RESILIENCE ACTION PLAN

STATE HIGHWAY SYSTEM

JUNE 2023

On behalf of the Florida Department of Transportation (FDOT), I am pleased to present the 2023 State Highway System Resilience Action Plan.

At FDOT, serving communities is at the heart of everything that we do. Florida continues to be one of the fastest growing states for both population and economic activity. At the same time, we also face a growing range of hazards, including hurricanes, other extreme weather events, and changing longer-term trends.

Resilience allows our infrastructure system to adapt to changing conditions and provide reliable transportation to all Floridians. Ensuring the resilience of our transportation system – and more importantly, the communities it serves – is one of our highest commitments to Florida's residents, visitors, and businesses.

The Resilience Action Plan examines the vulnerabilities of the State Highway System to flooding, storm surge, and other outside forces and identifies areas Florida can prioritize investments. This plan also identifies strategies for enhancing resilience in all aspects of how we plan, develop, design, construct, operate, and maintain the State Highway System. These strategies will help us apply the full range of our workforce, technology, and financial resources – as well as collaborate with our partners – to enhance the resilience of our existing system.

As we implement and update the Resilience Action Plan in the years to come, understanding each community's needs and priorities will support a transportation system that prioritizes the safety of our residents and visitors, improves the reliability of both personal travel and the supply chain, and enhances our quality of life.

I want to thank all our partners and the public who contributed to the development of this Action Plan. Your input will help us build a resilient transportation system that can turn challenges into opportunities and prepare Florida for the future.

EXECUTIVE SUMMARY

Florida's growing communities, unique location, geography, and environmental resources place the state at risk to hazards including flooding, storms, and sea level rise. The Florida Department of Transportation (FDOT) has a history of intentionally addressing exposure and vulnerability of transportation facilities to weather events and remains committed to building and maintaining transportation infrastructure designed to withstand or rapidly recover from these kinds of shocks and stresses.

The State Highway System (SHS) is a critical asset for moving people and freight. This Resilience Action Plan recommends strategies to improve the System's resilience. The statutory objectives of this plan are to:

- *Recommend strategies to enhance infrastructure and the operational resilience of the State Highway System that may be incorporated into the transportation asset management plan;*
- *Recommend design changes to retrofit existing state highway facilities and to construct new state highway facilities; and*
- *Enhance partnerships to address multijurisdictional resilience needs.*

FDOT developed the Action Plan in collaboration with local governments, metropolitan planning organizations, state and federal agencies, and other partners. The planning process included a review of existing policies, procedures, and guidance documents and an assessment of the SHS's vulnerability to certain water-related hazards.

The vulnerability assessment found that of the 12,121 centerline miles and 4,850 bridges on the SHS:

- 1,820 (15%) are located in a 100-year floodplain, including 2,156 bridges;
- 1,412 (12%) are located in a Category 3 storm surge zone including 1,334 bridges; and
- 138 (1%) are located in areas that could experience two feet of sea level rise by 2070, including 967 bridges.

It's important to note that roadway facilities and bridges are within a geographic area that may be exposed to hazards, but the facilities themselves may or may not be at risk due to their design.

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The specific potential impacts of these hazards will be determined through more detailed assessments, but the results of the vulnerability assessment allowed a starting point for prioritizing resilience improvements. Considering the hazards studied in combination, the plan identifies 57 centerline miles as high priority, 709 as medium priority, and 1,781 as low priority. These priorities can guide FDOT's Districts as they work with communities to determine vulnerability for retrofit, redesign, or potential relocation of existing infrastructure.

The Plan also lists strategies to increase the resilience of the SHS. The strategies address planning; project development and environment; design, materials, and construction; traffic operations and emergency management; and asset management and maintenance. The Transition to Implementation section identifies actions needed to implement these strategies.

This Resilience Action Plan focused on the SHS; however, its understood that county and local facilities are critical linkages in the transportation system as a whole, and those facilities located within the priority tiers identified in the plan may also be affected by the hazards. Collaboration and partnerships with communities are key to ensuring a resilient transportation system.

INTRODUCTION

The Florida Department of Transportation (FDOT) is committed to providing a safe transportation system that ensures the mobility of people and goods, enhances economic prosperity, and preserves the quality of our environment and communities. As part of that commitment, FDOT strives to build and maintain transportation infrastructure designed to withstand or recover from shocks and stresses.

This Plan focuses on potential hazards that could impact the State Highway System and the communities it serves. Some hazards are **shocks**, or unexpected short-term events or deviations from trends that can have a range of substantial negative effects. This plan focuses on specific shocks such as hurricanes and tropical storms. Other hazards are **stresses**, or long-term trends or pressures that undermine the stability and increase the vulnerability of the State Highway System. This plan focuses on specific stresses such as sea level rise and changing climate patterns.

Major storms, flooding, and sea level rise can cause temporary and permanent road closures, one-time and recurring road damage, and unsafe conditions that may prevent safe travel for Florida's residents, businesses, and visitors to their homes, work, school, medical care, and other important services. These conditions can significantly impact the quality of life and economy of Florida's communities.

In 2022, the Governor and Legislature directed FDOT to develop a Resilience Action Plan for the State Highway System (SHS) to assess potential impacts of flooding, storms, and sea level rise based on current conditions and potential future events. Three goals were identified for this Action Plan:

Recommend strategies to enhance infrastructure and the operational resilience of the State Highway System that may be incorporated into the transportation asset management plan

Recommend design changes to retrofit existing state highway facilities and to construct new state highway facilities

Enhance partnerships to address multijurisdictional resilience needs

This first Resilience Action Plan builds on FDOT's history of purposeful actions in support of a more resilient transportation system, while embracing continual improvement. It summarizes Florida's long track record of focusing on infrastructure resilience while giving direction for future resilience strategies by FDOT.

A. Max Brewer Bridge, Titusville

ACTION PLAN ORGANIZATION

The Resilience Action Plan is designed to meet all statutory requirements while also providing an overview of the importance of resilience, the evolution of resilience in Florida, and the strategies FDOT will advance to enhance resilience of the SHS.

Section 339.157, Florida Statutes, requires this plan to include an assessment of the SHS to identify resilience issues, alternatives, and prioritized needs; a systemic review of existing policies, procedures, and guidance documents; and provision of technical assistance to local agencies and modal partners on resilience issues. The table below shows each required element and the pages where it is addressed in the plan.

RESILIENCE ACTION PLAN REQUIRED ELEMENTS

REQUIRED ELEMENT	PAGE(S) WHERE ADDRESSED
Assessment of the State Highway System, including:	
• Synthesize historic and current issues	8-11
• Evaluate alternatives for retrofitting	12-17
• Develop prioritization criteria for resilience project identification	18-19
• Develop a prioritized resilience needs projects list	20-21
• Develop a statewide database	22-23
Systemic review of the department's policies, procedures, manuals, tools, and guidance documents	24
Provision of technical assistance to local agencies and modal partners on resilience issues	31

KEY TERMS USED IN THIS PLAN

Adaptation: Adjustment in natural or human systems in anticipation of or in response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative effects.

Exposure: When an asset or system experiences direct effects of climate variability or extreme weather events. Exposure is a prerequisite for vulnerability.

Hazard: Encompasses both shocks and stresses as defined below.

Resilience: The ability to adapt to changing conditions and prepare for, withstand, and recover from disruption.

Risk: A combination of the likelihood that an asset will experience a particular climate impact and the severity or consequence of that impact.

Shocks: Unexpected short-term deviations from trends that can have a range of substantial negative effects. These include events such as hurricanes.

Stresses: Long-term trends or pressures that undermine the stability of a system and increase vulnerability, such as sea level rise and changing climate patterns.

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change or extreme weather events.

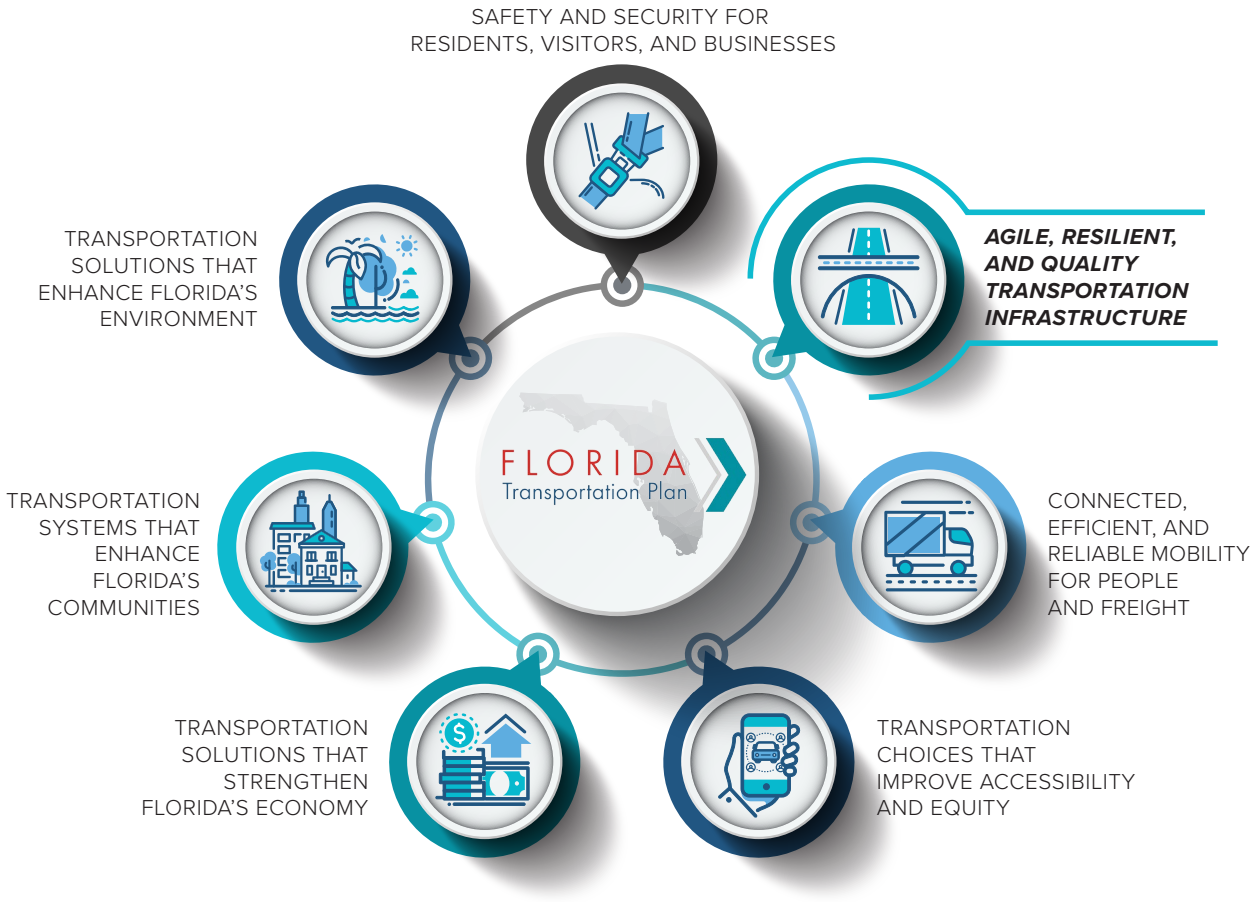
ACTION PLAN DEVELOPMENT

The Resilience Action Plan focuses on the 12,121 roadway centerline miles on the State Highway System (SHS) owned and maintained by FDOT. The development of this Action Plan included four key activities:

- Alignment with long range and policy plans of FDOT and its partners;
- A systematic review of the department's existing policies, procedures, manuals, tools, and guidance documents;
- An assessment of the SHS's vulnerabilities to certain water-related hazards; and
- Collaboration with internal and external partners to identify strategies to improve resilience on the SHS.

ALIGNMENT WITH LONG RANGE AND POLICY PLANS

The Florida Transportation Plan (FTP) is the state's long range transportation plan that guides Florida's transportation future. It is a plan for all of Florida created by, and providing direction to, FDOT and its statewide, regional, and local transportation partners. The FTP includes the following goals:



The goal of **"Agile, resilient, and quality transportation infrastructure"** recognizes the importance of transportation resilience and speaks to the need to plan, design, and construct infrastructure to withstand and recover from potential risks, such as extreme weather events and climate trends. Resilience is addressed in many FDOT plans. This Resilience Action Plan builds on the goals and objectives of FDOT and its partners.

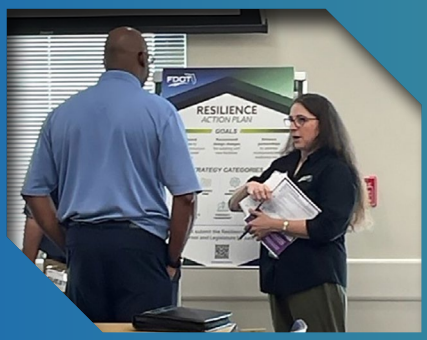
REVIEW OF FDOT POLICIES AND PROCEDURES AND INTERNAL COLLABORATION

FDOT conducted a self-assessment to understand how resilience is incorporated and integrated into the agency's business practice. This comprehensive self-assessment included a detailed review of FDOT's policies, procedures, manuals, tools, and guidance documents. The findings from this assessment informed the strategies and technical assistance portions of this Plan.

An internal cross-functional technical advisory team met regularly during the development of this Action Plan to provide subject matter expertise on the methodology of the vulnerability assessment, validate the data analysis and mapping, provide targeted input on strategies, and coordinate and disseminate information regarding the plan.

VULNERABILITY ASSESSMENT

FDOT conducted a vulnerability assessment of the SHS to identify segments of the SHS that may be affected by rainfall flooding, storm surge, sea level rise, and tidal flooding hazards. From this analysis, priority geographic areas and associated costs for resilience enhancements were identified and data gaps and opportunities were noted.



ACTION PLAN DEVELOPMENT

True to FDOT's ongoing commitment to community engagement, this Resilience Action Plan was developed with input from partners and the public. Engagement activities strengthen coordination, encourage input, and promote dialogue for a more inclusive and comprehensive planning process. A Community Engagement Plan (CEP), developed early in the process, guided the engagement activities.

FDOT CONDUCTED MORE THAN
40 BRIEFINGS
INVOLVING STATE, REGIONAL, AND LOCAL PARTNERS

The Resilience Action Plan development process actively sought and considered input from many interested groups including community stakeholders and agency partners. Input was gathered through a combination of briefings, presentations at partner and stakeholder meetings and workshops, and other input opportunities as presented. Partners reached included state agencies; associations representing regional and local government interests; regional resilience entities; community and environmental organizations, and other interested organizations and citizens. Throughout plan development, the participants provided valuable feedback that helped shape this Action Plan.

COMMUNITY STAKEHOLDERS

FDOT made valuable use of established partnerships with local and regional entities including metropolitan planning organizations (MPOs) and regional planning councils (RPCs). Tailored briefings to the MPO Advisory Council and individual MPOs allowed for specific comments and concerns to be discussed for this plan. During the Florida Metropolitan Planning Partnership meeting, specific comments on the strategies were received and used to refine the strategy statements. A briefing to the Florida Regional Councils Association engaged the RPCs collectively to share their resilience efforts and provide comments for this plan. Other standing groups were briefed to ensure a comprehensive collection of thoughts and ideas for this Action Plan, including the FTP Implementation Committee and the Environmental Partners Working Group.

Building on partnerships with regional resilience entities, a joint meeting of these organizations from around the state was held to leverage resources toward making meaningful resilience gains at the statewide and regional levels. Overall, briefings, webinars, and one-to-one meetings were conducted to receive input. FDOT also leveraged project work already in progress within FDOT Districts to build on existing collaboration.

AGENCY COORDINATION

To ensure agency coordination throughout the process, FDOT consulted regularly with Florida's Chief Resilience Officer to brief him on the development of the plan and receive his input. FDOT actively engaged in interagency coordination efforts already underway including monthly meetings of the Interagency Working Group for Resilient Recovery led by the Statewide Office of Resilience consisting of FDOT, the Florida Department of Environmental Protection (FDEP), Florida Department of Economic Opportunity (FDEO), and Florida Division of Emergency Management (FDEM). These agencies regularly engage in resilience activities and had relevant input on resilience strategies, approaches to measuring vulnerability, and potential technical assistance offerings. The working group provided FDOT with a valuable forum for their perspective-based input. In addition to these monthly meetings, FDOT reached out directly to FDEP, FDEO and FDEM to ensure coordination of statewide resilience efforts across state agencies. To capture an even broader perspective, FDOT also reviewed literature and other research from the American Association of State Highway and Transportation Officials and the National Cooperative Highway Research Program.

WHAT WE HEARD

- **Enhance coordination efforts with federal and state agencies**
- **Continue to integrate statewide efforts with regional and local activities for a holistic approach**
- **Consider every transportation project for possible resilience improvements**
- **Provide guidance on best practices**
- **Increase the list of hazards in future iterations**
- **Leverage data developed so local communities can link without recreating**
- **Continue collaboration around nature-based solutions to resilience**
- **Consider effects of compound flooding**
- **Consider hazard impacts on transit**

In addition to briefings and meetings, information on the Resilience Action Plan was available on the Department's website at Resilience (fdot.gov). A statewide webinar was held May 25, 2023, to kick-off a 14-day public comment period. The draft plan was available on the plan website for review along with an online comment form to obtain feedback. Over 170 comments were received, reviewed, and addressed in this final Resilience Action Plan.

FLORIDA'S RESILIENCE STORY

With 1,350 miles of coastline, Florida is vulnerable to sea level rise, flooding, and hurricanes and other tropical storms. Impacts of these hazards to the transportation system have long been a consideration in transportation planning and design.

Local agencies and MPOs prioritize projects that meet the needs of their communities. Throughout the transportation development process, project managers consider the potential impacts of hazards and identify strategies to adapt to, mitigate, or recover from those hazards.

Just as the laws and regulations addressing land use and development, design and construction standards, and evacuation practices have evolved, so too have strategies for addressing hazards affecting transportation facilities. For example, recognizing the impacts groundwater could have on a roadway facility as far back as the 1960s, FDOT design standards have required a three-foot clearance between the bottom of roadway base material and the estimated base clearance water elevation. Another example of inherent resilience is designing facilities to minimize damage and accelerate recovery from the shock of a hurricane.

Today's standard practices include using several past innovations that make facilities more resilient to high winds and water. For example, placing traffic signals on mast arms instead of hanging them from wires makes the signals more resilient to high wind conditions and less likely to be dislocated or disabled, keeping roadways safer. Using painted pavement markings helps ensure drivers can navigate without working traffic signals. Other resilience innovations that have been implemented successfully include:

- High-mast lighting with moveable fixtures, which allow adjustment into a more protective position during the storm and return to normal position as soon as the storm is over for fast recovery;
- Non-corrosive materials, which help facilities endure long periods of saltwater inundation; and
- Stormwater infrastructure, drainage design, maintenance procedures, and backflow preventers all prevent water from backing up in drainage systems, averting tidal intrusion and reducing repair times.

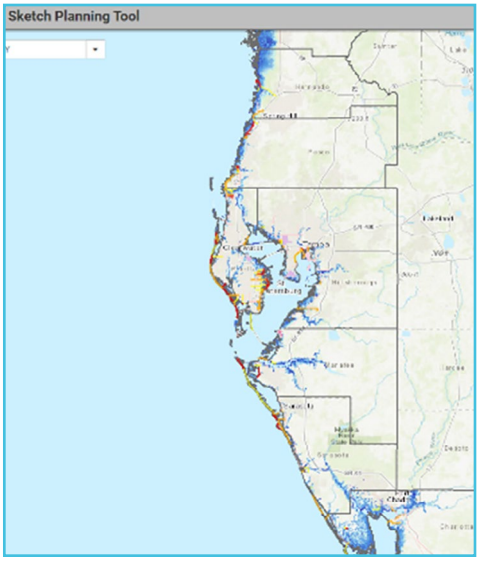
FDOT embraces creative adaptations to enhance the environment and protect communities and infrastructure. Nature-based solutions such as living shorelines, wetland enhancements, and oyster bed breakwaters, in concert with traditional infrastructure improvements, make roads that are more resilient to rising seas and more intense storms.

US1/Overseas Highway shoreline protection and road raising near Sea Oats Beach in Islamorada

SR A1A resilience improvements following Hurricane Sandy, Ft. Lauderdale

In addition to evolving design and construction practices, FDOT has invested in improvements to planning tools and practices to better incorporate the assessment of risks. For example, the Sea Level Scenario Sketch Planning Tool, an online tool to assess the effects of sea level rise on roadways, started as a proof-of-concept project in 2012. Currently, this tool also includes FEMA floodplain data, and its use has expanded to MPOs, RPCs, and other local and regional government agencies.

The concept of "resilience" or being able to operate in such a manner that the shocks and stresses do not cause widespread system failure has been exercised throughout FDOT's maintenance, operations, and evacuation protocols and practices for decades. Currently, FDOT's Transportation Asset Management Plan (TAMP) incorporates resilience as part of asset management.



Example from the Sea Level Scenario Sketch Planning Tool.

In 2020, FDOT adopted a resilience policy that defines the principles of resilience as **"the ability to adapt to changing conditions and prepare for, withstand, and recover from disruption."** The policy also acknowledges that hazards vary throughout the State and coordinated efforts within FDOT and among agencies and organizations are needed to ensure information sharing and alignment of resilience strategies.

FDOT coordinates with the FDEP, FDEO, FDEM, other state agencies, and the state's Chief Resilience Officer in a team effort to leverage resources. Each of these agencies contributes to sharing information and working to align resilience efforts across the state. FDOT also fosters established partnerships with local and regional collaborations, such as local governments, MPOs, RPCs, and regional resilience entities.

In addition to the Florida Transportation Plan, resilience is also addressed in other plans, such as:

STATEWIDE

- Strategic Intermodal System Policy Plan
- Transportation Asset Management Plan
- Florida Freight Mobility and Trade Plan
- Modal system plans for aviation, seaport, waterways, and rail
- Carbon Reduction Strategy (underway)
- Electric Vehicle Infrastructure Deployment Plan

REGIONAL AND LOCAL

- Long range transportation plans of Florida's metropolitan planning organizations;
- Local government comprehensive plans
- Climate action and resilience plans

HISTORICAL & CURRENT CONDITIONS

COMMUNITY TRENDS & CONDITIONS

Florida is one of the nation's largest and fastest-growing states, with more than 22.2 million residents as well as more than 137 million out-of-state visitors each year. About nine out of 10 residents live in urban areas and more than three out of four live in a coastal county today. Ensuring the safety, health, and prosperity of Florida's residents and visitors across 411 cities and 67 counties during shocks and stresses is a critical priority for FDOT and its partners as Florida continues to grow.

FLORIDA HAS A POPULATION OF
22.2 MILLION
TODAY, RANKING
3RD
AMONG THE STATES

Source: Bureau of Economic and Business Research (BEBR).

FLORIDA'S
65+ POPULATION
IS PROJECTED TO
GROW BY 73%
BY 2045

Source: BEBR.

15 MILLION PEOPLE
[3 IN 4 FLORIDA RESIDENTS] *LIVE IN A* **COASTAL COUNTY**

Source: US Census.

60% OF POPULATION GROWTH
BETWEEN 2021 AND 2050 IS PROJECTED TO BE CONCENTRATED IN
10 COUNTIES
[ORANGE, HILLSBOROUGH, MIAMI-DADE, LEE, PALM BEACH, BROWARD, POLK, OSCEOLA, DUVAL & PASCO]

Source: BEBR.

FLORIDA IS PROJECTED TO ADD
548 NET NEW PEOPLE PER DAY
BETWEEN 2021 AND 2050

Source: BEBR.

THE TOTAL NUMBER OF
OUT-OF-STATE VISITORS
TO FLORIDA IS PROJECTED TO
INCREASE 55%
BETWEEN 2019 AND 2031

Source: Economic Demographic Research.

FLORIDA'S TRANSPORTATION TRENDS & CONDITIONS

An extensive multimodal transportation system supports Florida's residents, businesses, and visitors. The State Highway System accounts for about 10 percent of Florida's nearly 124,000 centerline miles of public roads. It also supports the operation of urban and rural transit systems and connects with freight and passenger rail networks, seaports, commercial service and general aviation airports, and spaceports to move people and freight to, from, and within Florida. This plan focuses on the essential role of the State Highway System, but recognizes that shocks and stresses that impact this system also can impact other public roads and modal facilities.

- **12,121** CENTERLINE MILES OF SHS
- **4,850** BRIDGES ON SHS
- **19** COMMERCIAL SERVICE AIRPORTS
- **16** PUBLIC SEAPORTS
- **8** ACTIVE SPACEPORT LAUNCH SITES
- **30** URBAN TRANSIT SYSTEMS
- **2,738** MILES OF MAINLINE RAILROAD TRACK
- **18** RURAL TRANSIT SYSTEMS

Source: FDOT Florida Transportation Fast Facts.

This plan focuses on four specific hazards – rainfall flooding, storm surge, sea level rise, and tidal flooding – that may impact the SHS and the communities it serves.

THE AMOUNT OF
PRECIPITATION DURING HEAVY RAINSTORMS HAS INCREASED BY
27%
IN THE SOUTHEAST OVER THE LAST
60 YEARS

Source: US Environmental Protection Agency.

Rainfall flooding: As temperatures warm, the air holds more moisture in clouds before releasing it as rain. This can result in longer intervals between rain events and storms generating heavier rain in shorter periods of time, overwhelming stormwater and road drainage systems and leading to flooding. Florida's flat terrain keeps flood waters from draining quickly, including flooding from rain events, storm surge from hurricanes, and tides made worse by sea level rise.

ACCORDING TO NOAA,
SEA LEVELS
ARE PROJECTED TO
RISE 10 TO 12 INCHES
IN THE NEXT
30 YEARS,

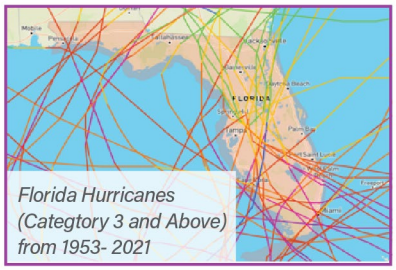
Source: 2017 State of U.S. High Tide Flooding with a 2018 Outlook.

Sea level rise: Sea level rise is an increase in the level of the world's oceans because of increased temperatures. One of the major causes of global sea level rise is thermal expansion caused by warming of the ocean. Sea levels will continue to rise due to warming that has already occurred. Higher sea levels amplify the impacts of storm surge, high tides, and coastal erosion. At about 3 millimeters per year, sea level rise may not seem like a big contributor to flooding in Florida. However, some types of infrastructure are not functioning as designed decades ago because of rising sea levels.

HURRICANE IAN

SEPTEMBER 2022
2.6M
RESIDENTS AFFECTED
10'-15'
STORM SURGE
$113B
IN ESTIMATED COSTS

Source: NOAA.



Florida Hurricanes (Categtory 3 and Above) from 1953- 2021

Storm surge: This rush of water inland during a tropical weather event is a hazard felt mostly at the coast, but rivers can transmit this surge far upstream. During Hurricane Ian in September 2022, storm surge levels were 10-15 feet above normally dry ground at Fort Myers Beach. As the storm crossed the state with continued rainfall – days after the storm had passed – water levels on the St. Johns River near Jacksonville fluctuated and the river continued to rise. This posed a threat to areas that were already dealing with storm recovery.

SINCE 2000,
TIDAL FLOODING
ACROSS FLORIDA HAS
INCREASED BY
352%

Source: sealeverise.org.

Tidal flooding occurs when sea level rise combines with local factors to push water levels above the normal high tide mark. Changes in prevailing winds, shifts in ocean currents, and strong tidal forces—which occur during a full or new moon—can all cause tidal flooding, inundating streets even on sunny days. According to the National Oceanic and Atmospheric Administration's (NOAA) High Tide Flooding Outlook, tidal flooding varies around the state with up to 6 days experienced in 2021.

All exhibits on pages 10-11 include the most recent available data. A full list of sources can be found at Resilience Action Plan sources.

VULNERABILITY ASSESSMENT

The vulnerability assessment of the State Highway System (SHS) included three steps:

STEP 1: IDENTIFY POTENTIAL IMPACTS

The vulnerability assessment first identified **geographic areas** that may be subject to water-related hazards. Inland locations, as well as coasts, lakes, and riverine locations, are at risk, but the roadway facilities in these at-risk areas may or may not be at risk themselves. The hazards examined included:

- **Rainfall Flooding,** using Flood Hazard Zone data from the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs).
- **Storm Surge,** using data provided by the Florida Division of Emergency Management based on the National Oceanic and Atmospheric Administration (NOAA) Seas, Lakes, and Overland Surges from Hurricanes (SLOSH) model.
- **Sea Level Rise,** using data provided by NOAA.
- **Tidal Flooding,** using data provided by NOAA.

Within the geographic areas affected by these hazards, FDOT identified segments of SHS roads and bridges exposed to each hazard. Because FDOT's objective in using inherently resilient techniques is for roads to be designed, built, and maintained to withstand or recover quickly from events, state roads are typically at higher elevations than the surrounding area and may not be inundated when the surrounding area is flooded.

Best available data were used for this assessment; additional and more refined data can be used in future assessments as they become available. Agencies and local governments have prepared resilience assessments using other data or prioritization methods, and their results may differ. This first assessment emphasizes the SHS, and the transportation system relies on these and other roads to provide mobility and access for people and goods. FDOT will coordinate with local partners on data and local/intersecting road conditions as more in-depth resilience reviews are performed as part of project development.

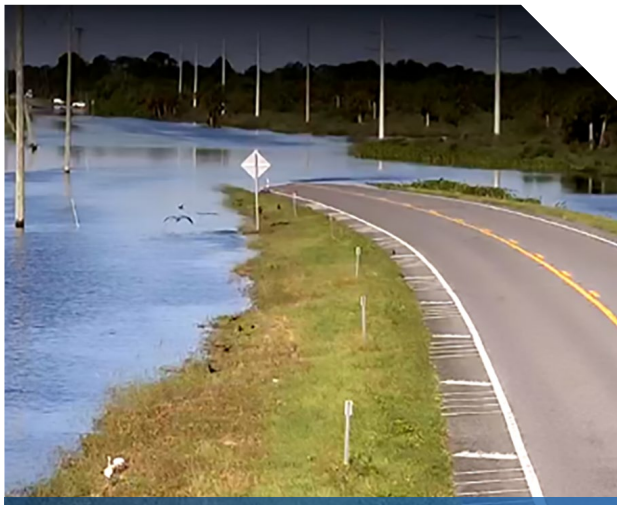
Additional detailed studies are needed to determine if the road or bridge itself would be impacted by a hazard based on specific characteristics of the facility and location.

In this section, the summed length of the segments potentially affected by a hazard is provided in centerline miles.[1] It is important to note there could be many of these segments along a specific roadway or bridge, making it difficult to report all these details in a statewide assessment. To accompany the Resilience Action Plan, FDOT prepared a database of the vulnerability assessment and prioritization analysis results (see page 20).

HAZARDS AND IMPACTS

Rainfall Flooding

Data from rainfall flooding events are reported in "return intervals" which reflect the likelihood or percentage chance that flooding will occur in an area. For this plan, FDOT looked at geographic areas that have a 1% and 0.2% chance of being flooded in a year. These areas are also referred to as the 100-year and 500-year floodplains, respectively, and are shown as Flood Hazard Areas on Flood Insurance Rate Maps produced by FEMA. Because Florida is a low-lying, relatively flat state, one out of every ten feet of Florida's SHS lies within the 100-year floodplain. Map 1 (Page 14) shows the Flood Hazard Zones of 1% and 0.2% annual chance return. Centerline miles and bridges exposed to this hazard are also shown.



SR 46 following Hurricane Ian, Brevard/Seminole County Line

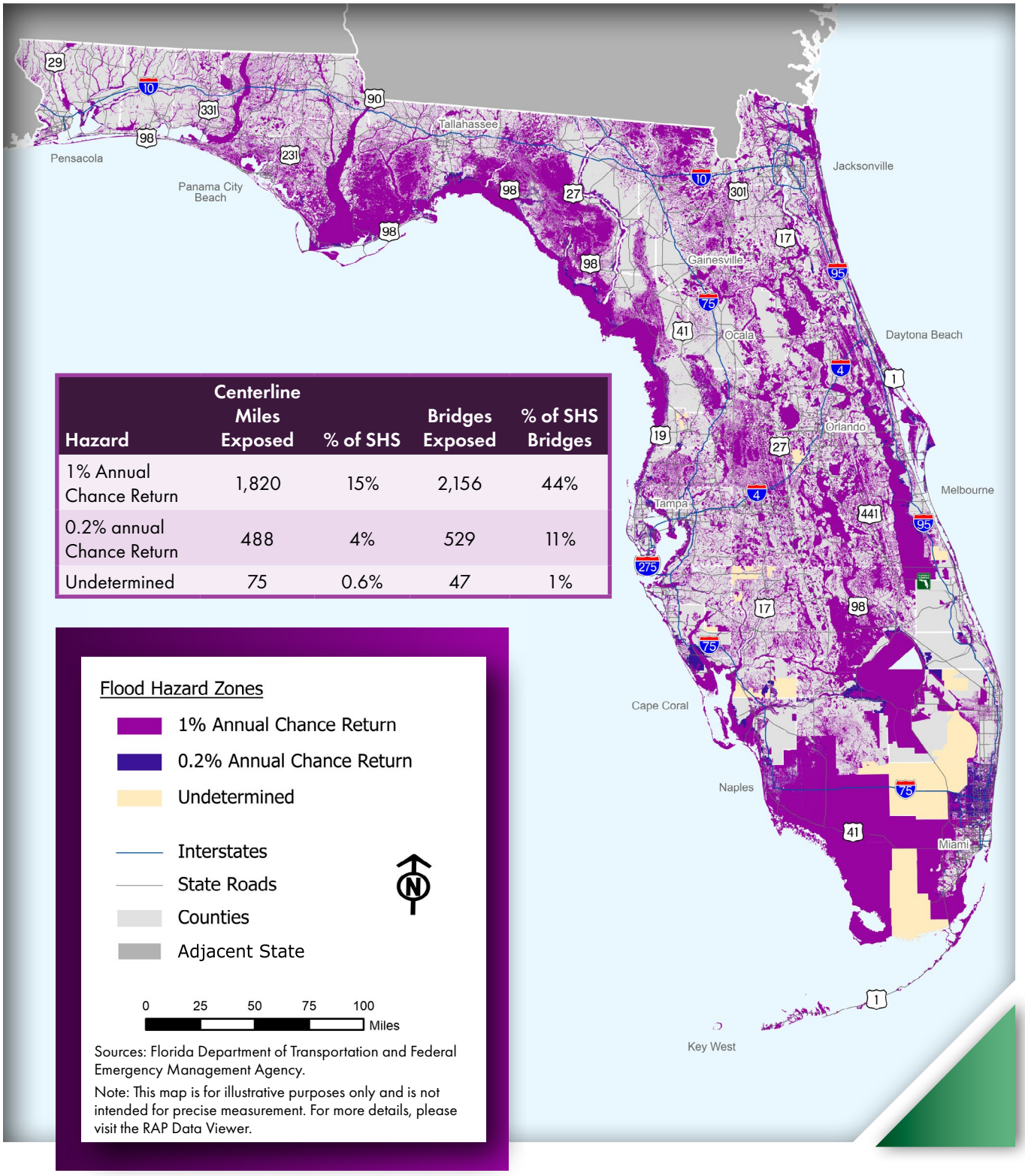
Storm Surge

While weather agencies provide flood and tropical weather watches and warnings, where and how strongly a storm will hit are still highly variable and can change unexpectedly. Hurricane strengths are referred to as Categories 1 through 5 based on wind speeds. Evacuations are ordered based on the areas to be affected by storm surge which is also affected by wind speed. For this plan, three hurricane categories were evaluated as described by the Saffir-Simpson Hurricane Scale: Category 1, where dangerous winds will produce some damage; Category 3, where devastating damage will occur; and Category 5, where catastrophic damage will occur. During hurricanes, storm surge is routinely anticipated along Florida's coasts, riverine areas and even lakes, particularly Lake Okeechobee, can be impacted by the push of water from wind. Map 2 (Page 15) shows current storm surge zones based on Category 1, 3, and 5 hurricanes. Centerline miles and bridges exposed to this hazard are also shown.

Storm surge along US 41 near Picayune Strand during Hurricane Ian

1 Centerline miles reflect the distance or length of a road segment regardless of the number of travel lanes it has. Statistics reported in lane miles factor in the number of lanes that may be part of a road segment. For example, a one mile stretch of a two-lane road consists of one centerline mile and two lane miles.

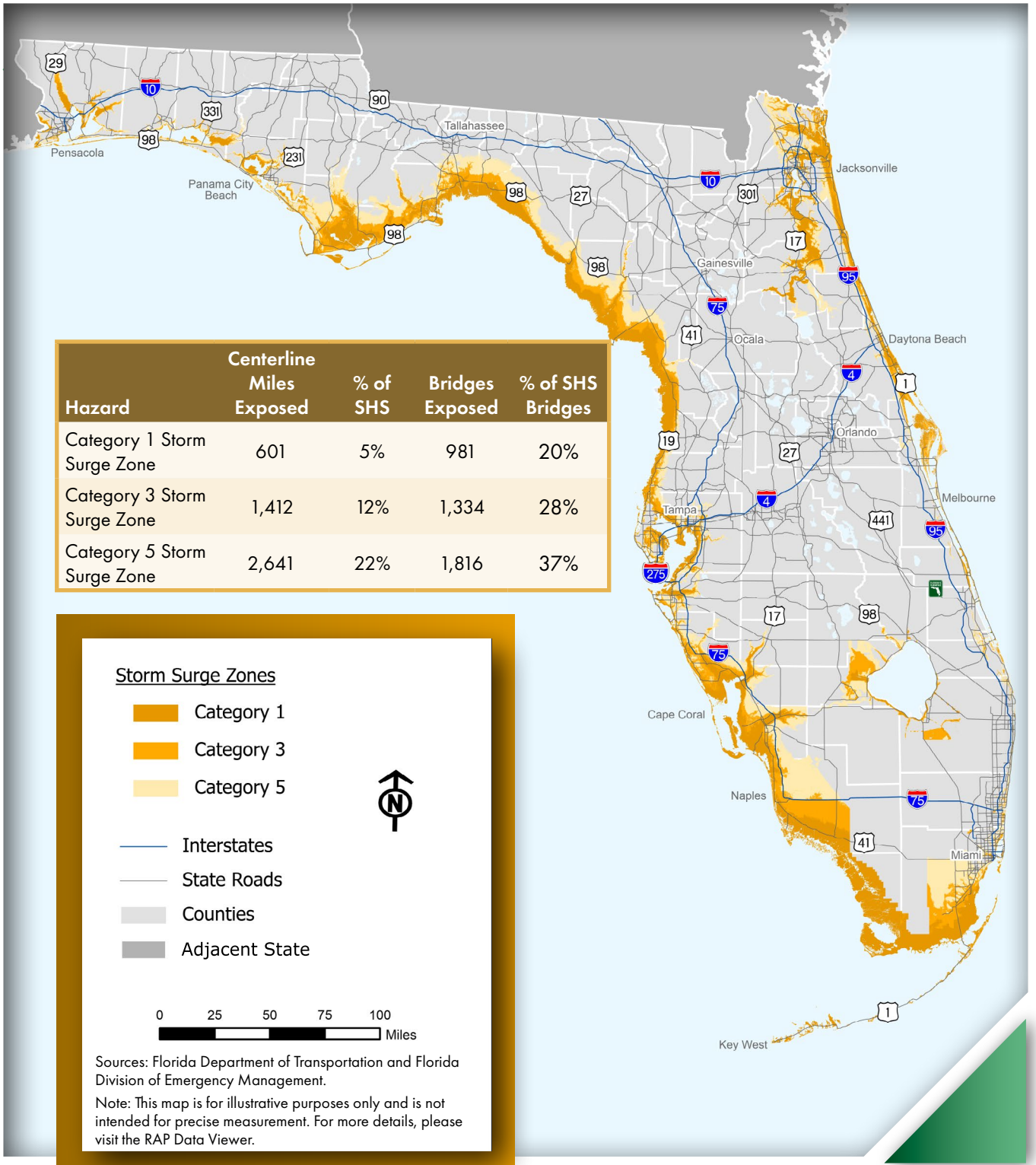
MAP 1. FLOOD HAZARD ZONES



Hazard	Centerline Miles Exposed	% of SHS	Bridges Exposed	% of SHS Bridges
1% Annual Chance Return	1,820	15%	2,156	44%
0.2% annual Chance Return	488	4%	529	11%
Undetermined	75	0.6%	47	1%

This is Map 1 in a series of 4 maps and should be reviewed collectively. For readability, data in water areas were omitted. The facilities in these areas are identified as exposed, as appropriate.

MAP 2. STORM SURGE ZONES: CATEGORIES 1, 3, AND 5



Hazard	Centerline Miles Exposed	% of SHS	Bridges Exposed	% of SHS Bridges
Category 1 Storm Surge Zone	601	5%	981	20%
Category 3 Storm Surge Zone	1,412	12%	1,334	28%
Category 5 Storm Surge Zone	2,641	22%	1,816	37%

This is Map 2 in a series of 4 maps and should be reviewed collectively. For readability, data in water areas were omitted. The facilities in these areas are identified as exposed, as appropriate.

VULNERABILITY ASSESSMENT

Sea Level Rise

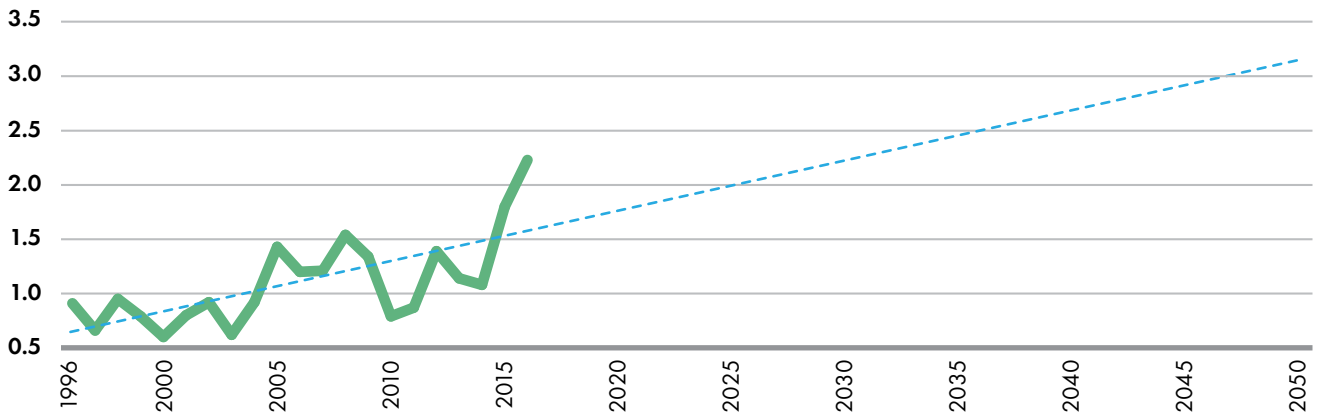
While flooding and storm surge result from short-term extreme weather or prolonged rainfall, sea level rise and tidal flooding are hazards that are slowly unfolding. Roads and bridges are planned for, designed, and maintained to last for up to several decades, so the future effects of sea level rise are important considerations for transportation agencies and communities. However, sea level is changing at different rates in different regions, and the amount of sea level rise is not experienced uniformly across the state. Assets may be improved to last different time frames based on service life and knowing which assets are affected by varying amounts of sea level rise offers flexibility. As such, the Resilience Action Plan uses an approach to identify affected geographic areas instead of using projections provided by NOAA (2022). Map 3 (Page 17) shows Sea Level Rise for 1, 2, 3, and 5 feet. Centerline miles and bridges in areas exposed to this hazard are also shown.

Tidal Flooding

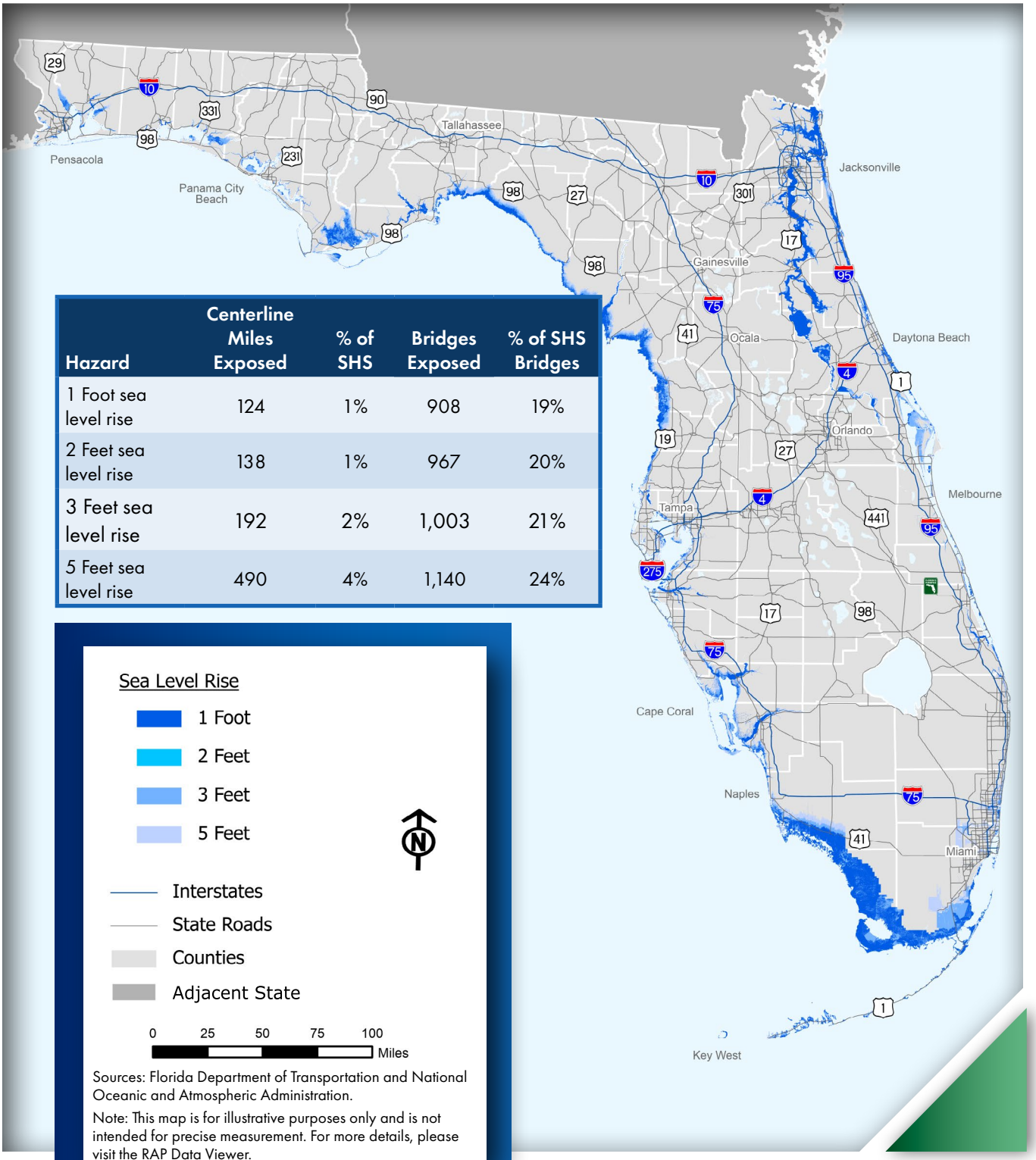
SR A1A during tidal flooding, Hollywood

Tidal flooding is associated with sea level rise, and like sea level rise, its effects are important considerations for transportation agencies and communities. The amount of tidal flooding an area experiences depends on the local high tide ranges and associated natural and built environments. Infrastructure, such as sea walls and back-flow preventers, can help to minimize local impacts. NOAA provides tidal flooding data at 15 locations in Florida where tide gauges are deployed to track sea levels. In 2000, four of these locations identified sea levels at heights that resulted in tidal flooding, with one or two days per year at each location. In 2016 (latest observed data), 11 of the gauges saw sea levels at heights to produce tidal flooding, with three to eight days at each location that year. The tide gauges provide a small snapshot of tidal flooding, and numerous communities in Florida are affected by tidal flooding - sometimes more frequently, particularly with the spring and fall tides. As sea levels are expected to rise, Floridians will experience more tidal flooding events. Sea levels fluctuate, and the chart below shows the five-year rolling average of tidal flooding days and the linear trend since 2000 for the 15 tide gauges. NOAA estimates an increasing rate of sea level rise and associated tidal flooding with a curved instead of a linear projection. A linear trend assumes the past rate of increased tidal flooding will continue in the future, and a curved (or exponential) trend reflects an increasing rate of change. By 2050, for the 15 tide gauge locations, an average of 20 days per year tidal flooding may occur, with some NOAA estimates higher at hundreds of days per year.

5-YEAR ROLLING AVERAGE NUMBER OF HIGH TIDE FLOOD DAYS



MAP 3. SEA LEVEL RISE: 1, 2, 3, AND 5 FEET



Hazard	Centerline Miles Exposed	% of SHS	Bridges Exposed	% of SHS Bridges
1 Foot sea level rise	124	1%	908	19%
2 Feet sea level rise	138	1%	967	20%
3 Feet sea level rise	192	2%	1,003	21%
5 Feet sea level rise	490	4%	1,140	24%

This is Map 3 in a series of 4 maps and should be reviewed collectively. For readability, data in water areas were omitted. The facilities in these areas are identified as exposed, as appropriate.

STEP 2: DEVELOP PRIORITIZATION TIERS

This plan defines prioritization criteria to serve as a guide for FDOT and partner agencies to use when making decisions about SHS infrastructure. The prioritization is based on the number of hazards affecting a location. The more hazards a geographic area is expected to be exposed to, the higher the priority. The specific hazards and thresholds used and the rationale for using them are:

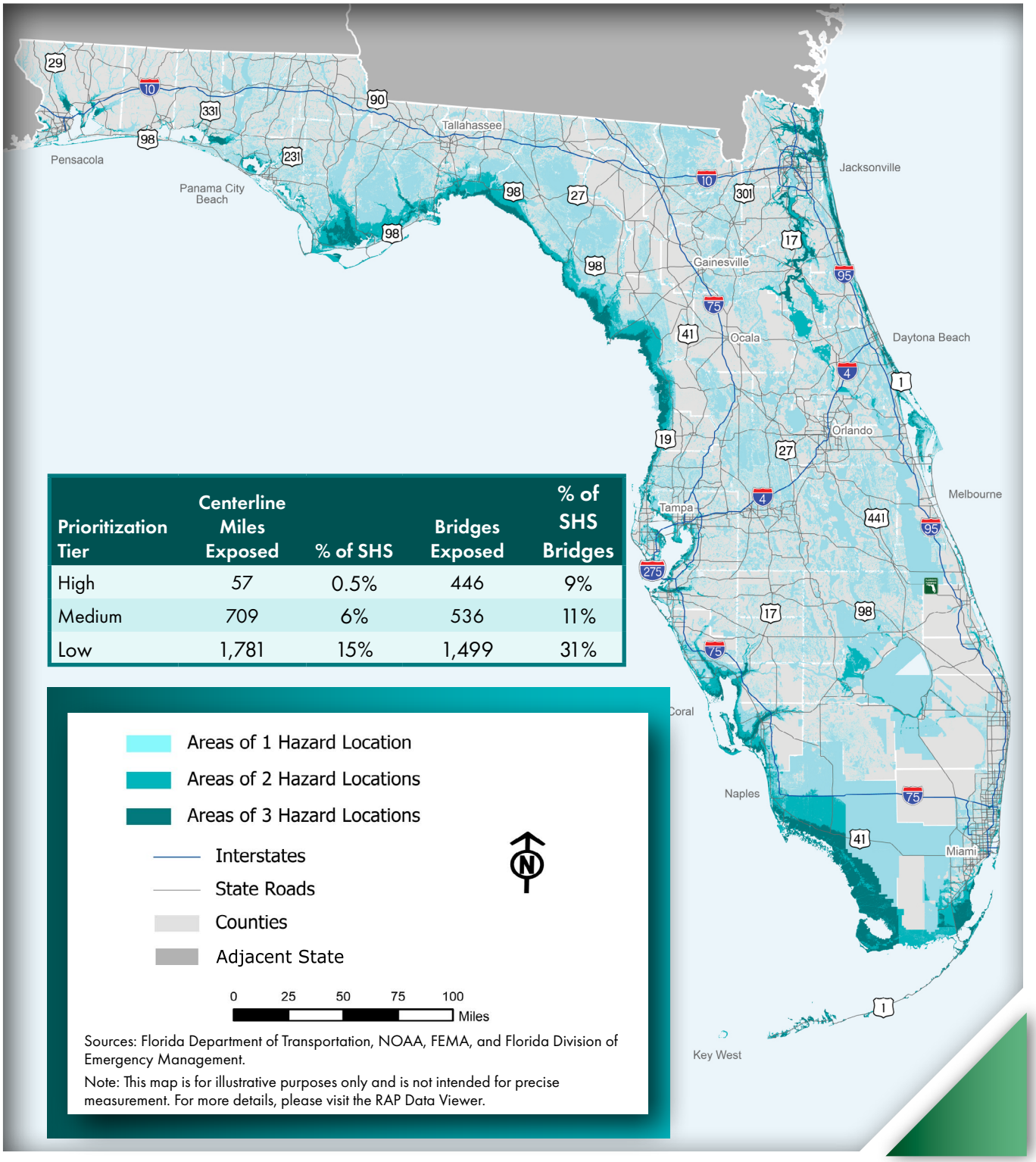
- **One percent (1%) flood return interval (100-year floodplain) –** Shows the extent of inland, riverine, and coastal flooding. The 0.2% return interval frequency (or 500-year floodplain) was considered too infrequent or unlikely to be included.
- **Storm surge for a Category 3 hurricane –** Reflects a moderate scenario for resilience purposes. Storm surge extents are periodically revised based on new data, and future resilience plan updates can revisit this threshold.
- **Two feet of sea level rise –** Based on long-range transportation planning horizons. Tidal flooding is not included as a separate hazard because it reflects an increasing sea level and could be considered duplicative.

VULNERABILITY TIERS

	HAZARDS AFFECTING A GEOGRAPHIC AREA		
VULNERABILITY	1% CHANCE OF FLOODING (100-YEAR FLOOD ZONE)	2 FEET OF SEA LEVEL RISE	CATEGORY 3 STORM SURGE
High	Geographic areas affected by **all** three hazards		
Medium	Geographic areas affected by **any two** of the three hazards		
Low	Geographic areas affected by **any one** of the three hazards		

Map 4 shows high, medium, and low vulnerability for geographic areas based on the prioritization tiers identified in the assessment. Centerline miles and bridges exposed within these tiers are also shown.

MAP 4. HIGH, MEDIUM, & LOW VULNERABILITY GEOGRAPHIC AREAS: AREAS OF 1-3 HAZARD LOCATIONS



Prioritization Tier	Centerline Miles Exposed	% of SHS	Bridges Exposed	% of SHS Bridges
High	57	0.5%	446	9%
Medium	709	6%	536	11%
Low	1,781	15%	1,499	31%

This is Map 4 in a series of 4 maps and should be reviewed collectively. For readability, data in water areas were omitted. The facilities in these areas are identified as exposed, as appropriate.

STEP 3: COMPILE A PROJECT LIST

The third step in the vulnerability assessment is to compile a list of current or potential projects, with associated cost estimates, for resilience needs in the high- and medium-tier geographic areas.

A list of projects within the high- and medium-priority geographic areas is included as **Appendix A**. The projects on this list are planned projects in the Department's Five-Year Work Program, the Strategic Intermodal System Second Five-Year Plan, and potential projects in the Strategic Intermodal System Cost Feasible Plan or that were identified by FDOT districts based on resilience needs. The projects listed are only those occurring on the potentially affected segments of the SHS within the high- and medium-tier geographic areas.

PROJECT COST SUMMARY BY TIER

Tier	Exposed SHS Centerline Miles	Exposed Bridge Centerline Miles	Total Number of Projects	Number of Projects in 5-Year Work Program	Total Cost Currently Programmed in 5-Year Work Program (Millions of $)	Average Cost per Project (Millions of $)
High	57	46	43	34	$438.47	$8.22
Medium	709	61	111	37	$230.62	

Projects not in the Work Program will be further developed and prioritized in conjunction with the local agencies and MPOs. Determining specific resilience investments and design techniques among strategies depends on the location of a project and specific road or bridge infrastructure being enhanced or built new. For example, whether the infrastructure is in an urban or rural area also influences viable solutions. Planning or project development and environment (PD&E) studies are typical ways to perform a detailed analysis of the potential impacts of hazards. Various alternatives are considered, and subsequent project designs and construction will further specify resilience enhancements.

The projects in the Work Program reflect total project costs and not only specific resilience improvements. The Department incorporates resilience into project development, design, construction, operations, and maintenance activities. Typically, resilience improvements are not implemented separately from other roadway or bridge improvements. A resilience-only project is one in which the primary goal of the project is to improve the resilience of the facility, as opposed to increasing capacity, for example. A capacity project could have resilience enhancements added, but resilience is not the primary goal. FDOT would expect to include resilience enhancements in existing projects or projects being pursued for safety, mobility, or accessibility reasons.

ADAPTATION APPROACHES

Resilience adaptation approaches can be applied individually; however, a variety of approaches are commonly applied depending on the needs of the area, the development patterns and characteristics around the project, or future stresses such as sea level rise.

Roadway and bridge adaptation approaches seek to: 1) protect an asset from harm, such as by raising the elevation or altering the alignment of infrastructure, or 2) allow the asset to withstand a hazard event like flooding or storm surge through the use of resilient designs, materials, or construction techniques. Pavement subbase or surface materials can be used that withstand inundation for longer periods to avoid washouts or compromise. Hardening shoulders or medians with materials or certain types of vegetation can assist in rapid recovery of inundated roads. Stormwater management and drainage techniques also assist in protecting an asset by storing rain or surge water temporarily until it evaporates, absorbs into the soil, or flows back out to sea. Providing additional storage in retention or detention ponds and providing roadway drainage through swales or stormwater systems can also be effective, if feasible.

Example adaptation approaches include:

- Backflow preventers and pumps to stop or reduce tidal or rainfall flooding.
- Pavement design or materials to withstand inundation/overtopping.
- Shoulder and median protection to stabilize road foundations and pavement through landscaping or hardscaping to withstand inundation/overtopping.
- Coastal area wave attenuation protection through natural or built solutions, such as rip rap or sea grasses to reduce erosion due to wave action.
- Coastal and riverine area protection with nature-based approaches such as dune enhancement, beach nourishment, or nature-based infrastructure embedded in drainage and stormwater systems.
- Drainage enhancements such as stormwater detention and retention, improved conveyance to address flooding, and basin- and watershed-level improvements to reduce flooding.
- Road elevation changes to raise a road above potential hazardous impacts.
- Relocation of affected infrastructure and the creation of redundant systems to improve system resilience.

The Department is implementing new steps to capture and track resilience-specific project costs.

SR A1A emergency repair after Hurricane Nicole, Flagler County

Wave attenuation devices (WAD) to reduce erosion

STATEWIDE DATABASE

In support of the Resilience Action Plan, FDOT developed a statewide database identifying assets vulnerable to current and future flooding. A cost estimate and schedule for enhancing the database with more site-specific information to improve the needs identification and prioritization process was also developed.

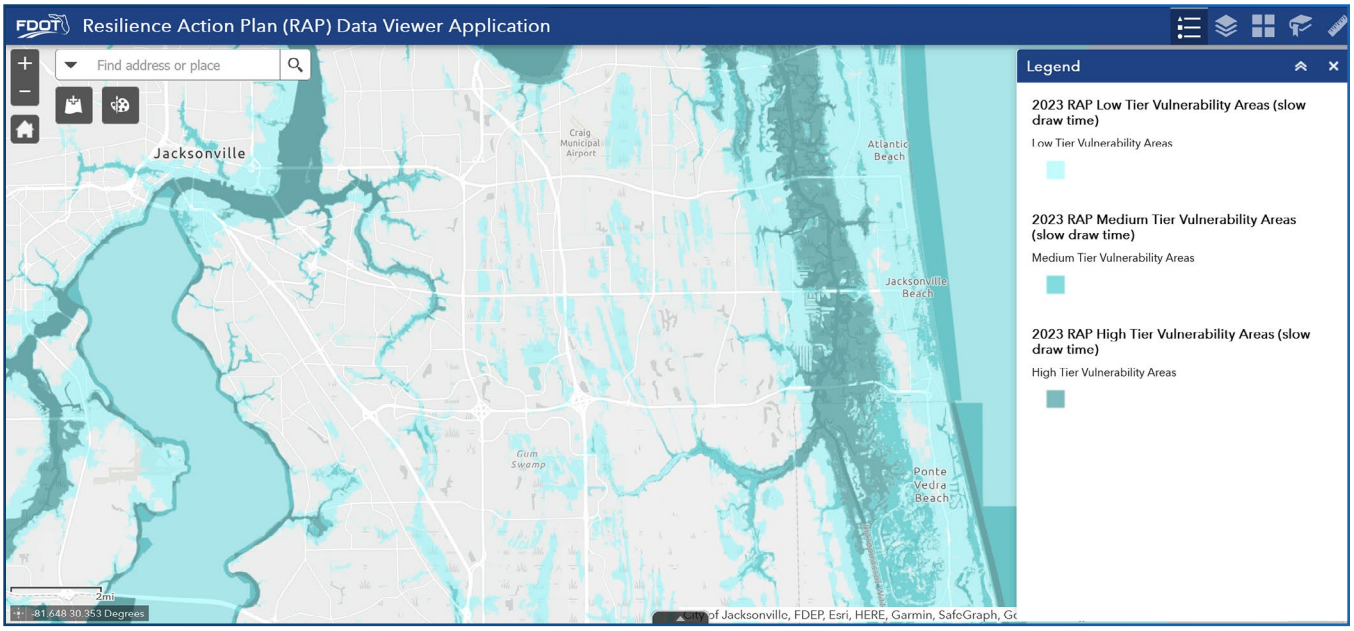
DATABASE

The database comprises the information used to conduct the statewide vulnerability assessment and identify the associated priority tiers. A Geographic Information System (GIS) is used to house the data, and mapping and data are access applications are provided to retrieve and display information. The RAP Data Viewer allows users to view and download data.

The database includes:

- ***State Highway System facilities;***
- ***FEMA Floodplains – one percent and 0.2 percent return intervals;***
- ***Sea level rise at multiple depths;***
- ***Storm surge extents;***
- ***State Highway System road segments and bridges in each of the priority tiers.***

The statewide database allows FDOT staff to evaluate potential impacts of different scenarios for flooding, sea level rise, and storm surge. This approach is the most effective method of incorporating these data into analysis and decision-making for all project phases. The data can be integrated into existing applications and processes, such as the Area of Interest Tool in the Environmental Screening Tool and mapping to support partner coordination.



POTENTIAL ENHANCEMENTS TO THE DATABASE

Enhancements to this statewide database could include adding data on:

- **Historical events,** showing past flooding, damage, or repairs. This would involve compiling existing mapped data and developing new data to identify and map each affected area, perhaps from the past 10 years of hurricanes and tropical storms. A procedure could be developed to include information on future events as they occur.
- **Roadway elevation.** Future vulnerability assessments should incorporate water hazard inundation depth information as well as the heights, or elevation, of transportation infrastructure. The existing database shows where storm surge, flooding, and sea level rise can be expected; however, it does not include information on which roads and bridges were built higher than ground level. FDOT's Survey Office is leading a statewide effort to obtain data and create high-resolution models of ground information. A next phase of that work would be to identify elevation data for all SHS roads and bridges. Additional activities could include enhancing the Sea Level Scenario Sketch Planning Tool to use roadway elevation information and include elevation data into the existing Roadway Characteristics Inventory.
- **Drainage assets, such as outfalls and culverts.** Some FDOT drainage engineers have inventories of drainage systems and infrastructure to meet individual district needs; others do not. Statewide coordination and coordination with regional and local agencies is needed to track both new infrastructure and existing systems consistently. This effort should include statewide drainage asset data collection and inventories, followed by development of an asset management system and program to better support scheduled maintenance similar to that for pavement conditions.
- **Other shocks and stresses, such as heat.** The initial database focuses on flooding-related shocks and stresses. Other disruptions should be considered such as extreme heat, wildfires, sinkholes, and/or tornadoes.

Another way to enhance the database is to integrate new data as it is published. The Florida Flood Hub for Applied Research and Innovation within the University of South Florida College of Marine Science is tasked with providing tidal and storm surge flooding data, as well as rainfall and compound flooding datasets. The timing for incorporating revised data into the Resilience Action Plan database depends on when the new datasets become available. These data updates would likely be an iterative process, where layers/datasets are added as they are published.

The table below provides initial cost estimates and schedule for enhancements.

ESTIMATED COST AND SCHEDULE FOR ENHANCEMENTS

POTENTIAL ENHANCEMENT	ESTIMATED COST	SCHEDULE
Historical Events	$500,000	Near-term
Integrating Best Available Data	$750,000	Periodic updates
Roadway Elevation Data	$1,250,000	Mid-term
Drainage Assets Inventory and Management System	$4,500,000	Long-term
Other Hazards	$750,000	Near-term

REVIEW OF FDOT POLICIES & PROCEDURES

As part of developing the Resilience Action Plan, FDOT conducted a systemic review of its existing policies, procedures, manuals, tools, and guidance documents to identify potential revisions that would facilitate cost-effective approaches for improving the resilience of the SHS. FDOT also analyzed how resilience is integrated throughout the agency. More than 230 FDOT staff participated in self-assessments that looked at three broad dimensions - people, processes, and tools – across multiple functional areas. The review and self-assessment identified the following potential opportunities and needs, which were considered in developing strategies for this plan:

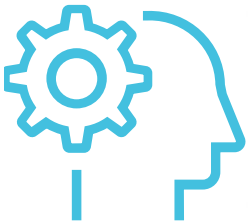
- **Resilience as a concept spans from planning through construction to operations** of the SHS, and therefore cuts across many policies, plans, and guidance documents. A **cohesive approach** to incorporating resilience through all of these documents - including consistent terminology and definitions - would maximize integration of resilience throughout the SHS.
- Many staff across these functional areas have job responsibilities that involve some aspect of resilience. FDOT staff will need a **strong understanding of the Resilience Policy and the Resilience Action Plan**, including how these policies and plans impact the responsibilities and activities of individual offices and staff. **Enhanced training** to explain shocks and stresses and their impact on mobility, accessibility, and safety would be valuable, including targeted training for specific functional areas. Structures to encourage ongoing collaboration across functional areas will be needed as well.
- **Guidance for planning and early decision-making**, such as planning scopes of work, the Project Development and Environment (PD&E) manual, and resilience guidance for long-range transportation planning for FDOT and MPOs could benefit from greater discussion of shocks and stresses that might affect potential projects and the approaches that could be considered in developing project alternatives. Areas covered could include purpose and need, effects of climate and extreme weather, resilience cost estimating, and addressing equitable outcomes.
- **Design standards could continue to be augmented** to include research, testing, and deployment of new materials, designs, and construction techniques, such as asphalt and concrete mixes, saltwater and storm resistant assets, and innovative stormwater management.
- **Operations procedures could be enhanced** to further ensure safety and mobility during evacuations and disruptions such as through enhanced use of technology and real time information, as well as rapid recovery such as through debris clearance and emergency repairs.
- **Many procedures and manuals could be enriched** to provide greater emphasis on agile and adaptive planning and decision-making.
- **New enhanced data and tools** can support many of these functions – including the statewide database discussed on pages 22-23, as well as greater integration of data on shocks and stresses into existing tools such as the bridge and pavement management systems.
- Throughout these processes, there is **opportunity for greater collaboration with local governments** to cohesively address local road and SHS improvements consistent with community visions, including considerations of building future facilities farther from areas affected by disruptive shocks and stresses.

STRATEGY FRAMEWORK

The Resilience Action Plan defines a set of strategies to help FDOT increase the resilience of the SHS. These strategies provide the framework for FDOT to collaborate with local, regional, and statewide partners to enhance infrastructure and operational resilience for the SHS, and through these actions support communities statewide. These strategies were developed in response to the vulnerabilities, potential impacts, and prioritized needs identified in this plan.

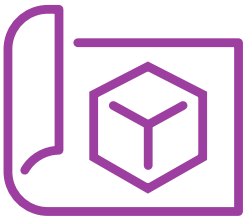
All strategies work in concert with the Florida Transportation Plan's overarching commitment to identify and mitigate risks throughout Florida's transportation system. In keeping with statutory guidance and FDOT's resilience policy, the strategies address all phases of planning and managing the SHS, from planning and project development and environment through design and construction, traffic operations and emergency management, and into asset management and maintenance.

FDOT already is implementing many strategies and actions related to resilience as part of its day-to-day operations. This plan highlights existing strategies that should receive greater emphasis, as well as new strategies for implementation during the next few years.



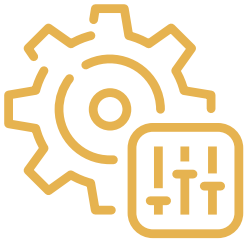
PLANNING

PROJECT DEVELOPMENT & ENVIRONMENT



DESIGN, MATERIALS, & CONSTRUCTION

TRAFFIC OPERATIONS & EMERGENCY MANAGEMENT



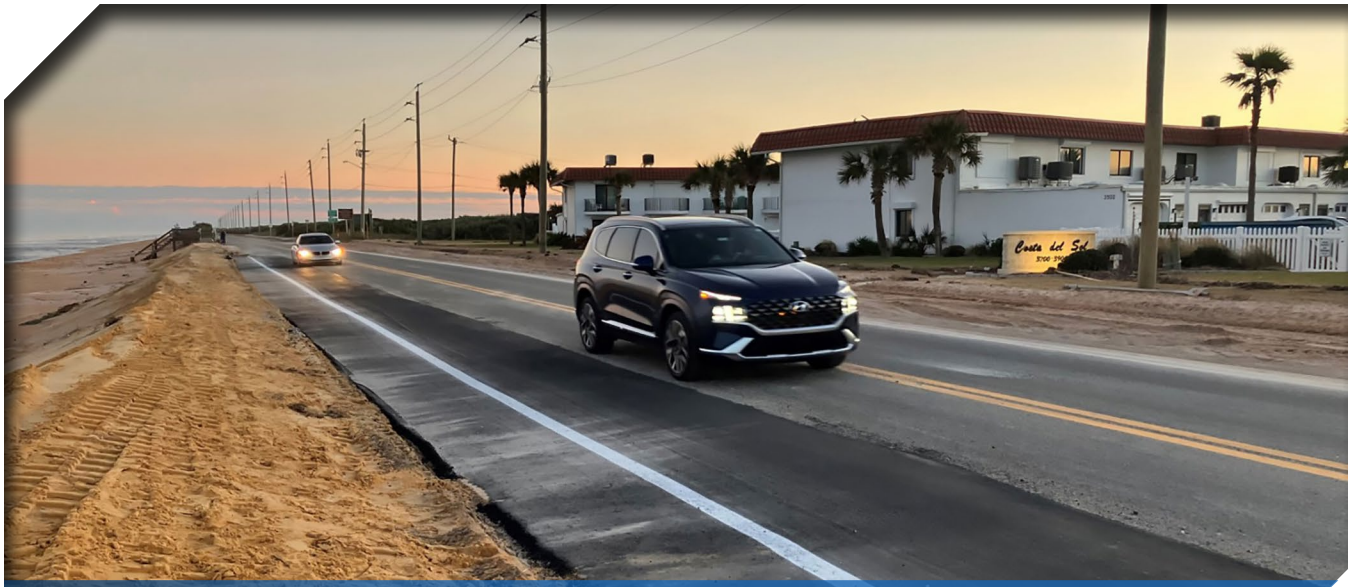
ASSET MANAGEMENT & MAINTENANCE

PLANNING

A resilient transportation system considers hazards and vulnerabilities at the earliest stages of planning, so these risks shape how agencies establish vision and goals, identify needs, and set priorities. FDOT will continue to make its planning process nimbler and more adaptive, with a focus on identifying potential risks and adjusting plans and policies to mitigate or respond to these risks. This approach will include more robust policies, technical analyses, and guidance for addressing resilience in the full range of planning decisions as well as further incorporating resilience in system level and long range transportation plans to promote alignment across partner plans..

STRATEGIES

- Develop, monitor, and regularly report existing and new performance measures on the resilience of the SHS.
- Monitor trends and conditions to continually identify potential impacts to the transportation system, building on the hazards identified in this plan.
- Conduct and regularly update vulnerability assessments of the transportation system based on the best available data, including updated data and projections generated by the Florida Flood Hub, building on the initial assessment conducted as part of this plan. Create consistent standards and methods for these assessments, including guidance on asset analysis, criticality factors, hazard identification, data sources, and planning horizons.
- Develop a risk management and decision-making framework to incorporate shocks, stresses, and other risks into decisions during all project phases.
- Expand the scope of planning studies and needs assessments to include retrofit or adaptation of existing infrastructure, development of new infrastructure to provide redundancy to at-risk facilities, and relocation of at-risk infrastructure. Develop benefit/cost and prioritization methodologies and tools to support decisions about allocation of funding sources targeted specifically at resilience improvements, as well as for advancing resilience needs for funding through asset management and capacity programs.



SR A1A repairs following Hurricane Nicole

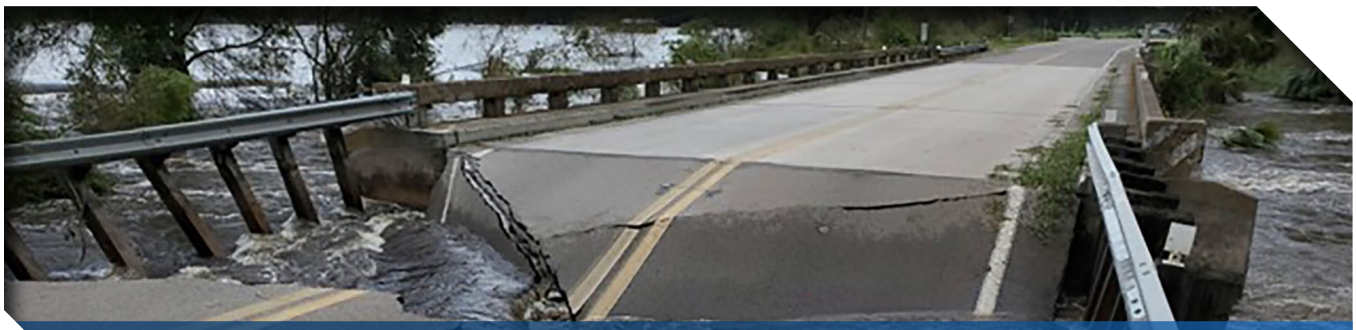
PROJECT DEVELOPMENT AND ENVIRONMENT

The Project Development and Environment (PD&E) phase advances initial needs into specific projects through detailed technical studies and extensive community input. This includes environmental review consistent with the National Environmental Policy Act (NEPA) and state law. Potential vulnerabilities and risks often can be more easily accommodated into project alternatives at this phase.

FDOT's PD&E processes are nationally recognized, including the Efficient Transportation Decision-Making (ETDM) process for engaging state and federal resource agencies in reviewing and commenting on potential community, socioeconomic, and environmental impacts at the earliest stages of project development. These processes already address multiple hazards and environmental factors and provide a foundation to address additional vulnerabilities and risks, incorporate resilience strategies into projects, and assess benefits (and potential impacts) of resilience investments.

STRATEGIES

- Integrate resilience strategies, such as adaptation or retrofit of existing infrastructure, development of new infrastructure to provide alternatives or redundancy to at-risk infrastructure, or relocation of at-risk infrastructure, into project alternatives to support purpose and need.
- Conduct technical analyses of future conditions, such as potential exposure to sea level rise, flooding, precipitation, storm surge, and other hazards as input to the PD&E process.
- Integrate data on hazards into the Area of Interest tool, and develop or enhance methodologies for assessing specific types of hazards such as compound flooding and hydrology assessments.
- Analyze the community, socioeconomic, and environmental impacts or co-benefits from transportation resilience investments and strategies, such as reestablishing previously severed hydrological connections, improving water quality, enhancing habitat, enhancing ecosystem services, and increasing the efficiency of energy, water, and wastewater systems.
- Enhance methods and tools for identifying potential land use and economic impacts of resilience investments and strategies, including impacts on adjacent properties.
- Coordinate with the Environmental Technical Advisory Teams (ETAT) to include resilience impacts as part of their review of projects in the ETDM process.



SR 64 at Peace River Bridge following Hurricane Ian, Hardee County

DESIGN, MATERIALS, AND CONSTRUCTION

The Design phase prepares the detailed engineering design, contract plans, specifications, and estimates for a project. Addressing resilience at this phase can include incorporating engineering features on roadways, bridges, or related infrastructure such as stormwater ponds and conveyance to help prevent or mitigate impacts from potential hazards. The Construction phase builds or enhances transportation infrastructure according to design plans. Incorporating resilience at this phase focuses on decisions about infrastructure and materials, as well as management of the construction work zone. FDOT already is implementing many of these strategies, and will continue to advance proven practices.

STRATEGIES

- Adjust project designs to reflect potential hazards by decreasing vulnerabilities, mitigating risks, and reducing the overall life cycle cost of constructing, operating, and maintaining infrastructure over its complete lifecycle.
- Advance adaptive designs that allow for more flexible use of infrastructure and right of way; value engineering solutions that increase resilience and functionality while reducing cost; and nature-based solutions such as living shorelines, ecosystem restoration, landscaping, and combined natural and hardscaped design elements.
- Address hazards and potential resilience strategies in drainage and stormwater system design, including potential regional stormwater solutions.
- Consider hazards and potential resilience strategies in developing right-of-way requirements for easements, acquisition, and permitting, including needs for surface water, stormwater, bridge approach, and higher road elevation.
- Use resilient materials that can withstand inundation, such as non-corrosive materials, that consider the health and resilience of the surrounding environment as well.
- Harden infrastructure during the construction process, such as raising road bases to address rising groundwater levels or advancing saltwater intrusion, and strengthening bridge supports.
- Use high-quality materials and well constructed pavements, including concrete, reclaimed asphalt pavement, and warm and cold asphalts mixes that extend resurfacing cycles, increase fuel efficiency, and minimize motorist delays.
- Identify, reduce, and mitigate flood impacts and other hazards to construction sites by using construction materials and techniques that consider the underlying soils, conditions, surrounding vegetation, and local hydrology.

Project GreenShores Living Shoreline (foreground)
Pensacola Bay Bridge/US 98 (background)

TRAFFIC OPERATIONS AND EMERGENCY MANAGEMENT

Traffic operations encompasses the daily functioning of the transportation system. FDOT is a recognized national leader in the use of Intelligent Transportation Systems (ITS) and Transportation Systems Management and Operations (TSM&O) that use technology to monitor the transportation system, help manage traffic flows, provide real-time traveler information, and employ managed lanes. Considering hazards and resilience strategies will help make these activities more effective as conditions change.

Emergency management includes activities to mitigate, prepare for, respond to, and recover from extreme weather events and other major disruptions. Florida is a national leader in preparing for and responding to hurricanes and other tropical storms, including a well-developed process for developing and updating emergency management plans at the local, regional, and statewide levels. These activities should continue to be enhanced in view of the changing hazards and risks facing Florida. While emergency management activities are broad, resilience strategies focus on mitigating impacts of and rapidly recovering from events and disruptions.

STRATEGIES

- Increase use of ITS/TSM&O to manage the transportation system and share traveler information with the community on a real time basis during both routine days and special events.
- Expand use of sensors and warning devices for early detection, agency coordination, and communication of hazards and potential impacts.
- Develop resilient infrastructure for all signals. Consider hazards and strategies such as floodproofing and backup power in specifications, procurement, and inspections of systems and equipment.
- Expand use of technology during major events to collect and share information with the community on road closures and other areas with loss of service or in need of emergency repair.
- Address the hazards identified in this plan when mapping detour routes and developing closure plans. Establish thresholds for acceptable infrastructure closure levels, including preemptive road closures before emergency events.
- Enhance planning for staging areas, fuel distribution sites, and similar locations and infrastructure during emergency events. Develop databases to share real time information on these resources during events.
- After recovery, provide information about the event to other FDOT offices to support continual enhancement of processes, procedures, and projects.
- Encourage emergency management partners to consider the hazards identified in this plan, as well as changing mobility needs for people and freight such as growth in electric vehicles, in updates of state, regional, and local emergency management plans.

Debris clean up following Hurricane Ian

ASSET MANAGEMENT AND MAINTENANCE

Asset management aims to preserve transportation infrastructure in a state of good repair. Asset management activities range from routine maintenance to major restoration projects. Asset management supports these activities with an integrated approach to performance measurement and monitoring, risk management, and life cycle planning. Resilience can be incorporated into all aspects of asset management for assets ranging from bridges and pavements to drainage and stormwater management systems, signage, lighting, and roadside technologies.

STRATEGIES

- Include infrastructure retrofit and adaptation strategies in Resurfacing, Restoration, and Rehabilitation (3R) projects, revising processes and procedures as needed.
- Develop methodologies and tools for analyzing the benefits and costs of incorporating resilience in asset management activities, including use of full life cycle costing.
- Expand the asset condition issues tracked for pavement, bridges, and stormwater to include the potential impacts of the hazards identified in this plan.
- Expand the set of assets that are actively managed to include culverts, embankments, storm sewer, stormwater management, and related systems, followed by development of an asset management system and program to better support scheduled maintenance similar to that for pavement conditions. FDOT also could enhance the existing drainage maintenance program for development, redevelopment, and future land use decisions and to address current standards, such as increased maintenance actions using video inspections and replacements.
- Adjust infrastructure and equipment inspection schedules, processes, data, and workforce capacity to address the full range of assets and hazards identified in this plan; for example, allow for more frequent inspections and maintenance of sensitive equipment and locations that may be exposed to hazards.
- Monitor maintenance expenditures for increased or more frequent repairs.
- Evaluate past events and repair needs as input to future asset management and project development.

Sunshine Skyway Bridge, St. Petersburg

TECHNICAL ASSISTANCE

FDOT works in partnership with MPOs, local governments, and modal partners in communities around the state to plan for future mobility and accessibility needs for Florida's residents, businesses, and visitors. Implementation of the Resilience Action Plan will build on these longstanding partnerships. In support of plan implementation, FDOT will provide technical assistance to MPOs, RPCs, local governments, and modal partners, which may include:

- Sharing data developed as part of the vulnerability assessment for this plan, as well as data about other hazards and aspects of resilience that could be developed in coordination with other state, regional, and local agencies.
- Developing guidance that outlines best and emerging practices for critical resilience improvement processes and planning, including methodologies for performing vulnerability assessments and other data analyses and adaptive planning design, construction, and maintenance processes.
- Developing and enhancing resilience tools, including databases, interactive maps, the Sea Level Scenario Sketch Planning Tool, and other new tools suggested in this plan.
- Facilitating connections to technical and financial resources from federal and other state agencies, such as the Federal Highway Administration, the Transportation Research Board, the U.S. Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the Florida Department of Environmental Protection, the Florida Division of Emergency Management, the Florida Department of Economic Opportunity, Florida Flood Hub, Florida's water management districts, and local municipalities.
- Offering training and technical support that helps partners understand how to incorporate resilience into transportation plans, projects, policies, and procedures, including how to effectively use the database, interactive maps, and tools.
- Facilitating information sharing through peer exchanges, coordination meetings, participation in regional collaboratives, or data clearinghouses.
- Improving data collection through identification of data gaps and appropriate data collection methods and tools.

TRANSITION TO IMPLEMENTATION

Implementation of this plan will include ongoing action by FDOT in collaboration with statewide, regional, and local partners in these six implementation areas:

PLAN MONITORING AND UPDATES

- Develop a timeline, milestones, and responsibilities for advancing the strategies into each project phase.
- Develop a process to monitor implementation of the Resilience Action Plan and identify needed adjustments to strategies.
- Update the Resilience Action Plan at least once every three years to include additional hazards, transportation infrastructure, and new or enhanced data. Work toward risk-based assessment and prioritization that addresses likelihood and consequences of hazards, multimodal needs of all users, including socially and economically vulnerable communities, and the importance of transportation infrastructure to communities and economic prosperity.

INTEGRATION INTO OTHER PLANS AND GUIDANCE

- Integrate the strategies identified in the Resilience Action Plan into other planning documents, including the FTP, Transportation Asset Management Plan, SIS Policy Plan, and other statewide modal and system plans.
- Update manuals, guidebooks, scopes of work, and other guidance documents to incorporate resilience strategies, including planning scopes of work, the PD&E Manual, FDOT Design Manual, and FDOT's Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways, known as the Florida Greenbook.
- Update FDOT's Work Program Instructions to clarify the eligibility of resilience-related investments for various state and federal transportation funding programs and the process for advancing resilience strategies into these programs.
- Develop a toolbox or guidance on resilience strategies to implement across functional areas in support of stand-alone resilience projects or as an add-on to other projects.

DATA AND TOOLS

- Enhance the database of FDOT and other agency data on hazards and asset information, as described in this plan.
- Develop and enhance tools to evaluate the potential impacts of hazards on transportation infrastructure, as well as the potential benefits and costs of resilience strategies (including the cost of no action). These may include the Area of Interest Tool, benefit/cost analysis tools, and prioritization tools.

Roundabout *Tamiami Trail*

TRAINING AND COMMUNICATION

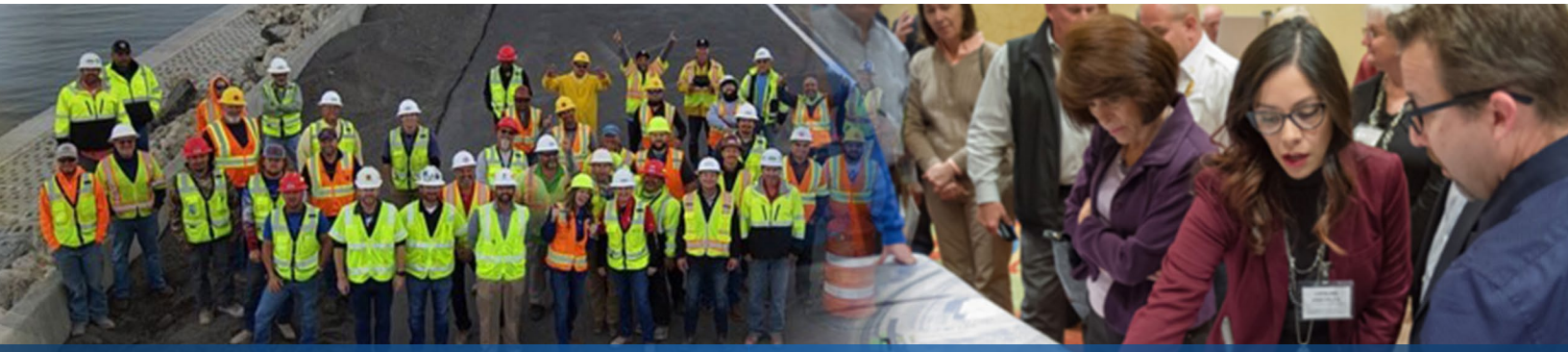
- Communicate the benefits of resilience strategies and investments, including proven and promising practices and noteworthy project examples, to elected officials, agency leaders and staff, and the public.
- Develop agencywide resilience training and guidance, including definitions of key terms, explanations of hazards and impacts, examples of potential resilience strategies, and use of commonly applied tools and data.
- Develop targeted training for specific functional programs and teams.

INTERNAL COORDINATION

- Define internal roles and responsibilities for implementing this plan and executing resilience strategies.
- Develop a cross-cutting internal team for implementation of the strategies in this plan.

COMMUNITY COLLABORATION

- Strengthen collaboration with regional and local partners, including local governments, MPOs, RPCs, regional resilience entities, and other transportation modes to identify and set priorities among transportation resilience strategies and investments; coordinate with community resilience goals and strategies; and coordinate transportation resilience strategies with development, redevelopment, and future land use decisions.
- Strengthen collaboration with Florida's Chief Resilience Officer and the Florida Department of Environmental Protection to advance the Governor's Executive Order 23-06 which includes direction for such coordination "to ensure [FDOT] identifies and considers water quality and flood mitigation benefits when developing and implementing its resilience planning."
- Strengthen collaboration with statewide partners, including the Department of Economic Opportunity, and Division of Emergency Management, and with water management districts to share data, leverage staff and funding resources, and advance policies and investments that support multiple goals.
- Strengthen collaboration with national transportation partners, including the Federal Highway Administration and American Association of State Highway and Transportation Officials, to identify, coordinate, and leverage funding, research, data, and policy development activities.
- Collaborate with additional research and data partners, including universities across Florida, Florida Flood Hub, the Transportation Research Board, the National Oceanic and Atmospheric Administration, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, and local municipalities.



Internal Coordination *Community Collaboration*

FOR MORE INFORMATION:

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