areas for various seabirds (Dugan and Hubbard 2006), however, the revetment is proposed behind an existing riprap revetment and no intertidal impacts are expected to occur. The permanent footprint of the revetment would permanently alter the site and up to 0.5 acre of American crocodile critical habitat.

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. Similarly, localized maintenance, as repairs will be needed over time.

Figure 8-3: Existing rip rap revetment along Fiesta Key East.

Fiesta Key West

Minor, adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1. An estimated 17,550 square feet of land will be modified for the installation of the revetment. There will be permanent adverse modifications of up to 0.5 acre and temporary adverse modifications of up to 1.0 acre of American crocodile critical habitat on Fiesta Key West. Historically, loggerhead, green, hawksbill, Kemp's ridley, and leatherback sea turtles are not documented to nest on Fiesta Key West. American crocodiles and alligators may find the habitat suitable for nesting. However, the revetment is proposed adjacent to the road and separated from the shoreline by a dense area of vegetation (Figure 8-4). The revetment site is not immediately adjacent or contiguous to waters accessible by American crocodiles or alligators. The main impacts expected to occur on Fiesta Key West are impacts to migratory birds and the permanent alteration of up to 0.5 acre of critical habitat for American crocodile. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Some impacts to breeding and nesting roseate terns could be mitigated by avoiding construction during nesting season. Revetments have the potential to modify the intertidal feeding areas for various seabirds (Dugan and Hubbard 2006). However, the revetment location proposed is not immediately adjacent or contiguous to the shoreline, and no intertidal impacts are expected to occur. The permanent footprint of the revetment would permanently alter the site and up to 0.5 acre of American crocodile critical habitat.

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. Similarly, localized maintenance, as repairs will be needed over time.

Figure 8-4: Area for the revetment adjacent to the road on Fiesta Key West.

Bahia Honda Key

Adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1 (Figure 8-5). An estimated 18,200 square feet of land will be modified for the installation of the revetment. There will be permanent adverse modifications of up to 0.5 acre and temporary adverse modifications of up to 1.0 acre of piping plover critical habitat on Bahia Honda Key. Bahia Honda Key has the largest concentration of loggerhead nests within the ROI. In addition, green, hawksbill, and leatherback sea turtles have historically nested there. Kemp's ridley sea turtles are not known to nest on Bahia Honda Key. American crocodiles and alligators may find the habitat suitable for nesting. However, the revetment is proposed north of an existing fence and campground road maintained by the park service which would prevent access from potential nesting reptiles. Therefore, there are no anticipated effects to reptilian nesting habitat on Bahia Honda Key. The main impacts expected to occur on Bahia Honda Key are impacts to migratory birds, sea turtles, American crocodiles, and alligators. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Construction activities have the potential to disturb nesting sea turtles or crocodilians via visual and auditory disturbances and increased activity within the site. These disturbances could cause a species to temporarily relocate to a different area expending valuable energy. The permanent footprint of the revetment would permanently alter the site and 0.5 acre of piping plover critical habitat.

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. Similarly, localized maintenance, as repairs will be needed over time.

Figure 8-5: Bahia Honda Key site conditions. The revetment is proposed north of the campground road, separating the nesting habitat from the revetment.

Long Key

Adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1. An estimated 15,000 square feet of land will be modified for the installation of the revetment at Long Key. There will be permanent adverse modifications of up to 0.5 acre of American crocodile critical habitat, 0.5 acre of Cape Sable thoroughwort critical habitat, and 0.25 acre of loggerhead sea turtle critical habitat. There will be temporary adverse modifications of up to 1.25 acres of American crocodile critical habitat, 0.75 acre of Cape Sable thoroughwort critical habitat, and 0.25 acre of loggerhead sea turtle critical habitat. Long Key has the second largest concentration of loggerhead sea turtles nests within the ROI. Green, hawksbill, Kemp's ridley, and leatherback sea turtles are not known to nest on Long Key. American crocodiles and alligators may find the habitat suitable for nesting. Long Key is the only known location of the Cape Sable thoroughwort within the ROI. The main impacts expected to occur on Long Key are impacts to nesting loggerhead sea turtles, American crocodiles, alligators, migratory birds, and Cape Sable thoroughwort. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Some impacts to breeding and nesting roseate terns could be mitigated by avoiding construction during nesting season. Revetments have the potential to modify the intertidal feeding areas for various seabirds (Dugan and Hubbard 2006). Construction activities have the potential to disturb nesting loggerhead sea turtles and/or crocodilians via visual and auditory disturbances and increased activity within the site. These disturbances could cause a species to temporarily relocate to a different area expending

valuable energy. The Cape Sable thoroughwort could be trampled, disturbed, or killed by construction and increased human activities. This could be avoided by surveying the project site prior to construction and creating a buffer around Cape Sable thoroughwort. The permanent footprint of the revetment would permanently alter the site, 0.5 acre of American crocodile critical habitat, 0.5 acre of Cape Sable thoroughwort critical habitat, and 0.25 acre of loggerhead sea turtle critical habitat

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. Similarly, localized maintenance, as repairs will be needed over time.

Indian Key Fill

Minor, adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1. An estimated 8,400 square feet of land will be modified for the installation of the revetment at Indian Key Fill. There will be permanent adverse modifications of up to 0.25 acre and temporary adverse modifications of up to 1.0 acre of American crocodile critical habitat on Indian Key Fill. Historically, loggerhead, green, hawksbill, Kemp's ridley, and leatherback sea turtles are not documented to nest on Indian Key Fill. American crocodiles and alligators may find the habitat suitable for nesting. However, the revetment is proposed behind an existing seawall which would prevent coastal access to the site by reptiles. The revetment site is not immediately adjacent or contiguous to waters accessible by American crocodiles or alligators. The main impacts expected to occur on Indian Key Fill are impacts to migratory birds and the permanent alteration of up to 0.25 acre of critical habitat for American crocodile. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Some impacts to breeding and nesting roseate terns could be mitigated by avoiding construction during nesting season. Revetments have the potential to modify the intertidal feeding areas for various seabirds (Dugan and Hubbard 2006) (Figure 8-6). However, the revetment location proposed behind an existing seawall, and no intertidal impacts are expected to occur. The permanent footprint of the revetment would permanently alter the site and up to 0.25 acre of American crocodile critical habitat.

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. Similarly, localized maintenance, as repairs will be needed over time.

Figure 8-6: Existing sea wall along Indian Key Fill.

8.14.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Negligible temporary or permanent adverse impacts to threatened and endangered species are expected to result from implementation of Alternative 6, because land disturbance for this alternative would be limited to modification of existing buildings. If acquisition of homes at risk to coastal flooding occurred, impacts to threatened and endangered species and critical habitats have the potential to be moderately beneficial and permanent, because as structures are demolished, these land area could revert to foraging and overwintering habitat for various species.

Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, as repairs will be needed over time.

8.14.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The effects of this alternative would be a combination of those listed above under Alternatives 1 and 6. The following Table 8-2, Species Conclusion Summary Table, summarizes these effects.

Table 8-2: Species Summary Conclusion Table

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
Piping Plover, Red Knot, Roseate Tern	May Affect, Likely to Adversely Affect	Construction may impact prey species, will alter habitat and may cause species to leave the action area from the visual disturbances, auditory disturbances, and increased human activity.
Piping Plover Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.5 acres of designated Critical Habitat and could impact prey species and foraging habitat. The revetments would adversely modify designated critical habitat. However, this is a very small percentage considering that almost the entire Bahia Honda Key is designated Critical Habitat.
Nassau Grouper, Smalltooth Sawfish, Oceanic Whitetip Shark, Giant Manta Ray	No Effect	There are no in water impacts associated with this project.
Pillar Coral, Rough Cactus Coral, Lobed Star Coral, Boulder Star Coral, Mountainous Star Coral. Elkhorn Coral, Staghorn Coral	No Effect	There are no in water impacts associated with this project.
Elkhorn Coral, Staghorn Coral Designated Critical Habitat	No Effect	There are no in water impacts associated with this project.
West Indian Manatee	No Effect	There are no in water impacts associated with this project.
American Alligator and American Crocodile	May Affect, Not Likely to Adversely Affect	Construction may disturb species due to temporary increases in human disturbance including auditory and visual disturbances during construction. The revetments would temporarily and permanently alter designated critical habitat. However, existing sea walls, revetments, and vegetation block access to Fiesta Key East and West and Indian Key Fill, creating limited access to these areas. In addition, the 2014 USFWS notes that crocodiles are uncommon south of Key

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
		Largo. Using the guidance from this letter, it is anticipated the impacts will be insignificant.
American Crocodile Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 1.5 acres of designated critical habitat, however, 1.0 of those acres are not accessible to crocodiles due to existing sea walls and rip rap revetments. The remaining 0.5 acre is at the southernmost extent of the range in the Florida Keys and occurrence is uncommon.
Kemp's ridley sea turtle	No Effect	Kemp's ridley sea turtles do not nest within the action area. Kemp's ridley sea turtles do not have critical habitat within the action area. There are no in water impacts associated with this project.
Green Sea Turtle, Hawksbill Sea Turtle, Leatherback Sea Turtle	May Affect, Not Likely to Adversely Affect	Green, Hawksbill, and Leatherback sea turtles rarely nest on Bahia Honda Key within the action area. The revetment on Bahia Honda Key will be north of an existing fence and campground road. The nesting area is south of the existing fence and campground road on Bahia Honda Key. Impacts to green, hawksbill, and leatherback sea turtles will be temporary and insignificant. There are no in water impacts associated with this project.
Loggerhead Sea Turtle	May Affect, Likely to Adversely Affect	Within the action area, Loggerhead sea turtles nest on Bahia Honda and Long Key. Historically, nests were also documented on West Summerland Key in the 90's. The revetment on Long Key will block access to nesting habitat. The revetment on Bahia Honda Key will be north of an existing fence and campground road. The nesting area is south of the existing fence and campground road, so impacts to nesting turtles are not anticipated on Bahia Honda Key.
Loggerhead Sea Turtle Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.25 acres of designated critical habitat and could impact nesting habitat on Long Key. The revetments would adversely modify designated critical habitat.
Cape Sable Thoroughwort	May Affect, Likely to Adversely Affect	Construction and human activities could disturb or trample plant. Construction of a revetment would permanently alter up to 0.5 acre of designated critical habitat.
Cape Sable Thoroughwort Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.5 acre of designated critical habitat. The revetments would adversely modify designated critical habitat.

There will be no effects to species under the purview of the NOAA PRD, as no structures or construction would be in the water. The Biological Assessment with these described effects is being submitted to USFWS.

8.14.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent impacts to threatened and endangered species or critical habitat would occur.

8.14.5 Best Management Practices to Avoid and Minimize Impacts on Threatened and Endangered Species for Alternative 7

1) All Reasonable and Prudent Measures as determined by USFWS at the conclusion of formal Section 7 ESA Coordination will be followed.
2) Construction schedules should avoid the most productive biological seasons, typically the nesting season for sea turtles, crocodiles, shorebirds and waterbirds but in some areas also may include migration or overwintering periods where fauna are present in high concentrations.
3) Buffers of 100 meters should be maintained around wading bird colonies, 200 meters around mixed tern/skimmer colonies, and 100 - 200 meters around solitary bird nests and larger for species with chicks. Buffers of at least ten meters should be maintained around sensitive plants.
4) Strict erosion and sediment control measures should be employed 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.
5) Surveys for protected species should be conducted prior to construction.
6) Biological resources should be monitored and/or surveyed during and throughout construction.

8.15 WILDLIFE

8.15.1 Alternative 1: Structural Only Alternative (Revetments Only)

This section is intended to focus on more common wetland and terrestrial wildlife species. Threatened and endangered species and migratory birds were discussed in the special status species section; and aquatic species were discussed in the fisheries and benthics sections.

With the exception of Long Key, the six proposed locations for the revetments currently provide limited habitat and/or foraging quality for wildlife.

West Summerland Key

This revetment includes approximately 10,725 square feet of wetland impacts. However, these are not high-quality wetlands; they are almost entirely herbaceous wetlands behind a seawall, cut off from the waterway.

Bahia Honda Key

In order to avoid beach impacts, the Bahia Honda Key revetment was originally planned along the beach, but was shifted upslope to a grassed and tree line area between the park fence line and U.S. Route 1 and the Overseas Trail. With this close proximity of these revetments to roadway noise as well as the danger of vehicle strike, as well as lack of vegetative community, they likely already have limited use by wildlife. The temporary construction staging area will be located on open uplands elsewhere, away from the beach, in an area that is not likely good habitat for wildlife.

Fiesta Key East, and Indian Key Fill

These proposed revetment locations are on eroded slopes adjacent to roadway and trail shoulders. With this close proximity of these revetments to roadway noise as well as the danger of vehicle strike, as well as lack of vegetative community, they likely already have limited use by wildlife.

Fiesta Key West

This proposed revetment is also immediately adjacent to the road and trail, is in very close proximity to mangrove and buttonwood mixed wetlands immediately downslope. However; these areas will not be permanently impacted. There would be temporary adverse effects on wildlife, as wildlife would likely avoid the mangrove area due to noise and disturbance during construction.

Long Key

The proposed Long Key revetment location is along the beach. Wildlife, and in particular foraging birds, will likely be displaced by the revetment location at Long Key. The special status species section describes the nesting, migratory, breeding, foraging, and overwintering habitat for numerous bird and turtle species. An estimated 15,000 square feet of land will be permanently modified for the installation of the revetment and much of this area is vegetated with herbaceous and scrubby shoreline species. The wrackline debris would also be displaced. There will be approximately 1.25 acres of temporary impacts for staging and construction access adjacent to the work area in the campground road, which would be restored following construction.

As mentioned earlier, FDEP's DPR expressed concerns about these wildlife impacts in their comments to USACE. USACE is aware that Long Key State Park is preparing a planting plan for this area. If agreeable to the park, its planting plan could be supplemented with a USACE upland dune vegetation mitigation plan to replace the impacted dune vegetation. This will likely take place within the state park, in an area the park deems ideal.

This Alternative would result in both indirect and direct, temporary and permanent, adverse impacts on wildlife. These impacts include disturbance from the permanent alteration of habitat and foraging area by the revetment footprint. Temporary construction access, grading activities, temporary stockpiling of rock would also occur in foraging areas. Similarly, localized maintenance, as repairs will be needed over time. The effects can be considered minor to

moderate, but not significant, because the noise and construction activity would be temporary. Also, suitable beach foraging areas will remain outside of the revetment footprint and area to be affected by construction noise and disturbance. Best management practices would be followed.

8.15.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Negligible temporary or permanent adverse impacts to wildlife species are expected to result from implementation of Alternative 6, because land disturbance for this alternative would be limited to modification of existing buildings. Animal species would likely avoid the area during construction. However, if acquisition of homes at risk to coastal flooding occurred, impacts to wildlife species have the potential to be moderately beneficial and permanent, because as structures are demolished, these land area could revert to habitat for various species. Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, as repairs will be needed over time.

8.15.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are the same as described under Alternatives 1 and 6 above. This Alternative would result in both indirect and direct, temporary and permanent, adverse impacts on wildlife. These impacts include disturbance from the permanent alteration of habitat and foraging area by the revetment footprint. Temporary construction access, grading activities, temporary stockpiling of rock would also occur in foraging areas. Similarly, localized maintenance, as repairs will be needed over time. The effects can be considered minor to moderate, but not significant, because the noise and construction activity would be temporary. Also, suitable beach foraging areas will remain outside of the revetment footprint and area to be affected by construction noise and disturbance. If acquisition of homes at risk to coastal flooding occurred, impacts to wildlife species have the potential to be moderately beneficial and permanent, because as structures are demolished, these land area could revert to habitat for various species. Best management practices described in Section 8.15.5 of this report would be followed.

8.15.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action to mitigate against coastal storm risk. No temporary or permanent adverse impacts to wildlife species would occur. Wildlife could continue to use the area for foraging.

8.15.5 Best Management Practices to Avoid and Minimize Impacts on Wildlife for Alternative 7

1) If practicable, construction schedules should avoid the most productive biological seasons for shorebirds and waterbirds but in some areas also may include migration or overwintering periods where fauna are present in high concentrations.
2) The Proposed Action shall adhere to the following standard Jacksonville District BMPs for migratory and shorebirds.
    a. All construction personnel shall 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.

b. Construction activities will be under surveillance, management, and control to prevent impacts to migratory birds and their nests.
c. A qualified bird monitor shall be present and shall 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, and must possess qualifications that include, but are not limited to: identifying bird species, nesting behavior, eggs and nests, and habitat requirements. He or she must also be familiar with state requirements and reporting procedures.
e. The bird monitor shall 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, shall be created and marked with signs to avoid entry.

3) Buffers of at least ten meters (30 feet) should be maintained around sensitive plants.
4) Strict erosion and sediment control measures should be employed 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.
5) Planting native vegetative seed mixes on disturbed land after construction is complete.
6) Vegetated dune impacts would be mitigated with a planting plan that complements the Park's, at a location agreeable to the Park. A draft planting plan is included in the Environmental Mitigation Plan found in the Environmental Appendix, Appendix D.

8.16 CULTURAL RESOURCES

Cultural Resource correspondence and other documents associated with this section can be found in Appendix E.

8.16.1 Alternative 1: Structural Only Alternative (Revetments Only)

Most of the proposed revetments are on artificial landforms and have had prior survey. Two recorded sites are within project areas, both dating to the first half of the 20th century. Site MO01473, Long Key Siding, is a railroad bed and was evaluated as not NRHP eligible. The revetment Area of Potential Effect NRHP (APE) on Long Key would impact the site. The other site is MO02117, a 20th century trash dump in the APE of a proposed construction yard area on Bahia Honda Key. The NRHP eligibility of this site has not been determined.

8.16.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

No infrastructure facilities in the Keys have been identified as NRHP eligible, so their modifications would not cause adverse effects to historic properties. However where measures may cause ground disturbance, archaeological survey would be needed.

In residential areas nonstructural measures would cause significant impacts to any NRHP eligible buildings, these impacts would be primarily in the NRHP listed Key West Historic District. The most severe adverse effects would be from acquisition/demolition. Elevating any NRHP eligible structure would be an adverse effect, but some designs are less so than others. Elevations may cause adverse visual effects to a historic district. Floodproofing may be adverse, or non-adverse. Dry floodproofing designs which require windows and doors to be sealed would cause adverse effects.

8.16.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The effects of this alternative would be a combination of those listed above under Alternatives 1 and 6. There would be a potentially significant permanent adverse effects for any demolition or modification on historic resources and/or historic districts. A Draft Programmatic Agreement (PA) has been prepared in consultation with the Florida State Historic Preservation Office, stipulating to the completion of all surveys and procedures for mitigating adverse effects to historic properties. It is found in the Cultural Resources Appendix, Appendix E.

8.16.4 Alternative 8: No Action and Future Without Project

The No Action Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. Historic buildings would continue to be exposed to flood risk, which can be expected to increase with climate change.

8.16.5 Best Management Practices to Avoid and Minimize Impacts on Cultural Resources for Alternative 7

1) Avoid buyout and demolition of properties contributing to the Key West Historic District.
2) Employ distinct but compatible designs when elevating historic buildings.
3) Conduct archaeological surveys where ground disturbance may occur.
4) Adhere to the requirements of the PA, once finalized, including all required mitigation.

8.17 RECREATION

8.17.1 Alternative 1: Structural Only Alternative (Revetments Only)

This alternative potentially affects four recreational facilities: the U.S. Route 1 Overseas Trail, Bahia Honda State Park, Long Key State Park, and a public pier at Fiesta Key.

Overseas Trail

The Overseas Trail, which parallels U.S. Route 1, has been damaged and some sections have been unusable since Hurricane Irma in September 2017. The trail is in close proximity to all of

the revetments except for the one in Long Key State Park. As mentioned earlier, FDOT's plans to repair the trail sections at West Summerland Key, Fiesta Key East and Fiesta Key West are expected to occur prior to the implementation of this project. The proposed revetments cannot permanently displace any sections of the trail, and therefore would have no direct, permanent adverse impact on the Overseas Trail itself. However, sections of the trail will likely have to be closed during the construction window at these three locations, which is expected to take approximately four to five months at each location. However, trail users could divert around the construction and use open sections of the trail. Once construction is complete, the revetments would provide added permanent erosion protection for the trails and the roadway itself. For the locations where the revetments are within the Florida DPR trail property, a permit would be required from the DPR for the permanent riprap encroachment.

Bahia Honda State Park

Florida DPR submitted a comment memo to the USACE indicating that DPR prefers no hardened structures in the Park, and instead suggested raising the campground roadway. As an alternative, USACE determined that there was enough space to move the revetment upslope of the campground road, and directly adjacent to the Overseas Trail, outside of the Park fence. With this shift, and with the temporary construction staging area also outside of the Park boundaries, the revetment will no longer have directly or indirect adverse effects on this Park.

Long Key State Park

The proposed revetment, estimated to be approximately 1,500 linear feet, is planned on a very narrow vegetated beach, upslope of MHW and parallel to the Park's campground access road. The beach itself is too narrow to provide areas for sunbathing use; however, there a few scattered picnic tables upslope of the beach. The beach and shallow water is usable for wading, swimming, walking, bird watching, and other passive uses, though there are other sections of beach that are more conducive for public use.

The DPR, in its comment memo, stated the following:

"DPR does have concerns with the preliminary plans at this Park. DPR has contractors in the permitting phase of installation of a visitor restroom in the area between US1 and the park drive, which is directly adjacent to the area proposed for shoreline stabilization. Construction/installation is slated to begin in spring 2020 and the project should take approximately six months after permit approval. Additionally, the Park's campground rebuilding design is nearing completion and this area is not compatible with shoreline armoring. DPR has plans to stabilize the area with a natural shoreline."

Because the proposed revetment would not go to construction in the near future, it would not conflict with the DPR's construction schedule for the restroom. In addition, the revetment conceptual plan could be further refined during the PED phase to be compatible and complementary to the campground rebuilding design, and/or to avoid impacting any plantings that the DPR installs.

However, installing a permanent revetment at this location would have a temporary and permanent direct and indirect adverse effect on this Park. Areas that are currently open for wading, swimming, walking, bird watching, and other passive uses would have more limited access with a permanent revetment structure in place. In addition, construction staging area stretches across the Park access roadway, which would require its temporary closure for four to five months. This would be a direct, temporary moderate impact, and a direct, permanent moderate impact on Long Key State Park. A DPR permit would be required for the temporary and permanent revetment encroachment.

Public Pier at Fiesta Key East

Between mile markers 70 and 71, across U.S. Route 1 from the Fiesta Key East revetment, there is a long public pier. Once a bridge trestle for U.S. Route 1, it now parallels U.S. Route 1 to the north. The pier is used mostly for fishing, but also sightseeing, photography, bird watching, walking, and other passive uses. There is a large public parking area adjacent to it, and this area would be used for construction staging. There would be no indirect or direct permanent impact on recreation here, because the area where the revetment itself will be placed is not used for recreation. However, construction would require the temporary closure of the pier for approximately four to five months. There is no other such pier nearby for use as an alternative; therefore, this would have a direct, temporary minor to moderate effect on recreation.

Indian Key Fill

This location, while not a “facility,” is owned by both DPR and FDOT and used by the public for recreation. As one of the few locations on the Keys where visitors can park and obtain free access to the water, the Indian Key Fill islands serve as gathering places for visitors wanting to spend leisure time near the water, wade, swim, fish, or put canoes or kayaks in the water. At least a portion of this upland area would have to be closed to the public temporarily during construction for safety. There are two other sections of Indian Key Fill to the southwest of this location that are similarly used for public recreation, and the public could still use those during construction. This alternative would have a direct and indirect, minor temporary impact on recreation. However, the embankment itself is not conducive to recreational use, so the revetment would have no direct or indirect permanent adverse effect on recreation.

For this alternative, there would be no temporary or permanent in-water impacts. Therefore, there would be no permanent adverse impacts on recreational navigation. Construction access and staging would occur from the land side rather than from the water. There are no public boating launches, aids to navigation, or buoys located in the near vicinity of any of the proposed revetments or staging areas; however, there are nearshore areas where navigation access for small craft such as canoes or kayaks could occur, and it is possible that some people may access the water directly off the shorelines.

Overall, Alternative 1 would have direct and indirect temporary and permanent impacts on recreation that are minor to moderate. In addition, recreational activities could be impacted by natural causes such as sea level rise and increased future storms. These could cause future

damage to recreational areas such as beaches, the Overseas Trail, State Parks, etc., as is discussed in the Cumulative Effects section of this report.

8.17.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves construction on existing upland structures, demolition of structures to be acquired, and construction access and staging for both. Construction staging areas would be directly collocated with the affected structures.

Elevation and acquisition of structures would apply only to residences, and would therefore have no temporary or permanent effect on recreation.

No known recreational facilities would be affected directly or indirectly by this alternative. However if they are, they will be compensated and/or relocated; and would be at least temporarily closed during construction or relocation.

For these reasons, this alternative could have a direct, negligible to minor, temporary adverse effect on recreation and a negligible to minor permanent adverse effect on recreation. In addition, recreational activities could be impacted by natural causes such as sea level rise and increased future storms. These could cause future damage to recreational areas such as beaches, the Overseas Trail, State Parks, etc., as is discussed in the Cumulative Effects section of this report.

8.17.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, this alternative would have direct and indirect temporary and permanent impacts on recreation that are minor to moderate. In addition, recreational activities could be impacted by natural causes such as sea level rise and increased future storms. These could cause future damage to recreational areas such as beaches, the Overseas Trail, State Parks, etc., as is discussed in the Cumulative Effects section of this report.

8.17.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. In addition, recreational activities could be impacted by natural causes such as sea level rise and increased future storms. These could cause future damage to recreational areas such as beaches, the Overseas Trail, State Parks, etc., limiting recreational activities.

8.17.5 Best Management Practices to Avoid and Minimize Impacts on Recreation for Alternative 7

1) For recreational safety, the shoreline areas that are under construction and their staging areas will be closed to the public.
2) Staging areas will be the minimum necessary to construct the project, and construction will be completed as soon as practicable.

3) Further coordination will be conducted with DPR in the PED phase, to avoid and minimize conflicts with the park and Overseas Trail operations. All required permits would be obtained.
4) The timing of the work will be coordinated with the County and FDOT to avoid and minimize conflicts with planned or ongoing County projects.

8.18 AESTHETICS

8.18.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment, the ROI is characterized by beautiful vistas of the water and wetlands, as well as views of the U.S. Route 1 Overseas Highway and Trail. As the only highway in Florida to be recognized as an “All-American Road” by the National Scenic Byways Program of the Department of Transportation’s Federal Highway Administration, overall viewsheds from both the Overseas Highway and the Trail are a unique part of the Florida Keys. During the scoping process, commenters stated verbally and in writing that they did not want unattractive structures installed.

The viewshed in the vicinity of each of the six revetment locations varies, but all revetment locations are within 100 feet of the Overseas Highway and Trail. Mangrove and/or buttonwood wetlands are present in the vicinity of the revetments at the West Summerland Key, Fiesta Key West, Fiesta Key East, and Indian Key Fill (Figure 8-7). However, recognizing impact on wetlands and aesthetics and wetlands, the revetment footprints were shifted upslope to avoid these areas.

Figure 8-7: West Summerland Key impact area (l). Long Key impact area (r).

All six of the proposed revetments would likely be visible from the Overseas Highway and Trail. At West Summerland Key, an herbaceous wetland would be replaced with approximately 750 linear feet of revetment adjacent to the Overseas Trail, which will itself need to be repaired and stabilized by FDOT. This Key is one of the less developed and more naturalized areas, so the revetment would be somewhat visually intrusive. Along Bahia Honda State Park, the revetment was relocated further upslope adjacent to the roadway and trail and away from the beach, thereby reducing the aesthetic impacts within the park itself. This would require removal of a portion of a tree line; however this would be outside of the park limits. At Long Key, the revetment would be along a beach where currently remnants of an old riprap structure remain. The new revetment will be approximately 1,000 feet long and approximately 15 feet wide. It would replace the old revetment; however, approximately half of the revetment would extend into areas that are not currently riprapped. The area is mostly naturalized and enjoyed by visitors, however; and new riprap would be an intrusive view. This is also an area where the Park has conceptual plans for shoreline planting; therefore, the new revetment structure would need to avoid plantings as practicable. At Fiesta Key West, approximately 1,350 linear feet of revetment would be placed immediately adjacent to the Overseas Trail. Minor tree removal may be needed there, but the revetment will be placed upslope of the existing mature mangroves. FDOT will also repair the damaged Overseas Trail and stabilize the slope at this location. At Fiesta Key East, there is already an extensive riprap revetment in place; the new revetment would be added to that and would be in keeping with this view. At Indian Key, approximately 400 linear feet of revetment would be placed on a sloped embankment immediately adjacent to the roadway and trail, which already contains some rock. This is an open area, and it is also in the vicinity of areas used by visitors, so it would be visible from the roadway, trail and the open space area itself (Figure 8-8).

Figure 8-8: Fiesta Key East impact area (l). Indian Key Fill impact area (r).

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas. During these times, heavy equipment would be visible for approximately four to five months at each location, in order to construct the riprap revetment. Similarly, localized maintenance, as repairs will be needed from time to time, for a lesser period of time.

Revetments are not commonly visible in the Keys; however they do exist. Revetments in the six proposed locations would not degrade the overall viewshed of the ROI. Overall, this alternative would have temporary and permanent minor adverse effects on aesthetics within the ROI.

8.18.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Land disturbance for this alternative would be limited to modification of existing buildings. Structures that will be elevated would remain similar in appearance, except that they could be seen from further distances. If acquisition of homes at risk to coastal flooding occurred, impacts to aesthetics have the potential to be either moderately beneficial or adverse and permanent, depending upon the perspective of the viewer and the attractiveness of the particular structure. As structures are demolished, these land areas would have a more naturalized view as they revert to wetlands or natural upland areas.

Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, as repairs will be needed over time. During those timeframes only, construction vehicles would be visible.

Minor temporary and permanent adverse impacts to aesthetics are expected to result from implementation of Alternative 6.

8.18.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, this alternative would have direct, minor, temporary and permanent adverse effects on aesthetics.

8.18.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent impacts to aesthetics would occur.

8.18.5 Best Management Practices to Avoid and Minimize Impacts on Aesthetics for Alternative 7

1) Revetment footprints have been reduced to avoid impacting existing woody vegetation to the extent practicable.
2) The minimum necessary vegetation will be removed for construction access.
3) After construction is complete, temporarily disturbed areas will be seeded and stabilized.

8.19 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)

8.19.1 Alternative 1: Structural Only Alternative (Revetments Only)

The ROI currently consists of roadside embankments along or near the Overseas Highway and Trail. Implementation of this alternative would include temporary and permanent land disturbance. However, no known industrial activities produce hazardous, toxic, and/or radioactive wastes adjacent to the project site; no known industrial activities discharge effluents near the shoreline; and no known records of such past activities exist. There also was no evidence noted of any of these contaminants during a site visit in December 2019. Therefore, no temporary or permanent adverse effects caused by HRTW would be expected to occur as a result of implementing this alternative.

8.19.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves disturbance to existing structures of varying ages; therefore, the potential exists for some structures to contain lead-based pain (LBP), asbestos containing materials (ACM), or polychlorinated biphenols (PCBs). As a result, a Phase 1 Environmental Site Assessment should be conducted for any affected structure constructed prior to 1978. If any such contaminants are found, the construction contract must include procedures for the lawful demolition, removal, and disposal of such wastes. With this stipulation, there would be negligible adverse permanent and minor adverse temporary impacts on HRTW.

8.19.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, with adherence to the Best Management Practices in Section 8.19.5, this alternative could have direct, but temporary and minor effects on HRTW. For either alternative, or for this combined alternative, a potential for hydrocarbon spills exists with dredging and construction equipment in the area, but accident and spill prevention plans specified in the contract specifications should prevent most spills. The construction contract would include requirements to properly manage, store, and dispose of all fuels and materials generated by or used for the project.

8.19.4 Alternative 8: No Action/Future Without Project

The No Action Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent impacts to HRTW would occur.

8.19.5 Best Management Practices to Avoid and Minimize Impacts on HRTW for Alternative 7

1) A Phase 1 Environmental Site Assessment is recommended for any structure to be disturbed that is older than 1978, to check for ACM, LBP, and PCBs.
2) If HRTW materials are found, the project specifications will include procedures that require that they be handled and disposed of in a lawful manner.
3) If HRTW materials are found, coordination will occur with the FDEP's Waste Division will occur.
4) The project specifications should include a fuel spill contingency plan.

8.20 SAFETY

8.20.1 Alternative 1: Structural Only Alternative (Revetments Only)

For this alternative, the identified locations along U.S. Route 1 that have less than 100 feet of land between the road footprint and the shoreline, and are not already being stabilized by others, will be stabilized with revetments. During construction, if all safety regulations are followed, there would be negligible temporary adverse effects on safety for construction workers and the public. There would be permanent direct and indirect beneficial effects for safety, through the protection from erosional damage due to coastal storms and SLR of vulnerable sections of U.S. Route 1, which is the only land evacuation route from the Keys.

8.20.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves temporary construction on existing structures, demolition of structures to be acquired, and construction access for both. During construction, if all safety regulations are followed, there would be negligible temporary adverse effects on safety.

There would be permanent direct and indirect beneficial effects for safety as a result of this alternative. Elevation and dry floodproofing both aid in adaptation of structures to SLR due to climate change. Acquisition and demolition will eliminate buildings that are expected to sustain significant damage from future storms and relocate residents to higher ground. In addition, the resulting open space could also help absorb coastal storm floodwaters and SLR and potentially help reduce flooding and unsafe conditions elsewhere. Flood warning systems and emergency planning would also help residents make preparations to prevent damage, and/or evacuate more effectively, orderly, and safely, reducing direct impacts on residents and businesses. Land use planning would also reduce impacts by reducing the future number of citizens located in areas most vulnerable to damage.

8.20.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. With best management practices, there would be negligible temporary adverse effects on safety, and there would be permanent direct and indirect beneficial effects for safety.

8.20.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would mean not implementing a build alternative. No temporary or permanent impacts to safety would occur, due to any build alternative. However, the Keys are located in a low-lying region, which makes them vulnerable to increased frequency of unsafe flooding conditions and damage. This can lead to various potentially dangerous conditions such as flooded or damaged evacuation route, stranded residents, power outages, and damaged buildings.

8.20.5 Best Management Practices to Avoid and Minimize Impacts on Safety for Alternative 7

1) Construction workers would be required to follow the Occupational Safety and Health Act (OSHA) regulations
2) Public access would be prohibited in construction zones
3) Construction schedules would be coordinated with the County and the Parks to prevent conflicts with other construction schedules.

8.21 UTILITIES

8.21.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment, the ROI includes all utilities within the Study Area in Monroe County that have the potential to be impacted. The major utilities within the Study Area include: buried potable, wastewater, and stormwater infrastructure, and buried and aboveground power transmission lines. Other underground telecommunication lines are also present within the Study Area.

There are existing underground utilities, including private telecommunication lines and a water transmission main located within portions of the FDOT right-of-way adjacent to U.S. Route 1 throughout Monroe County; however, there are no above ground utilities occurring in the proposed footprint of the six revetments. Construction of the six revetments would not directly impact any existing above-ground public or private utilities. Local investigations would be required to determine the exact location of buried utilities and their proximity to the revetment footprints. Utility impacts would be thoroughly vetted as the design process continues. Coordination would occur with the local utility companies including telecommunication providers (such as AT&T and Verizon) and the Florida Keys Aqueduct Authority to determine what action, if any, would be needed. At this time, utility relocation is not anticipated; however, if relocation was determined necessary in the future, it would represent a permanent, negligible to minor impact.

8.21.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

There would be minor, temporary to permanent impacts to utility infrastructure with implementation of Alternative 6. Implementation of measures such as elevation and dry floodproofing would likely require local investigations for existing utilities such as service lines to individual buildings for water, sewage, and power. There is the potential that smaller electrical components might require elevation (i.e. generator, air conditioning units, etc.) in conjunction with the floodproofing activities.

As the study progresses, if it is determined that the acquisition of any residential properties within the ROI is deemed necessary for those properties at the greatest risk of coastal flooding within the defined area of the floodplain, there would be associated construction activities during demolition and subsequent construction activities for the parcel (for example, restoration to a green space and/or conversion to a park). There would be temporary and minor impacts to utilities during demolition and proposed conversion of the parcels.

8.21.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The effects of this alternative would be a combination of those listed above for Alternatives 1 and 6. Utility impacts would be direct, minor and temporary to permanent with the implementation of both nonstructural and structural measures.

8.21.4 Alternative 8: No Action and Future Without Project

Coastal storms would continue to pose a potential threat to utility infrastructure in the future; consequently, existing public and private utilities would need to be repaired, upgraded, or relocated as needed.

8.21.5 Best Management Practices to Avoid and Minimize Impacts on Utilities for Alternative 7

Avoidance and minimization measures will be employed to the maximum extent practicable for all potential utility impacts. Practicable is defined as meaning the alternative is available and capable of being done after taking into consideration cost, existing technology, and/or logistics

in light of the overall project purpose(s). Specific examples of best management practices to avoid and minimize impacts on utilities include:

1) Once final revetment alignments and laydown areas are confirmed a detailed survey and coordinated effort with local utility companies would take place to accurately document the location of existing utilities
2) To ensure public safety, construction activities would safeguard against any temporarily exposed or relocated utility features, as necessary.
3) Potential impacts to both the general public in regard to service interruptions and to the utility providers in regard to utility relocations would be minimized to the maximum extent practicable.

8.22 AIR QUALITY

8.22.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment, the ROI for air quality is Monroe County, Florida, which comprises all of The Florida Keys – from Key Largo south to Key West. Monroe County is currently in attainment for all NAAQS criteria pollutants; therefore, the EPA's general conformity rule to implement Section 176(c) of the CAA does not apply and a conformity analysis is not required.

Direct air emissions would occur from the use of construction equipment such as excavators, dump trucks, and other motor vehicles during transportation of materials to the project site and construction of the six revetments resulting in negligible, temporary impacts to air quality. However, emissions would be localized and expected to disperse quickly.

Florida DEP regulates HAPs in accordance with the National Emissions Standards for Hazardous Air Pollutants (NESHAP), and permits are required for operations subject to applicable regulations or that emit air pollutants in sufficient quantities to warrant regulation. No air quality permits would be anticipated for the use of mobile construction equipment for construction of the six revetments.

8.22.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Air quality impacts resulting from implementation of Alternative 6 would be similar to Alternative 1 and would occur from the use of construction equipment necessary to elevate or demolish existing structures, as determined necessary. Impacts to air quality resulting from construction equipment emissions would be negligible and temporary.

8.22.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The effects of this alternative would be a combination of those listed above under Alternatives 1 and 6. Emissions from construction equipment for revetment construction or structure elevation or demolition would be localized and expected to disperse quickly. Additionally, project implementation would occur over a period of months to years and would not result in impacts

that could be meaningfully measured. Overall the effects would be expected to be direct, temporary, and minor.

8.22.4 Alternative 8: No Action and Future Without Project

No impacts to air quality would occur with implementation of the No Action and Future Without Project Alternative.

8.22.5 Best Management Practices to Avoid and Minimize Impacts on Air Quality for Alternative 7

1) No unnecessary idling of trucks or other equipment shall occur when not in use during construction.
2) Fugitive dust must be kept to a minimum. Dust minimization measures would be implemented as needed.
3) Spilled or tracked dirt or other materials must be removed promptly from pavement.

8.23 NOISE

8.23.1 Alternative 1: Structural Only Alternative (Revetments Only)

The ROI currently is subject to ambient traffic noise of the Overseas Highway and Trail that is permanent but varies throughout the day and night. All of the constructed revetments would be within 100 feet of this corridor.

Alternative 1 would have no permanent direct or indirect adverse effect on noise. However, there would be minor temporary adverse effects on noise during construction, due to backhoes, excavators, trucks, and other heavy equipment working in the vicinity of the revetment locations, as well as entering and exiting the highway.

The following are typical noise levels of construction equipment:

- Backhoe (maximum noise level: 80.0 dBA10)
- Compactor (maximum noise level: 80.0 dBA)
- Bulldozer (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)
  (USDOT, 2006)

Passive recreational use of the two state parks, Bahia Honda and Long Key, as well as Indian Key Fill, are the only noise-sensitive land uses within the ROI; no residences, schools, churches, businesses are present. The construction in the vicinity of Bahia Honda State Park would be outside of the park fence and much closer to U.S. Route 1 than construction at Long Key; therefore, the temporary effects on Long Key State Park would be more pronounced than those at Bahia Honda State Park. Because both are passive use parks, construction noise would impact such uses as camping, wading, hiking, canoeing, bird and wildlife watching, etc. Indian Key Fill also is used by visitors for similar passive uses such as wading, gatherings,

canoeing, and boating, therefore, effects would be similar. However, for safety reasons, visitor access and use will also be restricted around the construction zones, and possibly certain sections of the parks and Indian Key Fill may need to be closed off entirely. Therefore, the noise would occur when no or fewer people were in the vicinity.

Overall, this Alternative will have temporary, minor to moderate adverse effects, during construction only. Construction is expected to take between four to five months at each location. Noise levels would be subject to local noise ordinance requirements. Construction would be expected to take place only during normal business hours and not occur at night, early mornings, or on Sundays.

Sound can be abated by vegetation and objects (including buildings) that are between the location and a direct line-of-sight of the construction. Therefore, the mangrove and/or buttonwood wetlands that are currently present along the shorelines will remain in the vicinity of the revetments at the West Summerland Key, Fiesta Key West, Fiesta Key East, and Indian Key Fill may help to buffer noise effects from those using the waterways.

8.23.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 would have no permanent, direct or indirect adverse noise effects. However, minor to moderate temporary adverse noise effects are expected to result from implementation of Alternative 6, because construction for this alternative would take place in populated areas throughout the Keys, and would include modification or demolition of existing building.

These impacts will be similar to that of Alternative 1, except that less equipment and a shorter time at each location will be needed to raise a structure. Demolition of structures would entail heavier equipment such as bulldozers, but again, for shorter periods of time at each location. At these times, however, noise will approach that of an industrial area within 100 feet of the construction. Noise due to construction could be ten dBA higher than ambient noise up to 400 feet away from the construction site. Non-physical actions will not affect noise levels.

Overall, this Alternative will have temporary, minor to moderate adverse effects, during construction only. The duration of time to complete all of the work this alternative is not known at this time. However, just as for Alternative 1, noise levels would be subject to local noise ordinance requirements. Construction would be expected to take place only during normal business hours and not occur at night, early mornings, or on Sundays.

8.23.3 Alternative 7: Nonstructural and Structural Alternative, Combined (TSP)

The effects of this alternative would be a combination of those described above under Alternatives 1 and 6. Overall, this Alternative will have temporary, minor to moderate adverse effects during construction only.

8.23.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent impacts to noise would occur.

8.23.5 Best Management Practices to Avoid and Minimize Impacts on Noise for Alternative 7

1) Time constraints including noise ordinance requirements and use of equipment regulations can be effective in reducing the impacts caused during sensitive time periods.
2) Operating noisy equipment only when necessary and switching off such equipment when not in use can minimize noise impacts.
3) Other temporary abatement techniques could include the use of temporary and/or movable shielding for both specific and nonspecific operations, if needed. Some mobile shielding is capable of being moved intact. An example of such a barrier utilizes noise curtains in conjunction with trailers to create an easily movable, temporary noise barrier system (FHWA).

8.24 CLIMATE CHANGE AND SEA LEVEL RISE (SLR)

8.24.1 Alternative 1: Structural Only Alternative (Revetments Only)

For this alternative, the identified locations along U.S. Route 1 that have less than 100 feet of land between the road footprint and the shoreline, and are not already being stabilized by others, will be stabilized with revetments. Direct air emissions of greenhouse gases would occur from the temporary use of construction equipment such as excavators, dump trucks, and other motor vehicles during transportation of materials to the project site and construction of the six revetments. Greenhouse gas emissions would have an indirect permanent but negligible effect on climate change. There would be permanent beneficial effects for adaptation to climate change, as this is the purpose of the proposed action. The revetment areas would help protect U.S. Route 1 from erosional damage due to coastal storms and SLR.

8.24.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves temporary construction on existing structures, demolition of structures to be acquired, and construction access for both. Greenhouse gas emissions resulting from implementation of Alternative 6 would occur from the use of construction equipment necessary to elevate or demolish existing structures, as determined necessary. The greenhouse gas emissions would have an indirect permanent but negligible effect on climate change.

There would be permanent direct and indirect beneficial effects for adaption to climate change as a result of this alternative, as this is the purpose of the proposed action. Elevation and dry floodproofing both aid in adaptation of structures to SLR due to climate change. Acquisition and demolition will eliminate buildings that are estimated to sustain significant damage from future storms.

8.24.3 Alternative 7: Nonstructural and Structural Alternative, Combined (/TSP)

The effects of this alternative would be a combination of those described above under Alternatives 1 and 6. There would be an indirect permanent but negligible effect on climate change due to greenhouse gas emissions. However, there would be permanent direct and

indirect beneficial effects for adaptation to climate change. Flood warning systems and emergency planning would also help residents make preparations to prevent damage, and/or evacuate more effectively, reducing direct impacts on residents and businesses. Land use planning would also reduce impacts on residents and businesses by reducing the number of structures located in areas most vulnerable to damage.

8.24.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would mean not implementing a built alternative. No temporary or permanent impacts to climate change would occur, due to any build alternative. However, the cumulative effects of climate change as described in the Affected Environment chapter, and in the Cumulative Effects section below, would still occur. Significant adverse effects due to damages to buildings and roadways due to SLR and coastal storms would be expected to continue and increase, and structures and roadways protected by the proposed action would be more vulnerable to damage.

8.24.5 Best Management Practices to Avoid and Minimize Impacts on Climate Change and SLR for Alternative 7

1) Energy requirements for the proposed alternative would be limited to the fuel construction equipment associated with beach placement.
2) No unnecessary idling of trucks or other equipment shall occur when not in use during construction.

8.25 CUMULATIVE EFFECTS

There are a multitude of past, present, and reasonably foreseeable future projects within the study area. Regardless of whether Alternatives 1, 6, 7, or 8 is adopted, these efforts planned by others would be expected to occur.

A myriad of local, state, and federal projects and studies with sea level rise and climate change resiliency efforts from governmental and non-profit agencies will continue to be studied and implemented. Existing coastal storm risk management resilience efforts in Monroe County would continue to be implemented and maintained. Monroe County has a very active resiliency program. These efforts include, but are not limited to: conducting site-specific vulnerability studies, conducting studies for roadway elevations, completing a watershed management plan of the storm water infrastructure, updating LIDAR elevation data and SLR projections, identifying repetitive loss and adaption action areas, and adding policies to the comprehensive plan that dis-incentivize development in high-risk areas. This could also include physical efforts such as secondary and tertiary road raisings. Development centers may continue to grow; however, they would be subject to wetland, floodplain, and County regulations and requirements.

As a result of Hurricane Irma, there have been numerous washouts of the U.S. Route 1 Overseas Trail and/or the U.S. Route 1 roadway embankment along various sections of the Florida Keys. FDOT will be placing revetments or articulating block bank repairs at approximately 99 locations, including five that were deleted from our initial array of alternatives.

This work includes fill and slope repairs to the Overseas Trail where needed. Specifically, West Summerland Key and Fiesta Key West and East are among the locations that FDOT intends to repair, and are near the proposed revetments. FDOT's work also would require temporary upland staging areas.

It is unknown when FDOT's work will be done and what areas will be used for staging; so there may be cumulative temporary adverse effects on recreational land use on the Overseas Trail with the proposed revetments and FDOT repairs. Many sections of damaged trails unusable now will be restored. Once completed, these actions, should have permanent cumulative beneficial bank stabilization effects on the Overseas Trail, and in conjunction with the Proposed Action in particular, would further protect trail repairs at West Summerland Key and Fiesta Key West and East. FDOT's work, although mostly small-scale operations, will also repair damaged roadway embankments and help prevent future damage. FDOT's bank work and the Proposed Action would be designed to enhance preservation of utility infrastructure and service, and have beneficial effects on safety and transportation. It may be visible at certain locations, but if so, would be expected to have minor adverse aesthetic effects.

Other routine bank stabilization projects on public and private property would be expected to continue. It is possible that some of the existing breakwaters that are in disrepair in the Keys could be repaired or maintained by the County or others. Some of this work could potentially affect surface waters and water quality, vegetated wetlands. It could also potentially affect threatened and endangered species by blocking access and degrading existing habitat and foraging capabilities that was previously useful.

Other reasonably foreseeable work within the ROI is planned within Bahia Honda and Long Key State Parks. Both parks experienced washouts of their campground sites and access roadways in the vicinity of the proposed revetments; and both plan to repair the roads and campsites and reopen them for public use. Both parks also plan to implement shoreline replantings in washout areas. The Long Key revetment would need to be planned in coordination with the park and to accommodate their planting plan as practicable. Effects on threatened and endangered species or wildlife from those plantings would be expected to be beneficial enhancements through habitat enhancement and protection. Because there will be no in-water impacts, there would be no cumulative effect on fish or fishery resources, benthics, hardbottom, or SAV resources.

Cumulative effects on transportation from implementation of Alternative 7 combined with those of other described actions are predicted to be minor to moderate and beneficial. Cumulative adverse effects from implementation of Alternative 7 to navigation, geology, topography, and soils, HTRW, emissions and air quality and attainment status, noise, are predicted to be temporary, localized, and negligible to minor.

Any cumulative adverse effects from implementation of Alternative 7 are predicted to be minor and localized, and range from temporary to permanent in duration for aesthetics, and for hydrology, hydraulics, and bathymetry. Cumulative effects on wetlands and vegetated beach will also be to be minor and localized, and range from temporary to permanent in duration, because the unavoidable impacts will be mitigated. However, it can be expected that due to natural causes such as sea level rise, erosion would continue to occur, and shoreline wetlands could

therefore be eroded and/or migrate further inland. Likewise, these forces could cause further beach erosion and further inland retreat of upland vegetation. Expected SLR will be taken into account with any mitigation planting.

There also would be no significant cumulative temporary or permanent adverse effects to recreation from implementation of Alternative 7. However, recreational activities could be impacted by natural causes such as sea level rise and increased future storms, which could cause future damage to recreational areas such as beaches, the Overseas Trail, State Parks, etc., limiting recreational activities.

Threatened and endangered species in the ROI have species specific cumulative impacts. Piping plovers, red knots, and roseate terns are prone to effects from run off, invasive plants, habitat loss, and shoreline stabilization efforts. Sea turtles are prone to fishery interactions, boat strikes, habitat loss and artificial lighting along the coast. American crocodiles and alligators are prone to vehicle strikes, habitat loss, and hurricanes. Cumulative adverse effects to threatened and endangered species, critical habitat, and wildlife species from implementation of Alternative 7 are predicted to be localized, and range from temporary to permanent in duration (affecting up to 7.5 total acres- 2 permanent and 5.5 temporary) of critical habitat). It also should be noted that threatened or endangered species could become stressed due to deeper, warmer, more acidic waters from climate change and sea level rise.

Potentially significant effects were identified for threatened, endangered species, cultural resources, socioeconomics, from the Proposed Action itself. Cumulative impacts on threatened and endangered species are discussed in greater detail in the Biological Assessment in the Environmental Appendix, Appendix D, and coordination with USFWS is ongoing. Cumulative cultural resources effects, when combined with other potential effects by private homeowners, could be potentially significant if numerous historic homes and/or districts are affected by acquisition and demolition, or elevation. A PA has been drafted to address future effects and mitigation. Potential cumulative socioeconomic effects, combined with future land use restrictions and SLR, could be significant, as less land and housing becomes available. However, the land use restrictions and SLR would occur with or without the Proposed Action, and all affected residents would be eligible for relocation to a comparable residence with less potential for coastal storm damage.

Construction noise and emissions would be associated with some of these past, present, and reasonably foreseeable physical efforts. Any work within surface waters by others would require Section 401 and 404 Clean Water Act permits, a Rivers and Harbors Act permit County, and FKNMS requirements; all of which would require strict erosion and sediment controls, including minimization of turbidity, during construction. They also would be subject to applicable ESA and EFH regulations. However, the County indicates that generally, very limited wetland impacts are allowed; and as a general rule, mangrove impacts are not allowed.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue over the next 50 years. Predicted climate change impacts such as increased ocean

temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns, have the potential to cause changes in the nature and character of the estuarine ecosystem, sea levels and surface land temperatures in the ROI. Due to the synergistic effects from a combination of factors, and relative SLR, and an increase in the frequency and strength of storms, the risk from coastal inundation will rise in the coming years for the Florida Keys. Most of these impacts will directly affect local flooding and people, property, and the environment. As a result, beaches, vegetated shorelines, banks, and wetlands could erode further or become regularly inundated. As mentioned, all aquatic organisms, including fisheries, benthics, SAV, and threatened and endangered species, could become stressed due to deeper, warmer, more acidic waters from climate change and SLR.

However, implementation of Alternatives 1, 6, 7, or 8 would not be predicted to substantially cumulatively or synergistically interact with climate change and/or effects. Overall, the Proposed Action and those of other actions would be beneficial for adaptation to climate change.

CHAPTER 9 ENVIRONMENTAL COMPLIANCE

Compliance with the following environmental laws (and implementing regulations) and Executive Orders is required for the project alternatives under consideration (Tables 9-1 to 9-3) (note: this is not necessarily an exhaustive list of all applicable environmental requirements).

9.1 TABLES OF ENVIRONMENTAL COMPLIANCE, EXECUTIVE ORDERS, AND PERMITTING REQUIREMENTS

Table 9-1: Environmental Compliance

Title of Law	U.S. Code	Compliance Status
Abandoned Shipwreck Act of 1987	43 United States Code (U.S.C.) 2101	N/A
American Bald and Golden Eagle Protection Act of 1962, as amended	16 U.S.C. 668	Full compliance anticipated
Anadromous Fish Conservation Act of 1965	16 U.S.C. 757 a et seq	N/A
Clean Air Act of 1972, as amended	42 U.S.C. 7401 et seq	Full compliance
Archaeological and Historic Preservation Act of 1974	Public Law 93-291 and 16 U.S.C.469-469c	Pending, full compliance is anticipated with execution of PA with SHPO prior to the signing of the Final Record of Decision (ROD).
Clean Water Act of 1972, as amended	33 U.S.C. 1251 et seq	Pending. We expect to receive a general statement that provided the Water Quality Certification (WQC) is applied for and obtained, the project would comply with the CWA. Full compliance is achieved upon receipt of the WQC, which will be obtained during PED.
Coastal Barrier Resources Act and Coastal Barrier Improvement Act of 1990	Public Law 113-314 and 16 U.S.C. 3501 et seq	Pending, coordination with USFWS is ongoing
Coastal Zone Management Act of 1972, as amended	16 U.S.C. 1451 et seq	Coordination with FDEP is ongoing

Title of Law	U.S. Code	Compliance Status
Comprehensive Environmental Responses, Compensation and Liability Act of 1980	42 U.S.C. 9601	No coordination currently required. If CERCLA regulated materials are later identified, coordination will then be initiated. In such an event.
Deepwater Port Act of 1974, as amended	33 U.S.C. 1501	N/A
Emergency Wetlands Resources Act	16 U.S.C. 3901-3932	N/A
Endangered Species Act of 1973	16 U.S.C. 1531	Coordination with USFWS is ongoing
Estuary Protection Act of 1968	16 U.S.C. 1221 et seq	N/A
Fish and Wildlife Coordination Act of 1958, as amended	16 U.S.C. 661	Coordination with USFWS is ongoing
Flood Control Act of 1970	33 U.S.C. 549	Pending, full compliance is anticipated
Land and Water Conservation Act	16 U.S.C. 460	Pending, full compliance is anticipated
Magnuson-Stevens Fishery Conservation and Management Act	16 U.S.C. 1801	N/A, no in-water structures proposed.
Marine Mammal Protection Act of 1972, as amended	16 U.S.C. 1361	N/A, no in-water structures proposed.
Marine Protection, Research, and Sanctuaries Act of 1972	33 U.S.C. 1401	FKNMS is a Cooperating Agency. Coordination has been ongoing; no effects are anticipated
Migratory Bird Conservation Act of 1928, as amended	16 U.S.C. 715	Pending, full compliance is anticipated upon completion of coordination with USFWS and with adherence to BMPs.
Migratory Bird Treaty Act of 1918, as amended	16 U.S.C. 703	Pending, full compliance is anticipated upon completion of coordination with USFWS and with adherence to BMPs.
National Environmental Policy Act of 1969, as amended	42 U.S.C. 4321 et seq	Full compliance upon signature of the ROD

Title of Law	U.S. Code	Compliance Status
National Historic Preservation Act of 1966, as amended	16 U.S.C. 470 and 54 U.S.C. § 300101	Pending, full compliance is anticipated with execution of PA with SHPO prior to the signing of the Final ROD
Noise Control Act of 1972, as amended	42 U.S.C. 4901	Pending, full compliance is anticipated
Resource Conservation and Recovery Act of 1976	42 U.S.C. 6901 et seq	Pending, full compliance is anticipated during PED
River and Harbor Act of 1888, Section 11	33 U.S.C. 608	Full compliance
River and Harbor Act of 1899	33 U.S.C. 401 et seq	Full compliance
Safe Drinking Water Act of 1974, as amended	42 U.S.C. 300	Pending, full compliance is anticipated
Toxic Substances Control Act of 1976	15 U.S.C. 2601	Pending, full compliance is anticipated during PED
Uniform Relocation and Assistance and Real Property Acquisition Policies Act	42 U.S.C. 4601 et seq	Pending, full compliance is anticipated during PED

Table 9-2: Executive Orders

Title of Executive Order	Executive Order Number	Compliance Status
Coral Reef Protection	13089	Full compliance anticipated, with strict erosion and sediment controls
Protection and Enhancement of Environmental Quality	11514/11991	Pending, full compliance is anticipated
Protection and Enhancement of the Cultural Environment	11593	Pending, full compliance is anticipated
Floodplain Management	11988	Pending, full compliance is anticipated
Protection of Wetlands	11990	Pending, full compliance is anticipated
Federal Compliance with Pollution Control Standards	12088	Pending, full compliance is anticipated
Federal Compliance with Right-to-Know Laws and Pollution Prevention	12856	Pending, full compliance is anticipated
Federal Actions to Address Environmental Justice and Minority and Low-income Populations	12898	Pending, full compliance is anticipated. However, potentially significant adverse effects anticipated.
Protection of Children from Environmental Health Risks and Safety Risks	13045	Pending, full compliance is anticipated
Invasive Species	13112	Pending, full compliance is anticipated with adherence to BMPs
Marine Protected Areas	13158	Pending, full compliance is anticipated upon coordination with Florida Keys National Marine Sanctuary
Consultation and Coordination with Indian Tribal Governments	13175	Pending, full compliance is anticipated
Responsibilities of Federal Agencies to Protect Migratory Birds	13186	Coordination with USFWS is ongoing, full compliance anticipated with adherence to BMPs
Facilitation of Cooperative Conservation	13352	Pending, full compliance is anticipated

Title of Executive Order	Executive Order Number	Compliance Status
Preparing the United States for Impacts of Climate Change	13659	Pending, full compliance is anticipated
Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects (One Federal Decision)	13807	Pending, full compliance is anticipated upon signature of the ROD
Efficient Federal Operations	13834	Pending, full compliance is anticipated
Planning for Federal Sustainability in the Next Decade (2015)	13693	Pending, full compliance is anticipated

Table 9-3: Permitting Requirements

Law	Agency Responsible	Permit, Agreement, Authorization, or Notification Required
American Bald and Golden Eagle Protection Act of 1962, as amended	USFWS	"Take" permit if any eagles are accidentally harmed or killed; no take permit is anticipated
Comprehensive Environmental Responses, Compensation and Liability Act of 1980, as amended	USEPA	No effect, no superfund sites within the ROI
Clean Water Act, Section 401*	FLDEP	Pending. We expect to receive a general statement that provided the Water Quality Certification (WQC) is applied for and obtained, the project would comply with the CWA. Full compliance is achieved upon receipt of the WQC, which will be obtained during PED.
Clean Water Act, Section 404	There is potential that FDEP will assume Section 404 from USACE. The measure has passed the Florida state legislature but is still in development	If FDEP assumes the Section 404 program; permit verification would be obtained during PED.
Coastal Zone Management Act (CZMA)	FLDEP	CZMA Federal Consistency coordination is ongoing, and concurrence with our consistency determination is anticipated prior to issuance of the final report.
Endangered Species Act of 1973	NMFS	No effect, and no incidental take permit anticipated as no structures will be in the water.
Endangered Species Act of 1973	USFWS	Full Concurrence Determination in a Biological Opinion anticipated (Formal Consultation ongoing).
Fish and Wildlife Coordination Act (FWCA)	USFWS	FWCA Concurrence Memorandum.

Law	Agency Responsible	Permit, Agreement, Authorization, or Notification Required
Magnuson-Stevens Fishery Conservation and Management Act	NMFS	No effect, and no incidental take permit anticipated as no structures will be in the water.
Marine Mammal Protection Act of 1972, as amended	NMFS	No effect, and no incidental take permit anticipated as no structures will be in the water.
Marine Protection, Research, and Sanctuaries Act of 1972*	USEPA	Concurrence documentation, no effect anticipated as no structures will be in the water.
Migratory Bird Treaty Act of 1918, as amended	USFWS	"Take" permit; no take permit is required.
National Historic Preservation Act of 1966, as amended	Advisory Council on Historic Preservation, Florida DHR	PA is being coordinated with SHPO.
Noise Control Act of 1972	USEPA	Notification of any noncompliance; none anticipated.
Resource Conservation and Recovery Act of 1976	USEPA, FLDEP	Testing, quantification, and notification for any hazardous materials.
Rivers and Harbors Act of 1899	U.S. Coast Guard	No permit required, as no structures will be in the water.

N/A = Not Applicable; FLDEP = Florida Department of Environmental Protection; NMFS = National Marine Fisheries Service; USEPA = U.S. Environmental Protection Agency; USFWS = U.S. Fish and Wildlife Service; PED = planning, engineering, design phase

9.1 National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321 *et seq.*

The NEPA requires that all federal agencies use a systematic, interdisciplinary approach to protect the human environment. This approach promotes the integrated use of natural and social sciences in planning and decision making that could have an impact on the environment. NEPA requires the preparation of an EIS for any major federal action that could have a significant impact on quality of the human environment and the preparation of an Environmental Assessment (EA) for those federal actions that do not cause a significant impact but do not qualify for a categorical exclusion. The NEPA regulations issued by CEQ provide for a scoping process to identify and the scope and significance of environmental issues associated with a project. The process identifies and eliminates from further detailed study issues that are not significant.

As previously stated, the USACE used this process to comply with NEPA and focus this Integrated Feasibility Study and EIS on the issues most relevant to the environment and the decision making process. For a description of the agency, tribal, and public coordination

completed to date and information on the NEPA scoping that was completed, please refer to the Chapter 1, under Public and Agency Coordination. The Draft Final EIS will undergo a 45 day agency, tribal, and public review period. All comments will be addressed in the development of the Final Integrated Feasibility Report and EIS, and will include responses to the comments. The Final Integrated Feasibility Report and EIS, including all appendices and supporting documentation, will fulfill requirements of the NEPA for the Florida Keys Coastal Storm Risk Management Study. Upon completion of the Final Integrated Feasibility Report and EIS, which is signified by the signing of the Record of Decision (ROD), the project will be in full compliance with the NEPA.

9.2 Clean Water Act

The USACE will obtain a Water Quality Certification from the FDEP pursuant to the CWA. All construction activities will comply with federal guidance and regulations to provide information to reach a factual determination concerning Clean Water Act, Section 404 requirements (40 CFR 230.11) and applicable state water quality standards.

Section 401 and 404 of the CWA and 33 C.F.R. 336(c)(4) and 33 C.F.R. 320.4(b) require the USACE to avoid, minimize, and mitigate impacts to wetlands. Impacts to approximately 10,250 square feet of herbaceous wetlands are anticipated with implementation of this project. A wetland delineation has not been completed yet. It will be completed in the PED phase of the project. Final impact amounts will be determined upon more complete design of the project. The plan will be finalized as wetland impacts are determined in greater detail. However, it is noted that wetland mitigation will also be required to be done in compliance with the requirements under State and Federal laws, regulations, and requirements.

A conceptual wetland mitigation was developed for this project and will be coordinated with regulatory agencies for approval.

9.3 Rivers and Harbors Act, 33 U.S.C. 401 et seq.

This law and its implementing regulations prohibit the construction of any bridge, dam, dike, or causeway crossing over or in navigable waters of the U.S. without Congressional approval. The U.S. Coast Guard administers Section 9 and issues permits for construction of crossings over navigable waters. This law and its implementing regulations also allows the U.S. Coast Guard to require necessary lighting and aids to navigation and to approve any temporary or permanent closures or restrictions of navigation channels.

No in-water structures are being proposed, so no permit is required.

9.4 Federal Coastal Zone Management Act, 16 U.S.C. 1451 et seq.

The Federal Coastal Zone Management Act (CZMA) requires each federal agency activity performed within or outside the coastal zone (including development projects) that affects land or water use, or natural resources of the coastal zone to be carried out in a manner which is consistent to the maximum extent practicable, i.e. fully consistent, with the enforceable policies of approved state management programs unless full consistency is prohibited by existing law applicable to the federal agency.

To implement the CZMA and to establish procedures for compliance with its federal consistency provisions, the U.S. Department of Commerce, NOAA, promulgated regulations which are contained in 15 C.F.R. Part 930. As per 15 CFR 930.37, a federal agency may use its NEPA documents as a vehicle for its consistency determination.

The Florida Coastal Management Program (FCMP) was approved by NOAA in 1981 and is codified at Chapter 380, Part II, F.S. The state of Florida's coastal zone includes the area encompassed by the state's 67 counties and its territorial seas. The FCMP consists of a network of 24 Florida Statutes administered by eight state agencies and five water management districts. This framework allows the state to make integrated, balanced decisions that ensure the wise use and protection of the state's water, property, cultural, historic and biological resources; protect public health; minimize the state's vulnerability to coastal hazards; ensure orderly, managed growth; protect the state's transportation system; and sustain a vital economy.

As the designated lead coastal agency for the state, FDEP communicates the agencies' comments and the state's final consistency decision to federal agencies and applicants for all actions other than permits issued under Clean Water Act Section 404 and Section 10 of the Rivers and Harbors Act. The state's consistency decisions on those permits are made through the approval or denial of the wetland resource or environmental resource permits issued under Chapter 373, Part IV, F.S.

Upon publication of the draft EIS, coordination for the Federal Consistency Determination (FCD) will be initiated. (The Draft FCD with the CZMA is provided in the Environmental Appendix, Appendix D). Full compliance is anticipated.

9.5 Clean Air Act, as amended, 42U.S.C. 7401 *et seq.*

The Clean Air Act (CAA) is the comprehensive federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes the USEPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants.

Monroe County is designated as an attainment area for Federal air quality standards under the CAA. There would be temporary increases in air emissions associated with the construction of these alternatives. No air quality permits are anticipated to be required for this project because the project is located within an attainment area; USEPA's General Conformity Rule to implement Section 176(c) of the Clean Air Act does not apply and a conformity determination is not required.

9.6 U.S. Fish and Wildlife Coordination Act, 16 U.S.C.661-666(c)

The project is undergoing coordination with the USFWS and the State of Florida. A Fish and Wildlife Coordination Act Report or Memorandum is being prepared by the USFWS.

9.7 Endangered Species Act

A Biological Assessment evaluating the potential impacts of the proposed action on endangered and threatened species is in the process of being prepared and once complete will be provided

in Appendix D, Environmental Appendix. Critical habitat has been designated for some of the species that occur in the action area. Coordination with the USFWS pursuant to Section 7 of the ESA for the species provided in Table 9-4 below is ongoing.

Formal consultation with the USFWS is anticipated because of the potential, adverse effects to loggerhead sea turtle nearshore breeding, foraging and nesting areas; piping plover, red knot, roseate tern foraging and loafing areas, and potential habitat for the Cape Sable Thoroughwort, due to the construction of the revetments in the Action Area. Other effects to federally listed species include no effect or may affect, and not likely to adversely affect determinations. The analysis and findings are described in detail in the Special Status Species Section and in the Biological Assessment in Appendix D.

There will be no effects to species under the purview of the NMFS, as no structures or construction would be in the water.

Table 9-4: Federally Listed Species Known or with the Potential to Occur in the Action Area

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
Piping Plover, Red Knot, Roseate Tern	May Affect, Likely to Adversely Affect	Construction may impact prey species, will alter habitat and may cause species to leave the action area from the visual disturbances, auditory disturbances, and increased human activity.
Piping Plover Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.5 acres of designated critical habitat and could impact prey species and foraging habitat. The revetments would adversely modify designated critical habitat.
Nassau Grouper, Smalltooth Sawfish, Oceanic Whitetip Shark, Giant Manta Ray	No Effect	There are no in water impacts associated with this project.

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
Pillar Coral, Rough Cactus Coral, Lobed Star Coral, Boulder Star Coral, Mountainous Star Coral, Elkhorn Coral, Staghorn Coral	No Effect	There are no in water impacts associated with this project.
Elkhorn Coral, Staghorn Coral Designated Critical Habitat	No Effect	There are no in water impacts associated with this project.
West Indian Manatee	No Effect	There are no in water impacts associated with this project.
American Alligator and American Crocodile	May Affect, Not Likely to Adversely Affect	Construction may disturb species due to temporary increases in human disturbance including auditory and visual disturbances during construction. The revetments would temporarily and permanently alter designated critical habitat. However, existing sea walls, revetments, and vegetation block access to Fiesta Key East and West and Indian Key Fill, creating limited access to these areas. In addition, the 2014 USFWS letter referenced in Section 2.3.5 notes that crocodiles are uncommon south of Key Largo. Using the guidance from this letter, it is anticipated the impacts will be insignificant.
American Crocodile Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 1.5 acres of designated critical habitat, however, 1.0 of those acres are not accessible to crocodiles due to existing sea walls and rip rap revetments. The remaining 0.5 acre is at the southernmost extent of the range in the Florida Keys and occurrence is uncommon.
Kemp's ridley sea turtle	No Effect	Kemp's ridley sea turtles do not nest within the action area. Kemp's ridley sea turtles do not have critical habitat within the action area. There are no in water impacts associated with this project.

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
Green Sea Turtle, Hawksbill Sea Turtle, Leatherback Sea Turtle	May Affect, Not Likely to Adversely Affect	Green, Hawksbill, and Leatherback sea turtles rarely nest on Bahia Honda Key within the action area. The revetment on Bahia Honda Key will be north of an existing fence and campground road. The nesting area is south of the existing fence and campground road on Bahia Honda Key. Impacts to green, hawksbill, and leatherback sea turtles will be temporary and insignificant. There are no in water impacts associated with this project.
Loggerhead Sea Turtle	May Affect, Likely to Adversely Affect	Within the action area, Loggerhead sea turtles nest on Bahia Honda and Long Key. Historically, nests were also documented on West Summerland Key in the 90's. The revetment on Long Key will block access to nesting habitat. The revetment on Bahia Honda Key will be north of an existing fence and campground road. The nesting area is south of the existing fence and campground road, so impacts to nesting turtles are not anticipated on Bahia Honda Key.
Loggerhead Sea Turtle Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.25 acres of designated critical habitat and could impact nesting habitat on Long Key. The revetments would adversely modify designated critical habitat.
Cape Sable Thoroughwort	May Affect, Likely to Adversely Affect	Construction and human activities could disturb or trample plant. Construction of a revetment would permanently alter up to 0.5 acre of designated critical habitat.
Cape Sable Thoroughwort Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.5 acre of designated critical habitat. The revetments would adversely modify designated critical habitat.

9.8 Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C.1801 *et seq.*

This Act requires federal action agencies to consult with the National Marine Fisheries Service (NMFS) if a proposed action may affect Essential Fish Habitat (EFH). The waters of the Florida Keys, including the Atlantic Ocean, Florida Strait, and Florida Bay, contain EFH for many species. However, because there will be no in water or tidal wetland impacts, there will be no effect on EFH.

9.9 Anadromous Fish Conservation Act, 16 U.S.C. 757, *et seq.*

No in-water structures are being proposed; therefore, there will be no effect on anadromous fish.

9.10 Marine Mammal Protection Act, 16 U.S.C. 1631 et seq.

The Marine Mammal Protection Act (MMPA) prohibits the take of marine mammals including the West Indian manatee, and all cetaceans found in the ROI. No in water structures are being proposed; therefore, there will be no effect on Marine Mammals.

9.11 Section 106 and 110(f) of the National Historic Preservation Act, 16 U.S.C. 470 *et seq.*

The National Historic Preservation Act (NHPA) applies to properties listed in or eligible for listing in the National Register of Historic Places (NRHP); these are referred to as "historic properties." Historic properties eligible for listing in the NRHP include prehistoric and historic sites, structures, buildings, objects, and collections of these in districts. Section 106 of the NHPA and its implementing regulations at 36 CFR Part 800, require the lead federal agency to assess the potential effects of an undertaking on historic properties that are within the proposed project's Area of Potential Effect (APE), which is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist" (36 C.F.R. § 800.16[d]).

Adverse effects are possible, and potentially significant, if demolition and/or floodproofing and elevation is conducted on any NRHP-eligible structures and/or historic districts. Coordination is ongoing with the Florida State Historic Preservation Office (SHPO). Full compliance is anticipated with the execution of programmatic agreement (PA) with SHPO prior to the signing of the Final ROD.

9.12 Coastal Barrier Resources Act of 1982, as amended 1990.

The Coastal Barrier Resources Act (CBRA) was passed by Congress in 1982 to encourage conservation of hurricane-prone, biologically rich coastal barriers. The two types of mapping units under this Act are System Units and Other Protected Areas (OPAs).

- The System Units are predominantly privately owned coastal barrier lands along the Florida Keys that were relatively undeveloped at the time of their designation. CBRA prohibits most new federal expenditures that encourage development or modification of coastal barriers. Therefore, most new or substantially improved residences, businesses, or other developments in the CBRS are not eligible for certain federal funding and financial assistance, including coverage under the NFIP. Development can still occur within the CBRS, as long as private developers or other non-federal parties bear the full cost.
- OPAs are predominantly comprised of conservation and/or recreation areas such as national refuges, state and national parks, local conservation areas. The only federal spending prohibition within OPAs is the prohibition on federal flood insurance.

None of the proposed revetments occur within System Units. The revetments proposed at Bahia Honda Key and Long Key are within the OPAs, but that does not prohibit their construction. All nonstructural measures will occur outside of the CBRA System Units, unless they meet a

specific exemption, as determined by USFWS. At this time, an exemption is being considered only for three nonstructural measures for critical infrastructure, and for one property acquisition. Coordination with USFWS is ongoing at this time; and if these facilities do not meet the exemption, they will be removed from the Proposed Action.

9.13 Resource Conservation and Recovery Act, as amended, 42 U.S.C. 6901 *et seq.*

The Resource Conservation and Recovery Act (RCRA) controls the management and disposal of hazardous waste. Hazardous and/or toxic wastes classified by RCRA are materials that may pose a potential hazard to human health or the environment due to quantity, concentration, chemical characteristics, or physical characteristics. This applies to discarded or spent materials that are listed in 40 CFR 261.31-.34 and/or that exhibit one of the following characteristics: ignitable, corrosive, reactive, or toxic. Radioactive wastes are materials contaminated with radioactive isotopes from anthropogenic sources (e.g., generated by fission reactions) or naturally occurring radioactive materials (e.g., radon gas, uranium ore).

Elevation or demolition of buildings older than 1978 have the potential to generate chemical contamination, specifically in the form of asbestos-containing materials (ACMs), lead-based paint (LBP), or potentially polychlorinated biphenyls (PCBs). Prior to any disturbance of these structures, a Phase 1 Environmental Site Assessment would be required. If these materials are identified, they will be handled in accordance with RCRA and all other relevant laws. Excavation within the ROI of the proposed project is not anticipated to generate material with chemical contamination but that would be confirmed during the PED phase. Full compliance with RCRA is anticipated.

9.14 Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. 9601 *et seq.*

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) governs the liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous substance disposal sites.

There are no CERCLA/Superfund sites within the ROI. However, if any contaminated material was discovered in adjacent areas during construction, it will be handled in accordance with all federal, state, and local regulations, and be disposed of at upland disposal sites able to safely handle and store such material. Detailed specifications and requirements would be determined during the PED phase.

9.15 Submerged Lands Act of 1953

The proposed project will not affect submerged lands of the State of Florida.

9.16 Marine Protection, Research and Sanctuaries Act

The Act has two essential aims: to regulate intentional ocean disposal of materials, and to authorize any related research. While the MPRSA regulates the ocean dumping of waste and provides for a research program on ocean dumping, it also provides for the designation and regulation of marine sanctuaries.

Ocean dredged material placement is regulated under Section 103 of the Marine Protection Resources and Sanctuaries Act of 1972, Public Law 92-532 (MPRSA). The law states that any proposed placement of dredged material into ocean waters must be evaluated through the use of criteria published by the EPA in Title 40 of the Code of Federal Regulations, Parts 220-228 (40 CFR 220-228).

The FKNMS is a cooperating agency, and therefore has been involved during the development of this EIS. Although revetment structures were initially proposed within Marine Sanctuary waters, the revetment footprints were relocated upslope to avoid these areas. Therefore no Marine Sanctuary waters are anticipated to be impacted, and no permit would be required. However, should the design change and should there be any impacts below mean high water (MHW), then USACE will re-coordinate with FKNMS during the PED phase and obtain any required permits.

9.17 Executive Order 13089, Coral Reef Protection

The proposed action may affect U.S. coral reef ecosystems as defined in the EO. The order established the interagency U.S. Coral Reef Task Force to develop and implement a comprehensive program of research and mapping to inventory, monitor, and “identify the major causes and consequences of degradation of coral reef ecosystems.” The Order also directs federal agencies to expand their own research, preservation, and restoration efforts.

There will be no in water structures or impacts, and the project will adhere to strict erosion and sediment controls; therefore, there would be no effect on coral reefs.

9.18 Executive Order 11988, Floodplain Management

This EO states that federal agencies shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out agency responsibilities. Federal agencies should avoid, to the extent possible, the long and short term adverse impacts associated with the occupancy and modification of the Base Flood Plain (one percent annual chance floodplain as defined by FEMA), and the avoidance of direct and indirect support of development in the Base Flood Plain wherever there is a practicable alternative. For critical facilities, the 0.2 percent annual chance flood plain is typically evaluated. Under the EO, USACE is required to provide leadership and take action to:

- Avoid development in the Base Flood Plain unless it is the only practicable alternative;
- Reduce the hazard and risk associated with floods;
- Minimize the impact of floods on human safety, health and welfare;
- and Restore and preserve the natural and beneficial values of the Base Flood Plain.

From USACE ER 1165-2-26, in accordance with EO 11988, USACE uses the eight step process below to address flood plain management, with project-specific responses:

1. **Determine if the proposed action is in the Base Flood Plain.** All alternatives are located in the Base Flood Plain.

2. **If the action is in the Base Flood Plain, identify and evaluate practicable alternatives to the action or to location of the action in the Base Flood Plain.** Chapters 6-7 of this report discuss the process of considering, screening, and comparing alternatives.

3. **If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.** As discussed in Chapter 1 of this report, as part of NEPA, On December 3-4, 2018, the USACE held National Environmental Policy Act (NEPA) Open-House-Style Public Scoping meetings in the Cities of Islamorada and Key West. USACE staff were on-hand with storyboards to show the areas of the city to be addressed, to describe the potential measures, to answer questions, and to obtain public comments. Approximately 31 people attended, and eight public comments were submitted during and after the meeting. On September 11-12, 2019, the USACE held Open House Style Public Meetings in Key Largo and Key West to update the public on the measures and the alternatives. The meeting was an open-house style forum including updated storyboards and a brief introduction to the study and status update by the Norfolk District at the midpoint of the meeting. Approximately 40 people and the media attended these meetings, and a total of 23 public comments were received. The public was again given the opportunity to comment after the NOI was published on November 8, 2019. Prior to the September 2019 public meetings, a web-based GIS tool called Crowd Source Reporter was developed for the study to facilitate the communication of the proposed alternatives to the public and as an additional platform for the public and stakeholders to make comments with an option to reference them to a certain location on the map. All public comments and USACE responses from both of these meetings are included in the environmental appendix.

4. **Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the Base Flood Plain will affect the Base Flood Plain, impacts resulting from these actions should also be identified.** Protection of structures using structural and nonstructural measures will be beneficial and help the community to be more resilient and sustainable; if failure or the design is exceeded, impacts to people, property, and the environment would be adverse, temporary, and ranging from negligible to major depending on the level of flooding. Minimal losses of natural and beneficial flood plain values are expected mainly within the construction area and considered temporary and negligible.

5. **If the action is likely to induce development in the Base Flood Plain, determine if a practicable non-flood plain alternative for the development exists.** Most of the study area is developed, such that the purpose of the proposed action is not to induce development, but to help existing development be resilient and sustainable. New development is likely to occur without the proposed action.

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 flood plain values. This should include reevaluation of the "no action" alternative.** Citizens should be encouraged to have flood insurance and to evacuate if ordered to do so. New and existing citizens and local staff should have continuous outreach and education, as people tend to forget past flood events or they simply are not aware of the possible flooding. Local decision makers need to be fully informed and staff need to be able to properly conduct operations and maintenance.

7. **If the final determination is made that no practicable alternative exists to locating the action in the Base Flood Plain, advise the general public in the affected area of the findings.** All alternatives are located in the Base Flood Plain.

8. **Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.** Full compliance is anticipated with the goals of this Executive Order during the PED phase.

9.19 Executive Order 11990, Protection of Wetlands

This EO directs all federal agencies to minimize the destruction, loss, or degradation of wetlands; and preserve and enhance the natural beneficial values of wetlands in the conduct of the agency's responsibilities. Although a jurisdictional wetland determination has not yet been conducted for the Proposed Action, it is anticipated to cause the unavoidable loss of approximately 10,750 square feet of herbaceous wetlands. Full compliance is anticipated with the goals of this Executive Order during the PED phase, upon execution of a wetland mitigation plan in accordance with the 2008 Mitigation Rule would be provided as well as compliance with all other applicable federal, state, and local guidelines governing the protection of wetland areas.

9.20 Executive Order 13112, Invasive Species

Under this EO, the introduction of invasive species has been evaluated. The project would not induce the introduction or spread of invasive species to the project area, because the Proposed Action would adhere to the following standard BMPs for the Jacksonville District:

- Prior to the commencement of work, an invasive species prevention plan will be developed. It shall identify specific transfer prevention procedures and equipment cleaning sites.
- Sightings of any invasive species shall be included in a preconstruction report. Any subsequent sighting of invasive species shall be reported within 24 hours of siting. The reporting shall include date, time, location (latitude and longitude), photographs, environmental conditions, circumstances surrounding sighting disposition/behavior of the species, and any other notable observations. Reports shall be provided to the Jacksonville District Planning Division, Environmental Branch.

- All equipment would be thoroughly cleaned prior to and following work on the project site to ensure that materials including soil, vegetative matter, eggs, seeds, and other debris are not transported to other sites.
- Prevention protocols will also apply to clothing and personal protective equipment.

9.21 Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations

This EO directs federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low income populations, to the greatest extent practicable and permitted by law. The order is intended to promote nondiscrimination in federal programs that affect human health and the environment, as well as provide for minority and low-income communities' access to public information and public participation.

According to the USEPA's "EJ Screening Tool, approximately 17.4 percent of the population of Monroe County is foreign born, less that the state's percentage of 19.4 percent. The Median Household Income (MHI) for Monroe is $53,607 which is well above the State of Florida MHI of $46,956; yet the average yearly employee wage for Monroe is $31,820, while the statewide figure is $41,022. This apparent contradiction reflects a mix of retirees or others living off investments, and the majority of the labor force in low paying service jobs. The minority portion of the population is well below that for the state, with 28.7 percent for Monroe and 42.1 percent for the State of Florida. The minority population is mostly centered in Key Largo and especially Key West (USEPA, 2020).

In accordance with this EO, the USACE has determined that there are potentially significant effects on minority and low income populations. This is because approximately 300 residences located throughout the Keys will be subject to acquisition, demolition, and relocation. Approximately one-third of the acquisitions are located in Key West. Approximately 7,100 residences located throughout the Keys would be eligible for elevation, or raising of homes. Elevation would be voluntary for all residence owners; and both homeowners and renters would be forced to move temporarily while the elevation construction is accomplished.

Residential structures were identified for acquisition or elevation based on an assessment of which measure produced the most economic benefit. The economic modeling and analysis completed in this study compared the reduction in damage, or economic benefit, provided by elevation and acquisition for each structure at risk to flooding caused by coastal storms, to the cost to implement that measure. Acquisition, or buyout and demolition, would permanently displace people from their current residences, perhaps relocating people to places they would less desire to live for various reasons. However, acquisition of structures must be compliant with the Uniform Relocation Assistance and Real Property Acquisition Act, which provides protections and benefits to residents affected by acquisition or elevation of their residence.

Population Statistics

It should be noted that the breakdown of the following numbers and statistics is very preliminary and subject to change. The following discussion should be considered a generalization, for purposes of our consideration of EO 12898.

Based on income data from Monroe County (2019), just over half of the 300 households proposed for acquisition fall into low or low-to-moderate income dominated census block groups, and therefore, likely include environmental justice communities or individuals. In addition, thousands of residences within these areas would be eligible for residence elevation. It should be noted that this does not mean that all residences located in a low or low-to-moderate income dominated census block groups are low income and/or minority populations; it means that the majority of the population within that block meets that description. The following further breaks down the preliminary locations, from west to east, of the acquisition/relocations and elevations in relation to these block groups and localities.

Key West to Boca Roca Key (Mile Marker 0 through 6)

This locality has a 2010 Census population of 30,989. Of this population, 43percent are minorities and 31 percent are low income, and approximately 58 percent are renters. Key West includes 13 census block groups that have a majority of low to low-to-moderate income residents (USEPA, 2020). At least 85 percent of approximately 100 households proposed for acquisitions in Key West appear to be within majority low or low-to-moderate income block groups. In one such community north of Key West International Airport in particular, approximately 43 of out about 49 residences would be acquired, which would disrupt and eliminate this community as per EO 12898. The remaining proposed acquisitions are scattered throughout Key West and Boca Roca Key. Most of the thousands of households proposed for residence elevations are in Key West; and thousands of these households also would be within the low or low-to-moderate income block groups, which would be temporarily affected, but the residences would be permanently made more resilient to coastal storm risk.

East of Boca Roca Key through Cudjoe Key (Mile Marker 11 through 23)

This locality has a 2010 Census population of 5,936. Of this population, approximately 31 percent are minority; 26 percent are low income, and 31 precent are renters. Approximately four residences were identified for acquisition. However, this segment includes no census block groups that have a majority of low- to low-to-moderate income residents (USEPA, 2020), so none fall within those block groups.

East of Cudjoe Key through West Summerland Key (Mile Marker 23 through 35)

This locality has a 2010 Census population of 9,943. Of this population, approximately 18 to 19 percent are minority; 18 percent are low income, and 30 percent are renters. This segment includes three census block groups that have a majority of low to low-to-moderate income residents (USEPA, 2020). Six of the approximately 11 households proposed for acquisition in this population segment are within low or low-to-moderate income census block groups. In addition, over one hundred households that fall within a majority low or low-to-moderate income block group are proposed for elevations, and thus would be temporarily affected.

East of West Summerland Key through Duck Key, including Marathon (Mile Marker 35 through 60)
This locality has a 2010 Census population of 10,089. Of this population, approximately 40 percent are minority; 39 percent are low income, and 42 percent are renters. This segment includes five census block groups that have a majority of low to low-to-moderate income residents (USEPA, 2020). Approximately 57 of the 142 households proposed for acquisition in this population segment appear to be within low or low-to-moderate income block groups. In addition, at least one thousand households that fall within a majority low or low-to-moderate income block group are proposed for elevations, and thus would be temporarily affected.

Duck Key through Sea Oats Beach, Islamorada (Mile Marker 60 through 75)
This locality has a 2010 Census population of 1,537. Of this population, approximately 32 percent are minority; 17 percent are low income, and 27 percent are renters. Three locations were proposed for acquisition. However, this segment includes no census block groups that have a majority of low to low-to-moderate income residents (USEPA, 2020), so none fall within those block groups.

Islamorada through Plantation Key (Mile Marker 75 through 89.5)
This locality has a 2010 Census population of 2,621. Of this population, approximately 12 percent are minority; 27 percent are low income, and 37 percent are renters. This segment includes one census block group that has a majority of low- to low-to-moderate income residents (USEPA, 2020). Only one acquisition is proposed in this population segment and it is within low or low-to-moderate income block groups. Approximately 100 households that fall within the low or low-to-moderate income block group are proposed for elevations, and thus would be temporarily affected.

Plantation Key through Sunset Point in Tavernier (Mile Marker 89.5 through 96). This locality has a 2010 Census population of 6,449. Of this population, approximately 19 percent are minority; 27 percent are low income, and 34 percent are renters. This segment includes four census block groups that have a majority of low- to low-to-moderate income residents (USEPA, 2020). There are three households proposed for acquisition in this population segment, and they are within majority low or low-to-moderate income block groups. Around 1,000 households that fall within the majority low or low-to-moderate income block group are proposed for elevations, and thus would be temporarily affected.

Sunset Point through North Key Largo (Mile Marker 96 through 111, plus all of North Key Largo)
This locality has a 2010 Census population of 10,545. Of this population, approximately 26 percent are minority; 35 percent are low income, and 34 percent are renters. This segment includes two census block groups that have a majority of low to low-to-moderate income residents (USEPA, 2020). Approximately seven of the 23 households proposed for acquisition in this population segment are within a majority low or low-to-moderate income block groups. At

least 200 households that fall within the majority low or low-to-moderate income block group are proposed for elevations, and thus would be temporarily affected.

Uniform Relocation Act (URA)

As described in the Real Estate Appendix, Appendix F, the following discussion addresses the URA. Affected residents would be compensated through relocation to comparable residences and provided relocation aid, subject to the URA.

- Acquisition. This measure provides for purchasing a structure at the just compensation amount based on the appraised market value at the time and removing it from vulnerable areas by performing a subsequent demolition, and relocation of the residents. This is because acquisition was found to represent the best alternative to eliminating risks to the property and residents. Relocation benefits, based on a myriad of scenarios and qualifications of the resident's status when owning or occupying the home at the time, will apply in accordance with the URA.
- Elevation. Because elevation is voluntary, no relocation reimbursements would be anticipated under the Uniform Relocation Act for homeowners. However, an exception to paying relocation expenses exists when there is an eligible tenant in the property, and the tenant (rather than the property owner) is displaced to accomplish the voluntary measure benefiting the property owned by a lessor. In this case, such tenants may receive relocation benefits. Given that many low-income and minority families are tenants, this would help mitigate the adverse effect on those populations.

Eligible tenants temporarily relocating 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 could be hotels or apartments, depending upon availability in the community. All temporary housing costs require advance approval by the NFS after first obtaining the prior written approval of USACE. General Services Administration (GSA) per diem rates are the basis of allowable hotel reimbursement. Apartment costs are on market rents.

All conditions of temporary relocation must be reasonable. Any residential tenant who temporarily relocated for more than one year must be offered permanent relocation assistance, which may not be reduced by the amount of any temporary relocation assistance previously provided. At a minimum, tenants shall be provided the following: reimbursement for all reasonable out-of-pocket expenses incurred in connection with the temporary relocation, including the cost of moving to and from the temporarily occupied housing, and any increase in monthly rent or utility costs at such housing. Tenants are entitled to receive relocation advisory services as well, including reasonable advance written notice of the following:

- Address of the suitable decent, safe, and sanitary dwelling to be made available for the temporary period;

- Terms and conditions under which the tenant may lease and occupy a suitable decent, safe and sanitary dwelling in the building/complex upon completion of the project; and
- Provisions of reimbursement for all reasonable out of pocket expenses incurred in connection with the temporary relocation as noted above.
- In addition to relocation advisory services, displaced tenants may be eligible for other relocation assistance including relocation payments for moving expenses and replacement housing payments for the increased costs of renting or purchasing a comparable replacement dwelling.

Acquisitions and elevations could present special hardships to the elderly, handicapped, minority, or low income people, for whom moving may be more burdensome. Both acquisitions and elevations also could cause individuals to have to miss days of work during the process, which could adversely affect their families' income. However, unlike acquisitions, which would permanently relocate people, elevations would have a temporary effect, as residents could move back following construction.

Overall, slightly over half of the households that would be affected by acquisition are within low or low-to-moderate income block groups; therefore, more than half of those affected may be residents addressed pursuant to this EO. There also may be affected disadvantaged individuals throughout the Keys that do not necessarily reside in a low or low-to-moderate income block group. There would be a permanent effect of being relocated and not being able to return to their homes if they are acquired. It is notable that mostly, the acquisitions are scattered throughout the Keys; however, the continuity of one community in particular, north of Key West Airport, would be substantially and permanently disrupted as proposed, as its residents would be relocated to varying housing locations. Some residents may not wish to move, and moving could be a burden on low income and/or minority communities in particular.

On the other hand, residents may welcome the opportunity to relocate to an area less prone to storm damage, as well as reasonable moving costs and assistance as described in detail earlier, pursuant to the URA. A mitigating factor is that the residents would qualify for homes with similar values in areas that have less frequent damage due to flooding, in addition to being compensated for reasonable moving expenses. There would be beneficial permanent effects for acquisition and relocation and for elevation, residents relocated to areas would be less susceptible to damage, in the form of improved coastal storm resilience.

Thousands more low and low-to-moderate income households would be subject to the temporary impact of being relocated during the elevation of their homes. This could cause significant temporary effects. One mitigating factor is that elevation is a voluntary measure; property owners may chose not to take advantage of elevation. However, if the residents are renters, then they would be subject to the decisions of the property owner. Another mitigating factor is that tenants would qualify for temporary relocation costs reimbursement. Also, the disruption would be temporary; they could return to the same residences, so their communities

would not be permanently disrupted. Therefore, the elevation measure would not cause significant permanent effects on any disadvantaged populations.

In closing, the Proposed Action would cause temporary and permanent significant effects on low income and/or minority populations that may be adverse or beneficial, depending on perspective.

All members of the public were invited to participate in the NEPA public scoping meetings and to submit comments; and they now have the same opportunity again during the comment period following the release of this Draft EIS. All public comments will be considered in the development of the Final EIS. Therefore, the Proposed Action has met the requirement to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low income populations, and to provide for minority and low income communities' access to public information and public participation.

9.22 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks

This EO ensures that all federal actions address the unique vulnerabilities of children. Prior to any disturbance of structures older than 1978, a Phase 1 Environmental Site Assessment would be required. If ACM, LBP, or PCBs are identified, they will be handled in accordance with RCRA and all other relevant laws. Therefore, in accordance with this EO, the USACE has determined that no children would bear a disproportionately high share of adverse environmental consequences resulting from the proposed work and there should be no effect on children.

9.23 Executive Order 13807, Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects

This EO requires Federal agencies to streamline their environmental review process and decisions collaboratively as One Federal Decision (OFD). The EO sets specific timelines and goals for the concurrence process and NEPA review, requiring the NEPA process to be complete within two years of the date that the Notice of Intent (NOI) was published in the Federal Register.

9.24 Migratory Bird Treaty Act, 16 U.S.C. 703 *et seq.*; Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

This Act makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to federal regulations. The Proposed Action will adhere to the following USACE Jacksonville District's standard migratory and shorebird BMPs:

1. All construction personnel shall 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 shall be present and shall monitor the construction area from April 1 through August 31, unless specifically excepted by a USACE biologist.
4. The bird monitor must be approved by a USACE biologist, and must possess qualifications that include, but are not limited to: identifying bird species, nesting behavior, eggs and nests, and habitat requirements. He or she must also be familiar with state requirements and reporting procedures.
5. The bird monitor shall record any nesting activity in accordance with reporting requirements. Should nesting begin within the construction area, a temporary 200-300 foot buffer, as specified by the monitor and the USACE biologist, shall be created and marked with signs to avoid entry.

With adherence to these BMPs, a minor level of impact is expected on local migratory birds. No significant impacts to migratory birds is expected as a result of project implementation.

CHAPTER 10 CONCLUSIONS AND RECOMMENDATIONS

As a result of the hurricanes and coastal flood disasters in calendar years 2014, 2015, 2016, and 2017 that affected 33 states and three U.S. territories, supplemental investigation funds were appropriated for the initiation and completion of authorized flood and storm damage reduction studies by Public Law 115-123. The Florida Keys Coastal Storm Risk Management Study will be completed at 100 percent federal expense to identify strategies and recommend a project for implementation that would reduce the coastal storm risk and increase resiliency to the people and infrastructure throughout the Keys.

Given the projections for the frequency of intense coastal storms, their associated water surface elevations, and the added uncertainty of SLC, it is clear that coastal storm risk to the Florida Keys is not static and will increasingly affect the Keys. The manner of attaining risk reduction, as well as the level of that risk reduction that is attainable, is influenced by a range of considerations presented in this report. Economics are only one part of the analysis. The USACE, along with the Monroe County and engaged stakeholders has also considered impacts to cultural resources, social effects, and the environment along with the economic evaluation. Based on all the analysis conducted to date, the team has tentatively selected a plan that includes a combination of structural and nonstructural measures. The TSP is a large project with a total project cost of $6.5 billion. The project will provide extensive risk reduction to critical infrastructure, residents, and businesses throughout the Florida Keys. It will also provide coastal storm risk reduction for U.S. Route 1, the critical transportation route for evacuation and connectivity between the islands of the Florida Keys.

10.1 CONSTRUCTION SEQUENCING STRATEGY FOR THE RECOMMENDED PLAN

Due to the size and cost of the TSP, it is unlikely that funding for construction would be made available all at once. The PDT and Monroe County have discussed the need to develop a strategy for implementation and sequencing of the TSP in order to be prepared for available construction funds and to communicate the construction priority to stakeholders. The following sections describe a recommended path forward for project implementation. Appendix G, Nonstructural Implementation Plan, includes detailed information on the implementation of nonstructural measures proposed in the TSP.

10.2 PLAN IMPLEMENTATION

10.2.1 Consistency with Laws and Policy

This integrated feasibility report and EIS has been prepared in accordance with relevant laws and USACE policy. Specifically, this section of the report addresses:

- The specific requirements necessary to demonstrate that the project is technically feasible, economically justified, and environmentally compliant;
- and the costs and cost-sharing to support a Project Partnership Agreement (PPA).

Economic justification and environmental compliance of the TSP are described and demonstrated to be technically feasible within this report. The report also identifies that the TSP has NED benefits greater than costs. The EIS has been prepared to meet the requirements of NEPA and demonstrate that the TSP is compliant with environmental laws, regulations, and policies and has effectively addressed any environmental concerns of resource and regulatory agencies.

10.2.2 Cost Sharing and Real Estate Costs

Project First Cost is the constant dollar cost of the TSP at current price levels and is the cost used in the authorizing document for a project. Total Project Cost is the constant dollar fully funded with escalation to the estimated midpoint of construction. Total Project Cost is the cost estimate used in Project Partnership Agreements (PPAs) for implementation of design and construction of a project. Total Project Cost is the cost estimate provided to non-federal sponsors for their use in financial planning as it provides information regarding the overall non-federal cost sharing obligation. The TSP First Cost is $5.5 billion and the TSP Total Project Cost is $6.5 billion (Tables 10-1 and 10-2).

In accordance with the cost share provisions in Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. 2213), project design and implementation are cost shared 65 percent federal and 35 percent non-federal. The non-federal costs include the value of lands, easements, rights of way and relocations, and disposal/borrow areas (LERRDs). Total LERRDs are estimated to be $183,407,000 with the non-federal contribution estimated to be $2.3 billion (Table 10-2).

Table 10-1: First Cost Apportionment Table

	Federal (65%)	Non-Federal (35%)	Total
Initial Project Cost	$3,599,287,800	$1,938,072,850	$5,537,351,000
LERRD Credit	$0	$161,793,000	$161,793,000
Cash Contribution	$3,599,287,800	$1,776,279,850	$5,375,558,000

Table 10-2: Total Project Cost Apportionment Table

	Federal (65%)	Non-Federal (35%)	Total
Initial Project Cost	$4,213,847,300	$2,268,994,700	$6,482,842,000
LERRD Credit	$0	$183,407,000	$183,407,000
Cash Contribution	$4,213,847,300	$2,085,587,700	$6,299,435,000

Operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) requirements are considered in the economic analysis for the project. The non-federal sponsor is responsible for 100 percent of annual OMRR&R requirements, estimated at $301,000 per year. The federal government is responsible for preparing and providing an OMRR&R manual to the sponsor upon completion of the project.

10.2.3 Non-Federal Sponsor Responsibilities under the Project Partnership Agreement

A PPA package will be prepared, coordinated, and executed subsequent to the completion of the feasibility study and the final approval of this document. The PPA serves as the agreement between the Government and non-federal sponsor for the next phase of the project. The PPA reflects the recommendations of the feasibility study. The non-federal sponsor, Monroe County, Florida, has indicated support for the recommendations presented in this document. At the end of the feasibility study, Monroe County must provide a letter confirming their support for the plan that will be recommended for authorization by Congress and the desire to execute a PPA, which is required to implement the project.

As the non-Federal sponsor, Monroe County must comply with all applicable Federal laws and policies and other requirements, including but not limited to:

A. In a cost sharing coordination with the Federal Government, who shall provide 65% of the initial project cost, provide 35% of the costs of project construction.

1. Provide all lands, easements, rights of way, relocations, and disposal/borrow areas (LERRDs), including suitable borrow areas, uncontaminated with hazardous and toxic wastes, and perform or ensure performance of any relocations determined by the Federal Government to be necessary for the initial construction, operation, and maintenance of this project.

2. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law (PL) 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the construction, operation, and maintenance of the Project. However, for lands that the Federal Government determines to be subject to the navigational servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction.

3. Coordinate all necessary cleanup and response costs of any CERCLA-regulated materials located in, on, or under lands, easements, or rights of way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the project.

4. Cost-share of the cost of mitigation and data recovery activities associated with historic preservation, that are in excess of one percent of the total amount authorized to be appropriated for the project.

B. For fifty years, operate, maintain, repair, replace, and rehabilitate the completed project, or

functional portion of the project, at no cost to the Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and any specific directions prescribed by the Government in the Operations, Maintenance, Replacement, Repair and Rehabilitation (OMRR&R) manual and any subsequent amendments thereto.

C. Provide the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal project partner, now or hereafter, owns or controls for access to the project for the purpose of inspection, and, if necessary after failure to perform by the non-Federal sponsor, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall operate to relieve the non-Federal project partner of responsibility to meet the non-Federal project partner's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance.

D. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors.

E. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal regulations (CFR) Section 33.20.

F. As between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability. To the maximum extent practicable, operate, maintain, repair, replace and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

G. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1790, Public Law 91-646, as amended by Title IV of the Surface Transportation and Unifom1 Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform1 Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights of way, required for the construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

H. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense directive 5500.11 issued pursuant thereto, as well as Army regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

I. Participate in and comply with applicable Federal floodplain management and flood insurance

programs and comply with the requirements in Section 402 of the Water Resources Development Act of 1986, as amended.

J. Not less than once each year, inform affected interests of the extent of storm risk management afforded by the project.

K. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with the degree of storm risk management provided by the project.

L. Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might hinder its operation and maintenance, or interfere with its proper function, such as any new development on project lands or the addition of facilities which would degrade the benefits of the project.

M. Provide and maintain necessary access roads, parking areas, and other public use facilities open and available to all on equal terms.

N. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

O. Quarterly and after storm events, perform surveillance of the project to determine project maintenance or repair needs and provide the results of such surveillance to the Federal Government.

10.2.4 Design and Construction Considerations and Schedule

In order for PED to be initiated, USACE must sign a PPA with a non-Federal sponsor to cost share PED and construction. This project would require congressional authorization for PED and construction. PED and construction are cost shared 65 percent federal and 35 percent non-federal. Implementation would then occur, provided that sufficient funds are appropriated to design and construct the project.

A draft schedule for plan implementation was developed for planning and cost estimating purposes (Table 10-3). Actual construction timelines are subject to future project approval and appropriation of implementation funds.

Table 10-3: Draft Implementation Schedule

Florida Keys, Monroe County Coastal Storm Risk Management Project	
Milestone	**Date**
Submission of Chief's Report	**March 2021**
Chief Signs Report	**September 2021**
Execute Design Agreement*	**March 2022**
Pre-Construction Engineering and Design (PED)*	**May 2022**
Congress Authorizes Project	**WRDA 2024**
New Start Approval	**May 2024**
Project Partnership Agreement (PPA)*	**December 2024**
First Construction Contract Award*	**June 2025**
Construction Complete*	**August 2030**

*Requires additional funding beyond Feasibility Report

10.2.5 Real Estate Requirements

The non-federal sponsor is required to provide LERRDs necessary to implement a USACE Civil Works project. Currently, the TSP will require the non-federal sponsor to acquire temporary and permanent easements for construction. Total LERRDs cost is estimated to be $183,407,000.

10.2.6 Views of the Non-Federal Sponsor

The non-federal sponsor, Monroe County, Florida, has indicated their support for releasing this report for public and agency review and comment. USACE will request that the non-federal sponsor provide a formal letter of support and self-certification of financial capability before the Agency Decision Milestone and it will be included in Appendix F of the final report.

10.3 PATH FORWARD

A Chief's Report, the report of the U.S. Army Corps of Engineers Chief of Engineers, is developed when a water resources project requires Congressional authorization for construction. After the final feasibility report is submitted to USACE Headquarters, a Chief's Report is developed. Once the Chief of Engineers signs the report, the Chief of Staff signs the notification letters forwarding the Chief's Report to the chairpersons of the Senate Committee on Environment and Public Works and the House of Representatives Committee on Transportation

and Infrastructure. The signed Chief's Report is also supplied to the Office of the Assistant Secretary of the Army for Civil Works for review by the Administration.

This report, “Florida Keys Integrated Coastal Storm Risk Management Feasibility Study and Environmental Impact Statement” is scheduled to be submitted to USACE Headquarters in March 2021. A signed Chief’s Report is anticipated in September 2021.

Using the information in this feasibility report, the USACE will continue to coordinate with Monroe County to implement the recommended project in accordance with current policy and in the most expeditious manner available by maximizing the use of available construction and study authorities (i.e. modifications of ongoing projects/studies, post-authorization change reports, or new authorizations).

10.4 RECOMMENDED ACTIONS FOR OTHERS

While the USACE project would provide a significant reduction in coastal storm risk throughout the Keys, the recommended plan does not address all of the coastal storm risk experienced in the Florida Keys under current conditions or in the future. The study authority limits the study analysis to the effects of coastal storms including storm surge with consideration for wave attack, erosion, and sea level change in the estimates of inundation and how it is expected to damage infrastructure. This study did not formulate plans to address the impacts of general sea level rise that is often referred to as “sunny day flooding,” precipitation, or direct effects of wind associated. Due to these study limitations, there is some risk that will remain even with the recommended plan. This remaining risk is referred to as residual risk, which is inherent to any coastal storm risk management study as there is not one project that can reduce 100 percent of all facets of coastal storm risk in any study area.

Under the RP there remains residual risk from flooding beyond the design limitations, there are areas of the city that are outside the alignment of the RP, and nonstructural areas will still see impacts to roadways, utilities and the environment due to flooding. The USACE recognizes that the USACE authority and formulation methodology is limited in what it can provide, therefore, the study includes recommended actions for sponsor and other entities to consider in a holistic approach to flood risk mitigation and overall resiliency.

10.4.1 U.S. Route 1

FDOT is the agency responsible for the maintenance and repair of U.S. Route 1 and the agency has been meeting this responsibility to the best of their ability as funding has allowed. FDOT will be completing various shoreline stabilization projects along U.S. Route 1 in the next few years and it is recommended that they continue to not only maintain, but continually evaluate these projects and other areas along U.S. Route 1 to assess their vulnerability to coastal storm damage and if there are ways that they can be adapted to improve resiliency.

10.4.2 Nonstructural Recommendations

Monroe County has enacted code that de-incentivizes development in high risk areas, identifies building special building requirements and restrictions to reduce coastal storm risk to residential and nonresidential structures, and limits new residential development in the Keys with the goal

of maintaining an evacuation time of 24 hours as prescribed by the State of Florida. These regulations are encouraged to be maintained and expanded upon throughout the Keys as they are important in reducing the level of coastal storm risk throughout the Keys. It is also important that the county continues their work on current ongoing resilience initiatives and engages in new efforts as resources allow. Monroe County has recognized the need for adaptation measures for sea level rise and "sunny day" flooding and is currently working on various studies and projects to reduce the impacts of sea level rise in the Keys.

10.4.3 Natural and Nature Based Features

NNBF could not be included in the TSP, but the PDT recognizes that there are various opportunities for the implementation of NNBF in the Florida Keys even though they could not be recommended considering the authority for this study and the limitations protected habitat placed on the NNBFs considered in this study. Opportunities for NNBFs in the Florida Keys include both the enhancement/expansion of existing natural resources and the addition of natural features in new areas. The PDT recommends that Monroe County, the five municipalities, state and Federal resource agencies, and other non-governmental organizations in the Keys continue to prioritize the restoration of NNBFs in the Keys as a method of not only reducing coastal storm risk, but also improving the overall quality of the environment.

10.5 LIST OF AGENCIES CONTACTED

Table 10-4 list the agencies contacted through the process of this study.

Table 10-4: Agencies Contacted

Agency	Name of Contact People
Federal Emergency Management Agency	Gracias Szczech
Federal Highway Administration	Brandye Hendrickson
National Oceanic and Atmospheric Administration, Florida Keys National Marine Sanctuary	Lisa Symons, Joanne Delaney
National Oceanic and Atmospheric Administration, Marine Fisheries Service	Jennifer Schull, Pace Wilber, Sophie Godfrey-McKee
National Oceanic and Atmospheric Administration, Protected Resources Division	Sarah Furtak
National Park Service	Robert Johnson
U.S. Army Corps of Engineers	Maria Bezanilla

Agency	Name of Contact People
U.S. Coast Guard	Rear Admiral Peter Brown
U.S. Environmental Protection Agency	Jamie Higgins
U.S. Fish and Wildlife Service	Jeff Howe
U.S. Navy	Captain Bobby Baker
Florida Bureau of Historic Preservation, State Historic Preservation Officer	Jason Aldridge
Florida Bureau of Natural and Cultural Resources	Leah Gerlock
Florida Department of Environmental Protection	Roxanne Dow, Gus Rios, Gregory Garis, Meredith Kruse, Travis Ferguson
Florida Department of Environmental Protection, Department of Parks and Recreation	Diane Martin, Mark Duncan, Donald Bergeron
Florida Department of Environmental Protection, Southern Florida Watershed Management District	Kaitlyn Lizza
Florida Department of Transportation	Steven James, Elizabeth Fulcher, Jacquelyn DeAngelo, James Wolfe
Florida Wildlife Conservation Commission	Sue Schaf, James Keltner
Seminole Tribe of Florida, Tribal Historic Preservation Officer	Bradley M. Mueller
The Seminole Nation of Oklahoma	Gregory Chilcoat
Miccosukee Tribe of Indians	Fred Dayhoff
Monroe County Historic Preservation Commission	Diane Silva

10.6 LIST OF REPORT PREPARERS

Table 10-5 list the list of preparers who worked on this study and their years of experiences within their specific specialties.

Table 10-5: Report Preparers

Name	Contribution/Education
Bryan Adkins	Cost Engineering
Trent Elder	Geotechnical Engineering
Rachel Haug	Plan Formulation/BS, Environmental Policy & Planning
John Haynes	Cultural Resources/MA, Anthropology
Denise Kammerer-Cody	Economics/MS, Environmental Resource Management & Administration
Candice Miranda, EIT	Hydrology and Hydraulics/BS, Civil Engineering
Jesse Morrill-Winter	Economics
Paul Moye, P.E., CFM	Floodplain Management/BS, Civil Engineering
Stacey Nolan	Real Estate/ BS, Parks, Recreation & Tourism
Kathy Perdue	Environmental Analysis/BS, Environmental Science
Shannon Reinheimer	Environmental Analysis/BS, Biology
Matt Schulze, REM	Geotechnical Engineering/BS, Civil Engineering
Justine Woodward	Environmental Analysis/MS, Marine Science
Tammy Younkins	GIS/

10.7 STATEMENT FROM THE DISTRICT ENGINEER

I concur with the findings of the PDT and advise the TSP, as fully detailed in this Integrated Feasibility Report and Environmental Impact Statement, be authorized for construction as a Federal project.

I have given consideration to all significant aspects of the public interest. These interests include environmental, social, and economic effects that are anticipated from the implementation of the Recommended Plan. The engineering feasibility and compatibility of the project with the policies, desires, and capabilities of Monroe County, the State of Florida, and other non-federal interests have also been considered.

The recommendations contained herein reflect the information and policies available at this

time. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of highest review levels within the Executive Branch. Consequently, the recommendations may be modified by the Chief of Engineers before they are transmitted to Congress as proposals for authorization and implementing funding. However, prior to transmittal to Congress, the non-federal sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Patrick V. Kinsman, PE

Colonel, U.S. Army

Commanding

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