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Subtask 1.5: Peer State Flood Resiliency Programs

North Carolina Flood Resiliency Blueprint

Prepared for the North Carolina Department of Environmental Quality by AECOM, ESP Associates, and Insight

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Definitions

A comprehensive list of definitions applicable to multiple Flood Resiliency Blueprint documents is provided in a separate document.

- https://ncfloodblueprint.com/documents/DraftBlueprint_DefinitionsGlossary.pdf (PDF)

Parish: a territorial division corresponding to a county in other states.

Acronyms

BMP	Best Management Practice
CDBG-DR	Community Development Block Grant-Disaster Recovery
CDBG-MIT	Community Development Block Grant-Mitigation
CRMP	Virginia Coastal Resilience Master Plan
CRO	Chief Resilience Officer
CTP	Cooperating Technical Partners
CZM	Coastal Zone Management
DCR	Department of Conservation and Recreation
DEQ	Department of Environmental Quality
EOEEA	Executive Office of Energy and Environmental Affairs
FEMA	Federal Emergency Management Agency
FIF	Flood Infrastructure Fund
FIRM	Flood Insurance Rate Maps
FMP	Flood Mitigation Program
GLO	Texas General Land Office
HEC-HMS	Hydrologic Engineering Center's Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HUC	Hydrologic Unit code
HUD	US Department of Housing and Urban Development
IFC	Iowa Flood Center
IIHR	Iowa Institute of Hydroscience & Engineering
IWA	Iowa Watershed Approach
IWAIS	Iowa Watershed Approach Information System
LWI	Louisiana Watershed Initiative
NCDEQ	North Carolina Department of Environmental Quality
NFIP	National Flood Insurance Program
PMT	Project Management Team
RFPG	Regional Flood Planning Group
RMAT	Resilient Massachusetts Action Team
SACAP	Special Assistant to the Governor for Coastal Adaptation and Protection
SCOR	South Carolina Office of Resilience
SHMCAP	State Hazard Mitigation and Climate Adaptation Plan
SLAMM	Sea Level Affecting Marshes Model
PMT	Project Management Team
TAC	Technical Advisory Committee
TAG	Technical Advisory Group
TCRMP	Texas Coastal Resiliency Master Plan
TDQ	Technical Design and Quality
TWDB	Texas Water Development Board

US	United States
USACE	United States Army Corps of Engineers
WMA	Watershed Management Authorities

1 Introduction

This document aims to review governance schemes from at least five peer states and provide examples of how datasets, models, and platforms are used for decision-making and the levels at which governance decisions are made (e.g., regional, local, state). The result is a written report and presentation that documents the findings, develops an assessment of the pros and cons of each scheme, and provides recommendations for North Carolina's approach, including funding mechanisms for enabling implementation beyond local jurisdictional boundaries. Recommendations are given based on information learned and knowledge of North Carolina laws and policies. Rule changes necessary to implement a robust flood resiliency program have been identified.

Session Law, 2021 – 180 Section 5.9(c), required the North Carolina Flood Resiliency Blueprint (Blueprint) to evaluate the Louisiana Coastal Master Plan and the flood resiliency planning processes in South Carolina and Virginia. This review assesses those flood resilience programs. Additional state flood resilience programs were added to include Massachusetts, Texas, Indiana, and Iowa per the Partnership and Funding Technical Advisory Group (TAG) recommendation. The objective of this review is to capture and apply relevant information related to the following:

- Each program's structure and governance scheme
- Level at which governance decisions are being made
- Datasets and models that are used for the programs
- Platforms developed for decision-making
- Funding mechanisms to enable implementation, especially when beyond local jurisdictional boundaries

An overview of each state program is provided, with relevant links as available. Recommendations for inclusion in the North Carolina Flood Resiliency Blueprint are discussed.

2 Methods

This report is a systematic review of data self-reported by peer and non-peer state flood resiliency programs and not a meta-analysis. In this report, “peer state flood resiliency programs” refers to other East Coast state flood resiliency programs ahead of the Blueprint in developing and implementing similar programmatic, statewide resiliency efforts. Non-peer state programs are defined in this report as statewide flood resiliency-related programs administered by a non-east coast state.

A structured summary has been provided, including, as applicable, background, scheme of governance, program overview, decision-making tool, program funding, program status, recommendations, and limitations (questions that require further details from the peer/non-peer states themselves). The data used in this report was compiled through a review of publicly available sources and was informed by discussions with peer state program staff members (the Louisiana Watershed Initiative and Texas State Water Development Board informational interviews). Several third-party experts directly associated with the peer state programs of interest were also consulted to identify key information to inform Blueprint and review potential program discussion topics and questions for the previously mentioned interviews.

3 Peer-State Flood Resilience Programs

Peer state programs have been reviewed with examples of how datasets, models, and platforms are used for decision-making. The purpose of the review was to assist with developing a documented process for conducting flood resiliency planning at multiple scales that can be applied anywhere in the state. Considering North Carolina basins have different flood exposures, data and modeling needs, and capacities, peer state processes can serve as an example, help Blueprint avoid potential hurdles, and assist the Blueprint development process moving forward.

3.1 Louisiana Coastal Master Plan and Watershed Initiative Program

3.1.1 Background

Between 2000 and 2023, 19 floods and/or hurricane-related Federal Major Disaster Declarations carried response and recovery-related costs of over $16 billion in Federal Emergency Management Agency (FEMA) Public Assistance grants and $7 billion in FEMA Individual Assistance grants. This is an average of $1.5 billion expended federally per disaster. The Louisiana Coastal Protection and Restoration Authority, formed in 2005 to address recovery needs in the wake of Hurricane Katrina and Rita, is responsible for developing, implementing, and enforcing the coastal protection and restoration Master Plan. The Authority predicts these damaging flood events will only increase in severity and frequency with significant increases in vulnerability to coastal flooding, tropical cyclones, and increasing trends in extreme precipitation.[1]

In 2016 alone, two federally declared major disaster flood events caused an estimated $10 billion in damages and impacted more than 145,000 homes. One of these disasters occurred in August of 2016 when Louisiana experienced historic floods that led to extensive and costly damage and revealed the state's vulnerability to storm events. The 2016 major declaration included 26 parishes, and the total federal cost exceeded $1.4 billion. Recognizing the need for an innovative approach to floodplain management to contend with increasingly frequent, "billion dollar" flood events, Governor John Bel Edwards issued Executive Order JBE18-16 in 2018, forming the Council on Watershed Management and leading to the launch of the Louisiana Watershed Initiative.[2]

Building off the momentum and coordinated efforts to address impacts from the 2016 floods, the Louisiana Watershed Initiative (LWI), administered by Louisiana's Council on Watershed Management, aims to foster collaboration among agencies, subject matter experts, the public, and many other

[1] A 25 percent increase in vulnerability to tropical cyclones and increasing trends in extreme precipitation between 1958 and 2019 the amount of precipitation falling during heavy rainstorms has increased by 27 percent in the southeast. https://d10zxfp0rexahe.cloudfront.net/docs/CDBG-MIT-Master-AP-Approved-2_20_20.pdf (pg. 33) (PDF)

[2] "Gov. Edwards Announces Launch of Louisiana Watershed Initiative." Office of the Governor, 15 Aug. 2018, gov.louisiana.gov/index.cfm/newsroom/detail/1566.

stakeholders for a holistic and data-driven approach to flood management. The Coastal Protection and Restoration Authority created a framework for stakeholder, data, and policy coordination as part of the Flood Risk and Resilience Program. This framework was a basis for the LWI and its approach and operational structure.

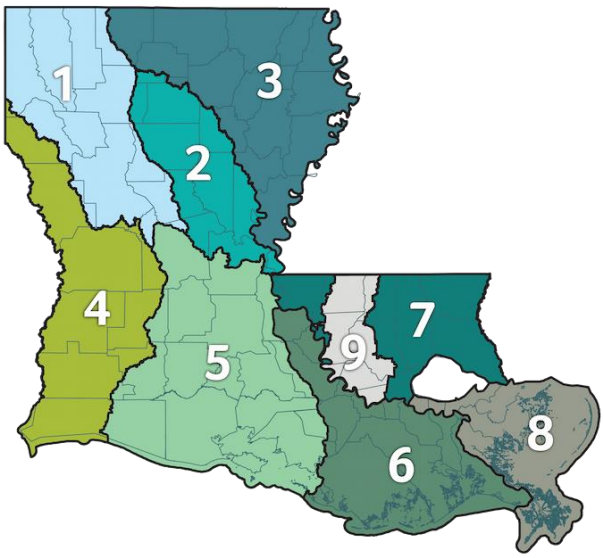

Figure 1. LWI Watershed Regions

Louisiana Watershed Initiative pivots from traditional flood mitigation efforts siloed by politically defined jurisdictions. Instead, the LWI takes a watershed-based flood management approach, using watershed regions (see **Figure 1**) to oversee floodplain management work across their respective parishes. The LWI also prioritizes a watershed management approach that promotes nature-based solutions that maximize the natural function of floodplains.

- https://watershed.la.gov/about

3.1.1.1 Program Funding

The Louisiana Watershed Initiative is funded through a $1.2 billion line of credit in CDBG-MIT funds that the State of Louisiana received from the US Department of Housing and Urban Development (see **Figure 2**). The line of credit is a funding control mechanism that does not include repayment or interest. As part of the funding agreement, the state developed an Action Plan[3] to outline how the budget would be allocated across LWI's various programs and operational needs.

[3] Louisiana Office of Community Development. *Master Action Plan for the Utilization of Community Development Block Grant Mitigation Funds* (CDBG-MIT). 30 Aug. 2019, d10zxfp0rexahe.cloudfront.net/docs/CDBG-MIT-Master-AP-Approved-2_20_20.pdf.

Programs		
Local and Regional Watershed Projects and Programs	$570,666,243	47 %
State Projects and Programs	$327,757,590	27 %
Non-Federal Cost Share Assistance	$96,988,107	8 %
Watershed Monitoring, Mapping, and Modeling	$145,670,040	12 %
Administrative Costs	$48,556,680	4 %
Watershed Policy, Planning, and Local Capacity Assistance	$24,278,340	2 %
Total Allocation	**$ 1,213,917,000**	**100 %**

Figure 2. Louisiana Watershed Budget

Any public entity within the nine watershed regions is eligible to apply for funds through local and regional projects and programs. For the Regional Capacity Building Grant Program, parishes and jurisdictions put forward an applicant to represent the watershed region and administer the grant on behalf of the watershed region.

- https://d10zxfp0rexahe.cloudfront.net/docs/CDBG-MIT-Master-AP-Approved-2_20_20.pdf (PDF)

3.1.1.2 Scheme of Governance

The Council on Watershed Management – or Watershed Council - oversees the LWI, Louisiana's statewide floodplain management program. The Council is comprised of five state agencies: the secretaries and executive directors of the Office of Community Development, the Department of Transportation and Development, the Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP), the Louisiana Department of Wildlife and Fisheries, and the Coastal Protection and Restoration Authority.

The Council collaborates to provide data, technical assistance, funding, and other resources to ensure that LWI efforts are founded on science, engineering, and objective decision-making. Specific agency responsibilities include:

- Office of Community Development: The Office manages disaster mitigation and recovery programs funded by federal Community Development Block Grant dollars.
- Department of Transportation and Development: This agency oversees the Statewide Data and Modeling Program, which develops watershed models. It also manages the Statewide Flood Control Program and the National Flood Insurance Program for Louisiana.
- Governor's Office of Homeland Security and Emergency Preparedness: The Office administers hazard mitigation programs such as Louisiana's Hazard Mitigation Grant Program, Building Resilient Infrastructure and Communities Program, Flood Mitigation Assistance Grant Program, and Public Assistance Grant Program. It also oversees state and local hazard mitigation planning.
- Louisiana Department of Wildlife and Fisheries: The Department collects data on Louisiana's fisheries and wildlife and provides technical assistance to promote conservation and

management efforts – particularly through nature-based solutions. The Department also reviews and advises on environmental permitting applications.

- Coastal Protection and Restoration Authority: The Authority oversees the Flood Risk and Resilience Program and Louisiana Coastal Master Plan, updated every six years. The Louisiana Coastal Master Plan is a concurrent and complementary component of LWI's statewide work.

The Council is supported by subject matter experts and other agency representatives who serve on TAGs. TAG members have various specialties in data, policy, engagement, and projects and planning and are responsible for coordinating input from stakeholders to the Council to support floodplain management decisions. TAG members further coordinate with regional steering committees and additional stakeholders, resulting in unprecedented collaboration to accomplish LWI's mission. The LWI has six primary TAGs, including public relations, data & modeling, policy, engagement and outreach, projects, and planning, as well as flexibility for creating other TAGs as new topics arise.

The Council further identified nine[4] designated watershed regions tasked with coordinating with their respective parishes to plan and implement flood risk projects and strategies. Each watershed region is responsible for organizing a regional steering committee of ten to 20 representatives from the various parishes with diverse areas of expertise and context organized around provisional watershed boundaries and hiring a watershed coordinator. The regional steering committees engage parish stakeholders to identify and implement programs and projects tailored to the needs of the watershed region.

The LWI also maintains a website with comprehensive and publicly accessible information on the various LWI programs, projects, plans, and watershed regions.

- https://watershed.la.gov/state-agencies

3.1.1.3 Datasets, Models, and Platforms for Decision Making

With an emphasis on objective, data-driven decision-making, LWI oversees a robust Statewide Data and Modeling Program, with support from federal partners such as the FEMA, United States Army Corps of Engineers (USACE), United States Geological Survey, National Oceanic and Atmospheric Administration, Natural Resources Conservation Service, and the United States Environmental Protection Agency. The TDQ team manages data collection and modeling efforts that inform a range of LWI work, including flood mitigation feasibility studies, consequences and risk assessments, no adverse impact assessments, and to evaluate proposed projects and policies.

The LWI uses the Hydrologic Unit Code 8 (HUC8) watershed scale and modeling software such as the Hydrologic Modeling System (HEC-HMS) for rainfall and runoff analyses and the River Analysis System (HEC-RAS) hybrid 1-D and 2-D for hydraulic models.

[4] The Council first identified eight watershed regions; however, the boundaries have since been revised to include nine regions.

TDQ also draws on local and federal entities' existing data and modeling work. **Figure 3**[5] shows examples of data and models that LWI uses.

Data Types	Examples
Existing Models	FEMA effective hydraulic models and BLE models; locally developed hydraulic models
Previous Watershed Studies	FIS, watershed master plans, regional drainage assessments
Digital Elevation Models (DEMs)	Coastal National Elevation Database (CoNED) Applications Project
Channel Surveys	USACE National Channel Framework (NCF) program, existing surveys from local projects
Precipitation Data	National Oceanic and Atmospheric Administration's (NOAA) NWS Stage IV radar product; NWS and local rain gauges; NOAA's National Severe Storms Laboratory (NSSL) Multi-Radar/Multi-Sensor (MRMS) radar product
Land Use and Soils	National Land Cover Dataset (NLCD); Natural Resources Conservation service (NRCS) digital soil survey data Soil Survey Geographic Database (SSURGO)
Hydraulic Structures	As-builts, previously conducted surveys, design plans, permit drawings, measurement-based sketch
Streamflow and Stage	United States geological Survey (USGS) streamflow database, USACE river gages database, NOAA tides and currents, Coastwide Reference Monitoring Program (CRMS), locally collected and validated water level data
Historical High-Water Marks (HWMs)	High-water mark databases collected by local, state, and federal agencies; Short-Term Network (STN) monitoring website
Historical Streamflow Flood Frequency Analysis	Guidelines for Determining Flood Flow Frequency – Bulletin #17C with Pearson Type III distribution with log transformation (Log-
	Pearson Type III) (USGS, 2019); Statistical Software Package (HEC-SSP) and PeakFQ analysis; other sources which factor in trends due to urbanization and regulation may be considered (Kilgore Consulting & Management, 2016).
Historical Flood Information	USGS post event database flood inundation layers; FEMA claims data, other locally sourced information
Elevation Datum	NAVD 88 Geoid 12B

Figure 3. Louisiana Watershed Initiative Models and Data

The LWI also oversees the River and Rain Gauge Network, which will be installed at 100 locations across the state over the next six years to collect real-time riverine and rainfall information. The gauge network was designed in collaboration with the United States Geological Survey, the Louisiana Department of Environmental Quality, the National Oceanic and Atmospheric Administration, the University of Louisiana at Lafayette, and Tulane University. Information from the enhanced network will support local and regional planning and mitigation work.

- https://watershed.la.gov/modeling-program

3.1.1.4 Program Overview

The LWI oversees and coordinates several ongoing programs:

[5] LWI Technical Design and Quality (TDQ) Team. *Guidance on Modeling Methodology in Support of the Louisiana Watershed Initiative Watershed Models.* 29 June 2021.

Local and Regional Projects and Programs: The program provides funding and technical support for local and regional projects that reduce flood risk and build community resilience. Over three rounds, the LWI will disburse $570 million of funding from HUD's Community Development Block Grant – Mitigation (CDBG-MIT) program. Eligible applicants for Round 1, which began in 2021, included any local or regional public entity in Louisiana, as long as it has the jurisdiction to implement, operate, and maintain the project.

The Office of Community Development is responsible for evaluating and prioritizing projects in coordination with a panel of representatives from agencies on the Council. Projects are prioritized through multifaceted scoring criteria that assign projects a total score out of 100, based on the distribution of points across five primary criteria, including effectiveness in minimizing risk (44); project costs and implementation (13); social benefits (12); enhancement of natural functions (15); and benefit to most impacted and distressed parishes (16). The project evaluation and scoring criteria used to select projects for the Watershed Projects Grant Program - Local and Regional - Round 1 can be accessed through the following link:

- https://d10zxfp0rexahe.cloudfront.net/docs/Round-1-Policies-and-procedures-Appendix-B.pdf (PDF).

Round 1 focused on implementation-ready, low-risk projects that address flood risks through a watershed-based approach and awarded $100 million to 28 projects. "Low-risk" projects are defined through LWI's project ranking/scoring criteria that include…

- Risk-reduction value
- Consideration of future flood risk
- Upstream and downstream flood effects
- Passivity and reliability
- Multi-jurisdictional flood risk reduction benefits
- Enhanced protection of critical facilities (e.g., hospitals, evacuation routes, emergency response facilities, power generation stations, etc.) and/or stabilization of essential community lifelines (e.g., transportation, communication, health, shelter, hazardous material, water, power)
- Avoided direct physical damage to built assets and agriculture - based on existing or approved permits for the built environment
- Adaptability/flexibility
- Project design life (in accordance with FEMA standards or supporting documentation)
- Replicability
- Historical/archeological/ geological impacts.

Round 2, which began in 2023, will award $100 million to projects that benefit low-to-moderate-income and disadvantaged communities in parishes most impacted and distressed by the 2016 floods. Round 3, scheduled to begin in 2024, will award funding to flood risk reduction projects that

are vetted and justified by watershed models and nature-based solution tools and will also focus on adopting resilient policies on a regional basis.

Design Support Program - Following the first round of funding, the LWI created the Design Support Program as a component of Round 2 to provide technical assistance to eligible, unfunded, and/or incomplete Round 1 applications of interest by funding engineering and design costs and project implementation. These projects focus on efforts that benefit the United States (US) Department of Housing and Urban Development (HUD)-identified impacted and distressed areas and low-to-moderate-income populations- and projects that incorporate nature-based solutions.

Regional Capacity Building Grant Program: This three-year program assists the nine watershed regions in building staff capacity and provides technical assistance to municipal partners. The goal is to establish long-term capacity and funding to continue beyond the life of this program. The program completed the first of two phases, including forming and funding temporary, regional steering committees using $400,000 per watershed region from HUD's CDBG – Disaster Relief (CDBG-DR) program, which began outlining work plans and recommendations. One applicant was identified per watershed region and assigned as the designated fiscal agent, responsible for assigning roles and responsibilities to accomplish program goals, metrics, and key tasks for the watershed region. The designated applicants were then responsible for submitting Phase II applications. Coordination within each region looked different from one another. For Phase I, eligible applicants (public entities located within the watershed region that have the capability to provide or be able to coordinate technical services) submitted one application for the region. Applicants must coordinate with all parishes throughout the watershed region and document agreements with *at least* 51 percent of the parishes.

The Program's second phase established and funded long-term watershed coalitions, allocating $800,000 per watershed region using funds from HUD's CDBG-DR program to move the work plan forward. Short-term regional steering committees were selected by regional leaders and parish representatives and are made up of members that reflect several different interests and demographics throughout the region. Coalition members are responsible for long-term watershed management throughout each region and exist beyond the program's life. The purpose of the watershed coalition is to provide formalized governance bodies that administer plans and projects over the long term. Coalition governance schema vary by region; however, most coalitions are composed of both private (academic, community representative, real estate industry, environmental professional, etc.), public, and non-profit representatives and have at least one primary watershed coordinator to facilitate activities across participating parishes and distribute project funds.[6]

The Statewide Data and Modeling Program: Engineers and subject matter experts are working to gather data and develop models that will facilitate objective, data-driven decisions related to floodplain management. The models are expected to be completed by 2023. Guidance[7] on modeling methodology was prepared by the LWI Technical Design and Quality (TDQ) team in June 2021. The

[6] https://watershed.la.gov/watershed-regions

[7] https://d10zxfp0rexahe.cloudfront.net/docs/LWI_Guidance_on_Modeling_Methodology-2021-06-29.pdf (PDF)

TDQ team also developed guidance[8] on LWI's Model Use, Storage, and Maintenance Plan in August 2021.

State Projects and Programs: LWI, in coordination with the Louisiana Office of Community Development, identified 20 projects that reduce flood risk, store floodwaters in ways that enhance natural habitats, and move people in flood-prone areas out of harm's way from various state agencies to fund based on their alignment with LWI objectives and agency missions. Examples of projects funded through this program include drainage / stormwater improvements, channel modifications, dredging, flood control structures, earthwork and grading, dam and spillway hardening, as well as nonstructural measures like floodplain buyouts.

Statewide Buyout Program: The program funds a voluntary buyout program to support low —to moderate-income residents with properties in flood-prone areas. It has invested $87 million across seven buyout locations.

Nature-Based Solutions Program: The program provides technical assistance, training, and resources to promote nature-based solutions to flooding and improving water quality.

Non-Federal Cost Share Assistance Program: The program offers matching funds or cost-share assistance for eligible federal programs. The State has allocated $96.6 million in Community Development Block Grant-Mitigation (CDBG-MIT) funds to match FEMA Hazard Mitigation Grant Program awards after the floods in 2016 and $15 million to match Hazard Mitigation Grant Program awards after the hurricanes in 2020.

Professional Resilience Occupations Louisiana: The LWI seeks to develop the statewide workforce and those in occupations that support flood resilience efforts. The Professional Resilience Occupations Louisiana funds training courses to ensure proper training in skills such as operating heavy equipment and conducting flood risk analyses. The first courses were offered in the spring of 2022 at six colleges across the state.

3.1.1.5 Program Status

The LWI is in the pre-application phase for the second round of project funding, and the final round is expected to take place in 2024. The LWI distributes funding through its programs based on prioritizing more immediate projects backed by established engineering practices and those with minimal risk of adverse impacts. Additional phases will include funding for projects based on the completed watershed models. The LWI maintains an interactive mapping tool[9] with information on the projects and programs underway in each watershed region.

The Regional Capacity Building Grant Program completed the first of the two phases, which included forming and funding ($400,000 per watershed region) temporary regional steering committees that began outlining work plans and recommendations for the future.

[8] https://d10zxfp0rexahe.cloudfront.net/docs/LWI_MUSMPlan-5-31-2022.pdf (PDF)

[9] https://watershed.la.gov/projects

3.1.1.6 Recommendations for Inclusion in the North Carolina Flood Resiliency Blueprint Process

Recommendations for a governing body to evaluate and/or approve flood mitigation projects and/or additional modeling and data needs for funding that can be applied to the Blueprint technical approach.

- NCDEQ maintains a website that includes comprehensive and publicly accessible information on the various blueprint programs, projects, plans, and watershed regions (if applicable)
- Create programs within the Blueprint that focus on capacity building and technical assistance to help communities implement flood resilience strategies
- Assisting the state in developing a Community Rating System Strategy for flood-vulnerable areas
- Output of action strategies will need input from subject matter experts to advise on administrative and legislative matters
- Facilitating similar Louisiana Watershed Initiative entities (e.g., Watershed Council, Working Group, Technical Advisory Groups) to help steer regional decisions
- Develop workflows focused on allowing multiple levels of government to interact successfully and stay on schedule throughout the process
- Develop a project plan to support the effort of building the framework to manage data and be focused on how the framework is scalable and the public-facing portal is usable and accepted by end users
- Develop guidance documents for other programs and projects that might inform the NC Flood Resiliency Blueprint in the future and ensure linkages between data, decisions, actions, and outcomes.

3.2 Massachusetts Integrated State Hazard Mitigation Plan and Climate Adaptation Plan

3.2.1.1 Background

The Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) was released in 2018 (see **Figure 4**). This plan provided a national model of integrating hazard mitigation priorities with forward-looking climate change data and solutions. SHMCAP is the first plan of its kind to comprehensively integrate climate change impacts and adaptation strategies with hazard mitigation planning, it also complies with current federal (FEMA) requirements for state hazard mitigation plans and maintains the

Figure 4. Massachusetts State Mitigation and Climate Adaptation Plan (SHCMAP)

Commonwealth's eligibility for federal disaster recovery and hazard mitigation funding under the Stafford Act.[10]

Prior to the SHMCAP, the state of Massachusetts advanced the following flood risk reduction and resilience actions.

- Investment in downscaled climate change projections at county and watershed scale
- Coordinated regional community-based (Hazard Mitigation Plans)
- Capital Investment in FY2019 of $60M for mitigation, adaptation, and emissions reduction
- Environmental Bond Bill in FY2018 of $2.4B for adaptation, preservation, and improvement of environmental and energy needs (Executive Order Number 569)
- Coastal Resilience Grant Program expansions
- Municipal Vulnerability Preparedness program growth

The SHMCAP encompasses the results of a multi-step planning process with a robust outreach and engagement program (see **Figure 5**). The planning process began in January 2017, and the plan was released in September 2018. A multi-agency team managed the planning process in close partnership with the Executive Office of Energy and Environmental Affairs (EOEEA), the Executive Office of Public Safety and Security, and the Massachusetts Emergency Management Agency. Technical specialists from several key state agencies comprised the project management team. The SHMCAP website served as the project's primary online presence and was an integral part of the stakeholder outreach and engagement program.

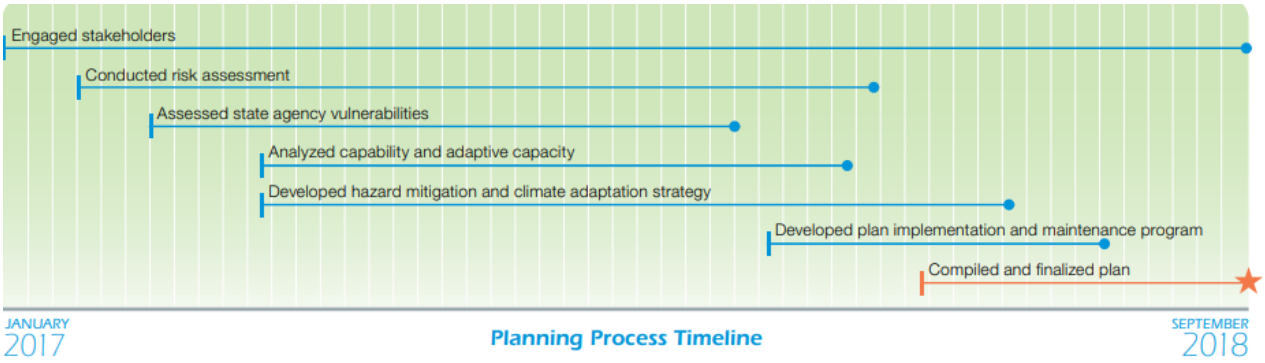

Figure 5. Planning Process Timeline

The SHMCAP integrates information on 14 natural hazards and four climate change factors: changes in precipitation, sea level rise, rising temperatures, and extreme weather. 85 out of 94 state agencies participated in a survey administered by the SHMCAP project management team to assess their climate vulnerability and risk in five sectors: Populations, Government, Built Environment, Natural Resources and Environment, and Economy.

[10] Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan | Mass.gov

3.2.1.2 Critical Item Assessment

1,000 critical items, including 386 assets, 340 functions, and 231 population groups, were assessed.

- Assets: (buildings, infrastructure)
- Function: (tourism, recreation)
- Population groups most impacted: (homeless, elderly, youth, minorities, language-isolated, low-income, disabled, veterans, people with mental illness or substance use disorders)

One of the earliest tasks completed in support of the planning process was the creation of a Project Management Team (PMT) to help guide and inform the plan throughout its development. The PMT was co-chaired by the Massachusetts Emergency Management Agency State Hazard Mitigation Officer and Massachusetts EOEEA Assistant Secretary of Climate Change, and it included representatives from numerous state agencies to allow representation of a variety of state interests and perspectives on hazard mitigation and climate adaptation.

A key component of the 2018 SHMCAP stakeholder outreach and engagement program was developing and implementing three stakeholder workshop series to inform stakeholders about the project and solicit input at key stages of the planning process to inform the plan development. The workshops were designed, facilitated, and led by the PMT and the consulting team. They were conducted at multiple locations across the Commonwealth to engage stakeholders from various geographic areas and interest groups.

The SHMCAP is continually reviewed, revised, and updated, accounting for changes in applicable information and stakeholder input. Changes in applicable information could include newly published studies, updating hazard history based on a recent event, or updating goals, strategies, objectives, and mitigation actions. The Resilient Massachusetts Action Team (RMAT) tracks and facilitates annual implementation updates for all SHMCAP actions through quarterly meetings, annual SHMCAP plan reviews, post-disaster reviews, and 5-year plan review and updates.

3.2.1.3 Risk Assessment Findings

The vulnerability and risk assessment found that many agencies are well-positioned to protect their key assets, accomplish their missions, and deliver critical services. Many also need additional capabilities and opportunities to increase resilience, including increased legislative support and spending and bond financing for resilience investments.

Between 2007 and 2014, inland flooding caused an average of over $9.1 million in damages per year, with the most vulnerable areas being highly developed or within the floodplain. More intense and frequent downpours will result in more frequent flooding and greater areas exposed.

According to SHMCAP, the rate of sea level rise could accelerate to 6.0 mm/year by the mid-to-late century. Boston Harbor tide gauge data show sea level rise at a current rate of 2.9 (+/- 0.15) mm/year. Coastal flooding could generate annual damages between $150 and $200 million (current storm activity, 2008 sea levels). The SHMCAP also provided valuable insights into the risks and impacts the Commonwealth has faced and will continue to face. The top five hazards for assets with a “High Risk” rating are Extreme Precipitation, Hurricanes/Tropical Storms, Nor’easters, Ice Storms, and Severe

Winter Storms. The effort included an assessment of state agency climate resilience, including its ability to reduce, respond to, and recover from changing conditions and challenges, including flooding and climate change.

Similar to how Blueprint will need to incorporate existing state agency efforts, the SHMCAP assesses the ability of agencies to withstand natural hazards and climate impacts as Excellent: six percent, Good: 38 percent, Satisfactory: 42 percent, Fair: 14 percent, and Poor: zero percent. The length of time for an agency to return to essential functionality following an extreme weather event that results in considerable damage to critical assets and/or functions was assessed as seven percent would take months, 32 percent would take weeks, 43 percent would take days, and 19 percent would take hours (an optimistic snapshot of agency preparation and readiness). Finally, regarding incorporating natural hazard mitigation and climate change adaptation into programs, 28 percent were already doing so, 32 percent were planning to, 29 percent were not yet, and 10 percent did not know when they would do so.

3.2.1.4 SHMCAP Strategy

The SHMCAP's Strategy addresses the risks and vulnerabilities from natural hazards and climate change impacts with the following goals:

1. Integrate Programs and build institutional capacity
2. Develop forward-looking policies, plans, and regulations
3. Develop risk-reduction strategies for current and future conditions
4. Invest in performance-based solutions that support efforts to build and sustain core capabilities across projects that prevent, protect, mitigate, respond, and recover from natural hazards
5. Increase education, awareness, and incentives to act

108 actions were recommended to accomplish this strategy. Of these, the following are most relevant to the North Carolina Flood Resiliency Blueprint. They are global actions intended to reduce risk across the state government and the Commonwealth.

1. As appropriate, incorporate hazard and climate change vulnerability into personnel and workplace policies, training, and guidance.
2. Create and deploy a SHMCAP project database
3. Develop climate change design standards. The Division of Capital Asset Management and Maintenance, Massachusetts Department of Transportation, Economic Office of Housing and Economic Development
4. Maintain and enhance climate change projections and specific climate change data sets to support distinct groups of end users
5. Review state building codes to incorporate hazard mitigation and resilience
6. Incorporate hazard and climate change vulnerability into capital planning, master planning, and facilities management functions.

7. Use available climate change projections and risk assessment data to assess vulnerabilities of all EOEEA properties. Support efforts across the administration to evaluate facilities held by other Executive Offices.
8. Expand and improve the Boston Harbor Flood Risk Model to create the Massachusetts Coastal Flood Risk Model. The Massachusetts Coastal Flood Risk Model is a more accurate representation of flooding risk because it is (1) a dynamic model that includes the critical processes associated with storm-induced flooding (winds, waves, wave-setup, storm surge, wave run-up, and overtopping, etc.), (2) calibrated to historical storm events that impacted Massachusetts with observed high water data and measurements, (3) high enough resolution to capture flood pathways in complex urban topographies, (4) a model that includes both hurricanes and nor'easters under changing climate conditions, and (5) able to capture the net effect of varying storm types, magnitudes, and frequencies.

3.2.1.5 Plan Implementation, Monitoring, and Maintenance Program

Following the issuance of the SHMCAP, a program was in place to regularly review, revise, and update it as conditions and information change and with input from stakeholders. To enable communication with the public, municipalities, state agencies, and other stakeholders, the online version of the SHMCAP, along with updates, is housed in the Resilient Massachusetts Climate Change Clearinghouse (https://resilient.mass.gov/home.html).

The governor at the time, Charlie Baker, launched the RMAT in 2019 to implement, monitor, and maintain the SHMCAP. The Executive Office of Energy and Environmental Affairs and the Massachusetts Emergency Management Agency lead the inter-agency team. Team representatives are from each Secretariat, called Climate Change Coordinators, supported by agency staff, stakeholders, and subject matter experts. Stakeholder is a broad-based term that changes but generally includes other state agencies, regional planning agencies, local governments, Nongovernment/private-sector organizations, including those representing critical infrastructure, engineering, social welfare, and economic development, environmental and natural resources organizations, and public health departments and organizations. The RMAT monitors and tracks the 2018 SHMCAP implementation process, makes recommendations, supports agencies on plan updates, and facilitates coordination across the Massachusetts government and with stakeholders, including businesses, cities, and towns.

- Conduct quarterly meetings, annual plan reviews, post-disaster reviews, and 5-year plan reviews and updates (which occurred in 2023).
- Track and facilitate the completion of annual implementation updates for all hazard mitigation and climate adaptation actions included in the plan.
- Ensure that the SHMCAP incorporates new data as they become available.
- Provide outreach, technical assistance, stakeholder engagement, and other educational services that increase general awareness and understanding of the SHMCAP.
- Coordinate the continuous enhancement of the SHMCAP through collaborative partnerships and the active engagement of key stakeholders.

- Support incorporating the SHMCAP into other state plans and programs as appropriate.

3.2.1.6 Climate Resilient Design Standards and Guidance

The SHMCAP also established the foundation for Climate Resilience Design Standards and Guidance to integrate the best available statewide climate change projections and hazard data to inform early/conceptual planning and design of infrastructure, buildings, and natural resource assets in Massachusetts in conjunction with traditional engineering assessments, feasibility analyses, and cost-benefit analyses, which is an open-source tool through FEMA's website.

- https://www.fema.gov/grants/tools/benefit-cost-analysis

The Climate Resilience Design Standards Tool is an interactive web-tool that provides a preliminary climate risk screening and recommended climate resilience design standards for projects with physical assets incorporated into the process from preliminary planning to project review (see **Figure 6**). Outputs of the tool include:

- Evaluation of whether a project is within a mapped environmental justice population
- An Ecosystem Service Benefits score indicates the protection of natural resources and the implementation of nature-based solutions.
- Preliminary Climate Exposure score, which screens whether the overall project and assets are exposed to impacts of natural hazards
- Preliminary Climate Risk Rating to identify building and infrastructure assets with "high risk" designation

Development of the Climate Resilience Design Standards Tool involved active engagement and regular feedback from representatives from the RMAT, as well as subject matter experts (see **Figure 7**). Five internal working groups were established for the subtopics: Scientific, Building Assets, Infrastructure Assets, Natural Resource Assets, and Capital Planning. A group of consultants, academics, municipalities, regional planning organizations, non-profit agencies, and federal agencies reviewed preliminary draft materials, which took approximately eight months.

Climate Resilience Design Standards Tool Project Report

SESD- Beverly Pump Station
Date Created: 1/5/2023 10:08:12 AM
Created By: Nickgolben1
Date Report Generated: 1/5/2023 10:23:08 AM
Tool Version: Version 1.2
Project Contact Information: Nick Golben (Nick.Golben@aecom.com)

Project Summary

Link to Project

Estimated Capital Cost: $10000000.00
End of Useful Life Year: 2070
Project within mapped Environmental Justice neighborhood: No

Ecosystem Service Benefits	Scores
Project Score	Moderate
Exposure	**Scores**
Sea Level Rise/Storm Surge	Moderate Exposure
Extreme Precipitation - Urban Flooding	High Exposure
Extreme Precipitation - Riverine Flooding	Not Exposed
Extreme Heat	High Exposure

Asset Preliminary Climate Risk Rating Summary

Number of Assets: 1

Asset Risk	Sea Level Rise/Storm Surge	Extreme Precipitation - Urban Flooding	Extreme Precipitation - Riverine Flooding	Extreme Heat
Beverly Pump Station	High Risk	High Risk	Low Risk	High Risk

Climate Resilience Design Standards Summary

	Target Planning Horizon	Intermediate Planning Horizon	Percentile	Return Period	Tier
Sea Level Rise/Storm Surge					
Beverly Pump Station	2070	2050		200-yr (0.5%)	
Extreme Precipitation					
Beverly Pump Station	2070			50-yr (2%)	Tier 3
Extreme Heat					
Beverly Pump Station	2070		90th		Tier 3

Scoring Rationale - Project Exposure Score

The purpose of the Exposure Score output is to provide a preliminary assessment of whether the overall project site and subsequent assets are exposed to impacts of natural hazard events and/or future impacts of climate change. For each climate parameter, the Tool will calculate one of the following exposure ratings: Not Exposed, Low Exposure, Moderate Exposure, or High Exposure. The rationale behind the exposure rating is provided below.

Figure 6. Example of Climate Resilience Design Standards Tool Project Report

Climate Resilience Design Standards Tool:
Sea Level Rise/Storm Surve Design Criteria
Projected Water Surface Elevation Map: 2030, 0.5% (200-yr)

Project Name: SESD- Beverly Pump Station
Location (Town): Beverly

0.05 0.1 0.25 Miles

Created by: Nickgolben1
Date Created: 1/5/2023
Tool Version: 1.2

N

Asset Name	Planning Horizon	Return Period	Max	Min	Area Weighted Average (ft-NAVD88)
Beverly Pump Station	2030	0.5% (200-yr)	10.4	10.4	10.4

Figure 7. Climate Resilience Design Standards Tool Output: Projected Water Surface Elevation Maps

3.2.1.7 Recommendations for Inclusion in the North Carolina Flood Resiliency Blueprint Process

While this program is different in structure from the one North Carolina is developing, it addresses similar challenges and environmental issues. It can provide lessons learned regarding the methods and partnerships that it integrates. The following section includes recommendations for how NCDEQ can most effectively govern and distribute funding to Blueprint initiatives. Recommendations in this section cover topics including the evaluation and approval of flood mitigation projects, additional modeling, and data needs.

Establishment of a Project Management Team comprised of technical experts from key state agencies and multiple stakeholders that eased information exchange and support for the plan. The goals of the PMT include oversight of and contribution to the development of the SHMCAP. The PMT consists of staff across departments and agencies, including representatives from the following entities:

- Office of Coastal Zone Management
- Department of Conservation and Recreation
- Department of Energy Resources
- Department of Public Health

- Department of Transportation
- Division of Capital Asset Management and Maintenance
- Executive Office of Energy and Environmental Affairs
- Executive Office of Public Safety and Security
- Massachusetts Bay Transportation Authority
- Massachusetts Emergency Management Agency

Several best practices and lessons learned from the SHMCAP process apply to the Blueprint, including:

1. A robust stakeholder engagement program with opportunities for meaningful contributions during the project
2. Development of a methodology and web-based survey to support state agencies in consistently performing vulnerability assessments and provide automated report generation within project budgets
3. Development of an easy-to-use tool for prioritization of actions identified during the planning process and support the development of the state's strategy that would allow any validated organization to provide input
4. Assign staff to regularly review, revise, report on, and update the goals in each watershed's Blueprint as conditions and information change. This group of staff should track and facilitate the completion of annual implementation updates for each Blueprint and ensure that the vulnerability assessments incorporate new data as they become available.
5. Assign staff to provide outreach, technical assistance, stakeholder engagement, and other educational services that increase awareness and understanding of the Blueprint. This group should coordinate the continuous enhancement of the Blueprint through collaborative partnerships and the active engagement of key stakeholders. They should also be responsible for incorporating each watershed's Blueprint into other state plans and programs as appropriate.

3.3 South Carolina Office of Resilience

3.3.1.1 Background and Overview

The South Carolina Office of Resilience (SCOR) was established in September 2020 through Bill 48-62-10 of the 123rd session of the South Carolina General Assembly.[11] Its creation established the role of chief resilience officer, created an advisory committee, transferred the South Carolina Disaster Recovery Office to SCOR, led to a statewide resilience plan, and created a state fund for resilience planning, disaster relief, and hazard mitigation (South Carolina General Assembly, 2020). The program

[11] https://www.scstatehouse.gov/sess123_2019-2020/bills/259.htm

was created in response to the increase in storm severity South Carolina has faced, starting in 2015 (The Post and Courier, 2021).

The original Disaster Recovery Office was a temporary solution and started as a disaster relief program, which was later made more permanent due to Hurricanes in 2016-2018. They have now expanded their focus to resilience efforts and hazard mitigation.

SCOR is headed by the Chief Resilience Officer, a governor-appointed position, and is organized into three central program departments.

1. Mitigation – Covers public infrastructure (ranging from storm sewer installations and updates to retention ponds, waterway, and wetland restoration), buyouts, plans and studies, and project matching funds
2. Disaster Recovery- Assists individuals who have uncovered damages or unmet needs from disaster damages
3. Disaster Case Management - Pairs a citizen with a case manager to help them determine their needs post-disaster event and create an 'Individual Recovery Plan.'

3.3.1.2 Datasets, Models, and Platforms for Decision Making

SCOR uses numerous information resources and datasets to assist local municipalities and others in learning more about resilience. These cover general topics such as the Sendai Framework for Disaster Risk Reduction, the USACE South Atlantic Coastal Study – South Carolina Appendix, FEMA's guide for local communities on building community resilience with nature-based solutions, information and resources on community services and equity, infrastructure, economic activity, codes, zoning, regulations and planning, and funding opportunities.

- https://scor.sc.gov/resilience/resources

An ongoing Modeling Technical Workgroup aims to create an inventory of existing hydrologic and hydrographic models, identify data gaps, recommend modeling needs, and evaluate proposals for modeling improvements.

3.3.1.3 Program Funding

The South Carolina Office of Resilience used two state-level funds created while the office was codified. Both funds were established in September 2020 by SC Code §48-62-10 and are administered by the State Treasury. The purpose of the funds is to implement and maintain the Statewide Resilience Plan and for disaster relief assistance, hazard mitigation, and infrastructure improvements.

The Disaster Relief and Resilience Reserve Fund can be used in federally declared disasters. This fund helps those whose damages were not fully covered by federal funding or who are not eligible for federal funding. It can also be used for grants/loans to help local economies during a disaster.

The South Carolina Resilience Revolving Fund provides loans to communities looking to purchase flooded properties and restore the floodplain. This fund is only for state and local government use and

is one of two created by the passing of the South Carolina Disaster Relief and Resilience Act in the 2020 South Carolina General Assembly session. [12]

SCOR has received $293M from HUD CDBG – Disaster Recovery (CDBG-DR) and is managing three CDBG-DR programs – the 2015 severe storm (flood), Hurricane Matthew (2016), and Hurricane Florence (2018). As of September 2022, SCOR completed construction projects under the Disaster Recovery program, established after historic flooding in 2015, that repaired or replaced over 1800 homes. These two programs each exclusively served low-to-moderate-income citizens. SCOR has also received $4.5M in CDBG-MIT funds for mitigation activities that will increase resilience to disasters and reduce or eliminate the long-term risk of loss of life, injury, damage to and loss of property, and suffering and hardship by lessening the impact of future disasters.

3.3.1.4 Program Status

A key objective of the program was to develop and implement a Strategic Statewide Resilience and Risk Reduction Plan (Resilience Plan). The Resilience Plan, which was published in June of 2023, is intended to guide state investment in flood mitigation projects and the adoption of programs and policies to protect people and property. The Resilience Plan Advisory Committee helped develop the Resilience Plan and coordinated efforts on a state level. Agencies included the Department of Natural Resources, the Department of Insurance, the Department of Agriculture, the Emergency Management Division, the Sea Grant Consortium, and the Department of Commerce. An additional 18 members participated from other state agencies and organizations, such as the Center of Resilience Excellence, South Carolina, the City of Charleston Office of Resilience and Sustainability, the Municipal Association of South Carolina, the Forestry Commission, the USACE Charleston District Office, and the University of South Carolina Hazards Vulnerability & Resilience Institute. The Strategic Statewide Resilience and Risk Reduction Plan can be found through the following link:

- https://scor.sc.gov/sites/scor/files/Documents/FINAL%20RESILIENCE%20PLAN_06282023_compressed.pdf (PDF)

SCOR has created many communication pieces, including Flood Vulnerability in South Carolina (PDF), with clear data in easily readable and memorable formats.

For flood resilience planning, SCOR uses a watershed-based approach, considering water flow over the built and natural landscape, planning beyond jurisdictional boundaries, and considering the downstream impacts of upstream actions. SCOR is currently implementing the Salkehatchie River Basin pilot program, which received $750,000 in funding out of the $900,000 in total project costs from the National Fish and Wildlife Foundation's National Coastal Resilience Fund, as the first step in developing and administering a fully operational S.C. Resilient Coastal Communities Collaborative Program.

[12] https://scor.sc.gov/index.php/resilience/sc-disaster-relief-resilience-act

South Carolina has 30,000 miles (about 48280.32 km) of waterways spanning eight major watersheds, including the Broad, Catawba, Edisto, Pee Dee, Salkehatchie, Saluda, Santee, and Savannah (see **Figure 8**).

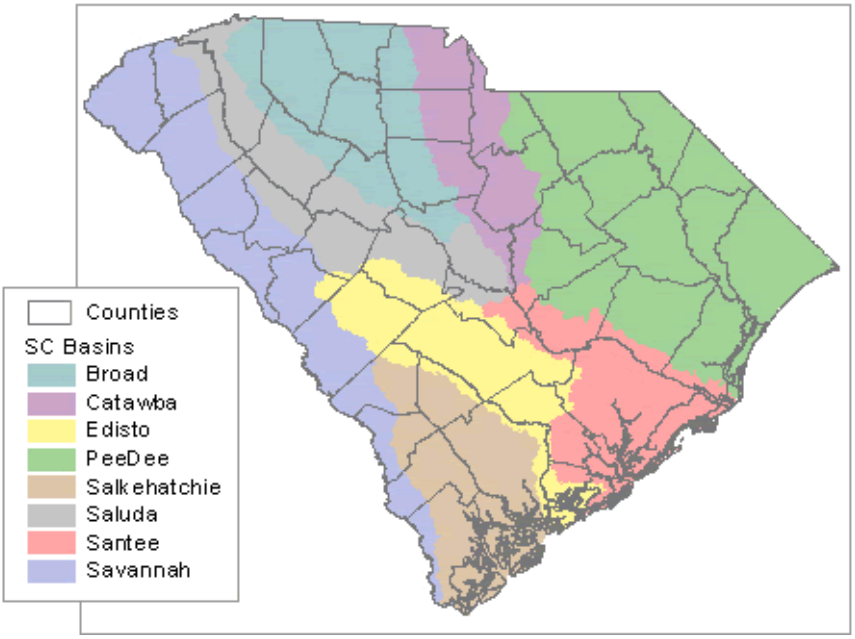

Figure 8. South Carolina Hydrologic Footprint

Several subcommittees and ad hoc committees provided feedback and input on critical systems and resilience-related work. Six subcommittees provided broader statewide input on environmental systems, economic systems, community services, infrastructure systems, building codes and zoning, and cultural resources. Eight ad hoc committees were also created to develop recommendations in the following areas:

- Data Collection and Coordination
- Education, Outreach, and Property Disclosure
- Planning
- Zoning and Land Use
- Building Codes Community Services
- Critical Infrastructure Design
- Stormwater Design and Maintenance
- Recovery Coordination

The Resilience Plan provides information on a variety of topics, including a:

- Description of known flood risks for each of the eight major watersheds of the state.
- Examination of existing and potential losses associated with extreme weather events and other natural catastrophes, as well as land management practices that exacerbate extreme weather events, resulting in increased flooding, wildfires, and drought conditions.

- Identification of data and information gaps that affect the capacity of state agencies and local governments to adequately evaluate and address the factors that increase flood risk and recommend strategies to overcome such gaps.
- Development of recommendations at an appropriate scale, including sub-watershed or local government levels, to decrease vulnerabilities and adverse impacts associated with flooding.
- Estimation of the number and cost of residential properties within the State for which floodplain buyout may be appropriate.
- Articulation of a strategy for providing resources, technical assistance, and other support to local governments for flood risk reduction action.
- Integration of recommended approaches to risk reduction into existing state strategies for hazard mitigation, environmental protection, and economic opportunity and development.
- Opening opportunities for stakeholder input from citizens around the state.
- Coordination of state-wide disaster recovery efforts and activities and collaboration between federal, state, and local stakeholders.
- Distribution of technical planning assistance for state and local governmental entities.
- Distribution of grants to higher education institutions and other state and local governmental entities to research resilience concerns specific to South Carolina.

3.3.1.5 Recommendations for Inclusion in the North Carolina Flood Resiliency Blueprint Process

- Consider analyzing multiple factors/data sets, then assign a point system to rank mitigation ideas. For example, the low-to-moderate income dataset was not the only factor used in SCOR's Flood Mitigation Report of the Pee Dee and Santee Watersheds. There were 198 project ideas analyzed using eight factors to determine if a project idea should be implemented. **Figure 9** depicts the process used to rank and organize the infrastructure, buyouts, and planning project ideas submitted to SCOR for analysis.

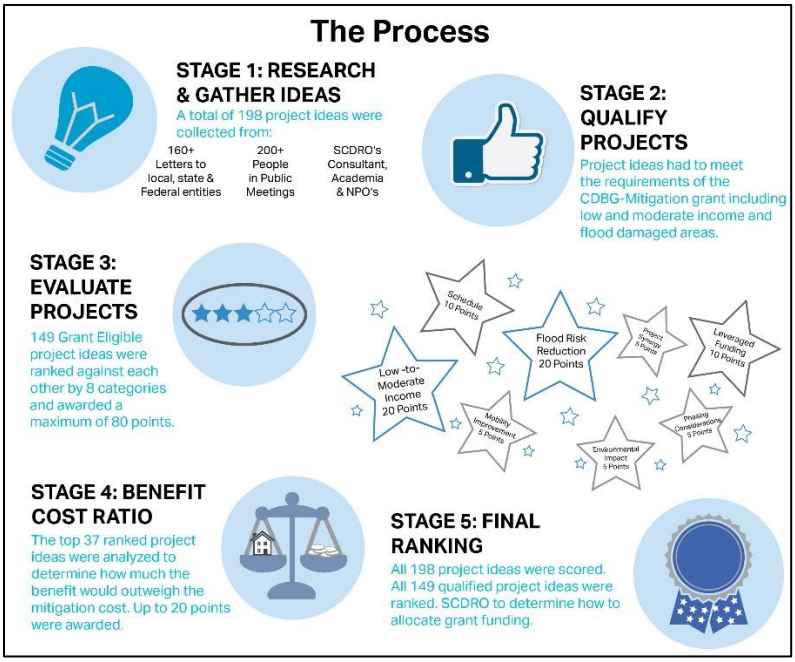

Figure 9. SCOR Process

- SCOR had numerous Council of Government meetings with local communities at the initial stage of the project. The purpose of these meetings was to collect mitigation projects/plans. From the 198 project ideas submitted, a surprisingly large percentage did not have as-built drawings or shovel-ready projects. Not surprisingly, communities with the funds to hire City and County engineers were able to provide mitigation project ideas that were ready for implementation. Disadvantaged communities did not have the resources to provide a detailed mitigation project idea; therefore, SCOR used some of the funding for planning to hire contractors to create those mitigation ideas for these communities. The Blueprint can learn from SCOR's past experiences and should focus on supporting vulnerable and impacted communities prior to the initial project submission round of its programs.
- Engage stakeholders at the local level at the beginning, middle, and end of the process, including asking for their opinions on key decisions.
    - Communities would like an interactive role with SCOR throughout the entire process. Local agencies are more receptive to implementing mitigation projects in their community when directly involved in decision-making. Making decisions without consulting or, at the very least, informing communities of these selections erodes confidence in the program's vision.
- Develop a plan to understand and use appropriate resources that inform a data-rich riverine and coastal flood risk analysis
- Consider developing an overall plan that engages state agencies and other levels of government to ensure things like data purchases are aligned with a common objective

3.4 Texas Coastal Resiliency Master Plan

3.4.1.1 Background

In 2016, the Commissioner of the Texas General Land Office (GLO) recognized a need for more resources and planning for coastal protection and planning. The Coastal Resources Division of the Texas GLO was directed to create the first Texas Coastal Resiliency Master Plan (TCRMP), which was released in early 2017 and focused on issues of concern and resiliency strategies (see **Figure 10**). The 2023 Coastal Resiliency Master Plan is the third installment of the coastal plan.

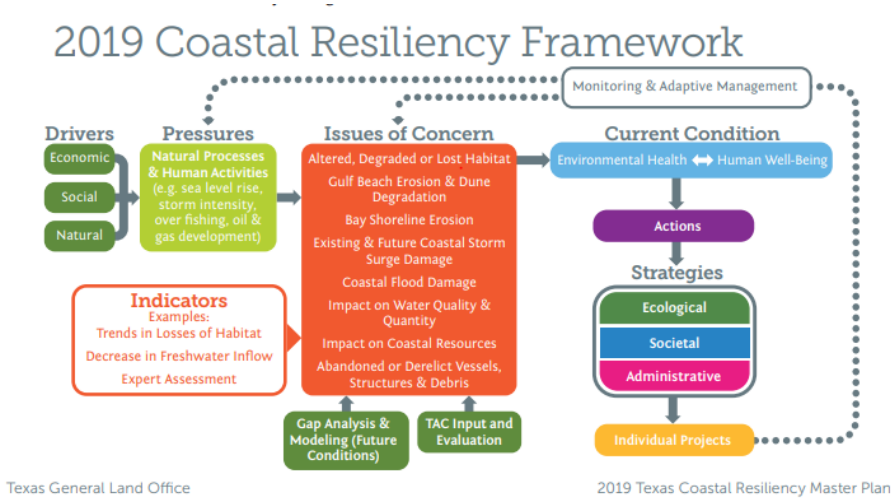

Figure 10. Texas Coastal Resiliency Framework

The 2023 TCRMP was developed using the following goals:

1. The GLO will use this plan to direct its authority to identify, select, and fund projects that address coastal vulnerabilities and restore, enhance, and protect the Texas coast.
2. Develop an adaptable plan that accommodates changing coastal conditions. This plan will provide system-wide, multiple lines of defense solutions to restore, enhance, and protect coastal habitats, infrastructure, and communities.
3. Communicate the Texas coast's environmental, social, and economic value to local, state, and national audiences.

The 2023 Texas Coastal Resiliency Plan was released on April 3, 2023.

3.4.1.2 Program Overview

The TCRMP identifies eight coastal vulnerabilities that most significantly affect Texas coastlines:

4. Degraded or lost habitat
5. Gulf shoreline change
6. Bay shoreline change
7. Storm surge flooding

8. Inland flooding
9. Tidal flooding
10. Degraded water quality
11. Degraded water quantity

The coastline has been divided into four distinct regions, with other designations for coastwide or multi-region projects (see **Figure 11**). The GLO develops data-driven assessments of vulnerabilities within each of the coastal regions. These vulnerabilities are also assessed and vetted by the GLO's Technical Advisory Committee, comprised of over 200 practitioners and experts in coastal engineering, science, research, and decision-making, among other fields.

Potential projects to be included within the TCRMP are prioritized in tiers. Tier 1 is the highest priority tier, with project work prioritized to be completed first. The GLO selects the projects after extensive consultations with its Technical Advisory Committee, which evaluates each project for its merit to address the vulnerabilities in the vicinity of the project.

After Tier 1 projects have been selected, the GLO works with project stakeholders to fund and implement them; however, the TCRMP is not itself a funding mechanism. Tier 1 projects have the benefit of being listed in a statewide plan when soliciting funding from various grant sources. They are also eligible for special use of certain grant funding administered by the GLO. For example, Tier 1 projects are eligible to receive funds for construction without an associated required local match.

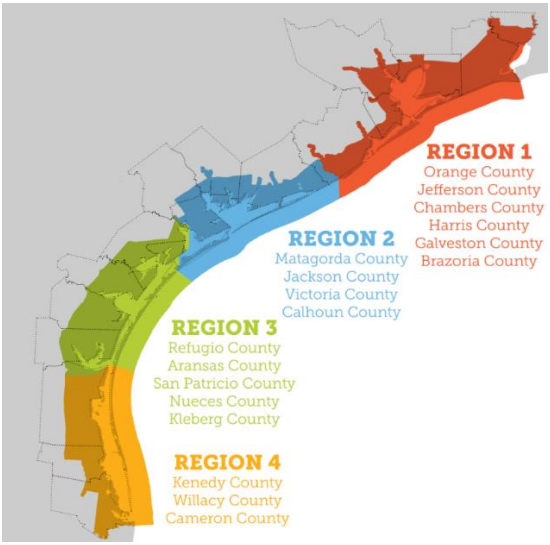

Figure 11. Texas Coastline's 4 Regions

For the 2023 TCRMP, 121 projects were selected as Tier 1 projects. All projects are listed by name, location, and projected costs. The purpose of Tier 1 projects is to address coastal vulnerabilities and restore, enhance, and protect the Texas coast. The plan defines ten actions as a series of coordinated approaches that show where Texas's coastal resiliency needs now intersect with the vision that the Texas GLO and its partners share to improve the coast's future. The Texas GLO hopes to champion future resiliency projects that align with one or more of the proposed actions, which can and often do accomplish more than one resiliency goal. Each of the Tier 1 projects selected corresponds to one or more of the ten actions, which include:

- Managing coastal habitats
- Managing gulf shorelines
- Managing bay shorelines
- Improving community resilience
- Adapting to changing conditions

- Managing watersheds
- Growing key knowledge and experience
- Enhancing emergency preparation and response
- Addressing under-represented needs
- Maintaining coastal economic growth

3.4.1.3 Datasets, Models, and Platforms for Decision Making

The GLO Planning Team utilized local studies and developed the new Sea Level Affecting Marshes Model (SLAMM), Advanced Circulation + Simulating Waves Nearshore, and the FEMA Hazard US (Hazus) models to understand and predict potential future scenarios for landcover change, coastal storm and flood risk, and infrastructure impacts. Models were developed to identify the most vulnerable portions of the Texas coast to long-term processes such as relative sea level rise and erosion. The models were also used to assess whether large-scale coastal restoration project suites are effective solutions for reducing coastal vulnerability. This was accomplished by modeling with and without projects, as if no actions were taken, using the SLAMM interface. These two scenarios (with and without projects) were compared to test whether the projects provided protection from surges on the present and future landscapes after decades of relative sea level rise.

AECOM, in partnership with the Harte Research Institute, modeled existing land cover and change in land cover to provide baseline conditions and predict future ecological change based on rising sea levels. Without mitigating action, the models showed that significant portions of the coast would be at risk of land loss, with current habitats and low-lying communities converting to open water by 2100. These results also demonstrated that large-scale sediment placement would increase the elevation of bay bottoms and offset the subsidence rate.

Economic impact modeling was conducted using Hazus to quantify potential damage to infrastructure. Results showed a considerable percentage increase in total losses (including building loss, content loss, relocation cost, income loss, rental income loss, and wage loss) compared between current conditions and conditions in 2100 without projects. Assuming an intermediate low rate of relative sea level rise, approximately 132 to 554 percent increase would be expected in the total losses incurred by a Category 2 hurricane, depending on the coastal region. Assuming an intermediate-high rate of relative sea level rise, the total loss would increase from 312 to 1,685 percent compared to the present day.

3.4.1.4 Program Funding

The GLO maximizes state funding for coastal projects by seeking matching funds from local and federal partners. Five times the state legislature appropriation of $25 million has been secured for a total of $135 million.[13] Sources of funding include:

- Federal

[13] https://www.glo.texas.gov/coast/grant-projects/overview/index.html

  - Natural Resource Development Act
  - RESTORE Act
  - National Fish and Wildlife Foundation-Gulf Environmental Benefit Fund
  - Gulf of Mexico Energy Security Act.
- State
  - Coastal Erosion Planning and Response Act
  - Coastal Management Program
  - Coastal Impact Assistance Program (discontinued)

The Grants Projects Listing Website is a user-friendly, searchable website dedicated to grant projects, enabling users to find information about the many projects receiving funding along the Texas coast.

3.4.1.5 Recommendations for Inclusion in the North Carolina Flood Resiliency Blueprint Process

Recommendations for a governing body to evaluate and/or approve flood mitigation projects and/or additional modeling and data needs for funding that can be applied to the Blueprint technical approach.

- Select regional relative sea level rise rates reflective of coastal regions
- Collect available habitat and risk datasets to guide coastal analyses (e.g., FEMA, National Wetlands Inventory, local datasets)
- Identify modeling suite to develop baseline (present-day) and future expected conditions
- Establish cutoff for future conditions modeling (e.g., 2100)
- Develop modeling methodology, expected outputs, and protocols (found in Subtask document: Public Domain H&H Modeling, Storm Frequencies, and Climate Forecast Models Support Tools14)
- Develop storm surge and land cover change models to demonstrate coastal storm risk to communities and ecosystems (e.g., Advanced Circulation, SLAMM, or other models)
- Identify drivers and pressures that are leading to coastal vulnerabilities
- Develop a list of coastal vulnerabilities and establish the level of concern for each by geography and type
- Develop a list of at-risk coastal natural resources and establish the level of concern for each by geography and resource type
- Identify success metrics for improving coastal resilience and natural resource restoration
- Stand up Technical Advisory Committee or other process for an independent, third-party review of results

[14] https://ncfloodblueprint.com/documents/Subtask3_5_6_7_HH_Freq_ClimateModels.pdf

- Address under-represented needs and provide environmental, economic, and social co-benefits as well as risk reduction factors to incentivize restoration project solutions. Like the TCRMP, Blueprint should identify and prioritize areas with no organized or active stakeholders, areas with historically few flood resiliency projects, and communities identified as socially vulnerable.

3.5 Texas State Flood Plan

3.5.1.1 Background

The state of Texas routinely experiences extremes of dry and wet weather. Extended droughts are often followed by major storms, which can sometimes end a drought in a single storm. Since 2003, 15 flood and severe storm-related disasters have been declared in Texas, and 15 declared hurricane disasters. Such events created the need for $278 million in Texas Flood Mitigation Assistance grants since 2015.

Considering these reoccurring floods, in 2019, the Texas Legislature and governor expanded the role of the Texas Water Development Board (TWDB) in flood planning and financing by authorizing the TWDB to administer a new state and regional flood planning process. The process is designed to produce the first-ever state flood plan for Texas. The plan will include a ranked collection of recommended flood mitigation projects for the state. The cornerstone of this new process is flood planning regions based on river basins. This new methodology aims to initiate a recurring process for developing regional and state flood plans. The regional planning boundaries allow for more tailored considerations and technical approaches for each region. Regions roughly follow river basin boundaries; however, per S.B. No. 8 passed by the Louisiana legislature, the TWDB board has the authority to divide river basins to avoid having an impracticably large area for efficient planning in a flood planning region as well as in response to stakeholder input. As a result, the TWDB formed 15 flood planning regions in comparison to the 23 major river basins (HUC 6) in the state (**Figure 12**).

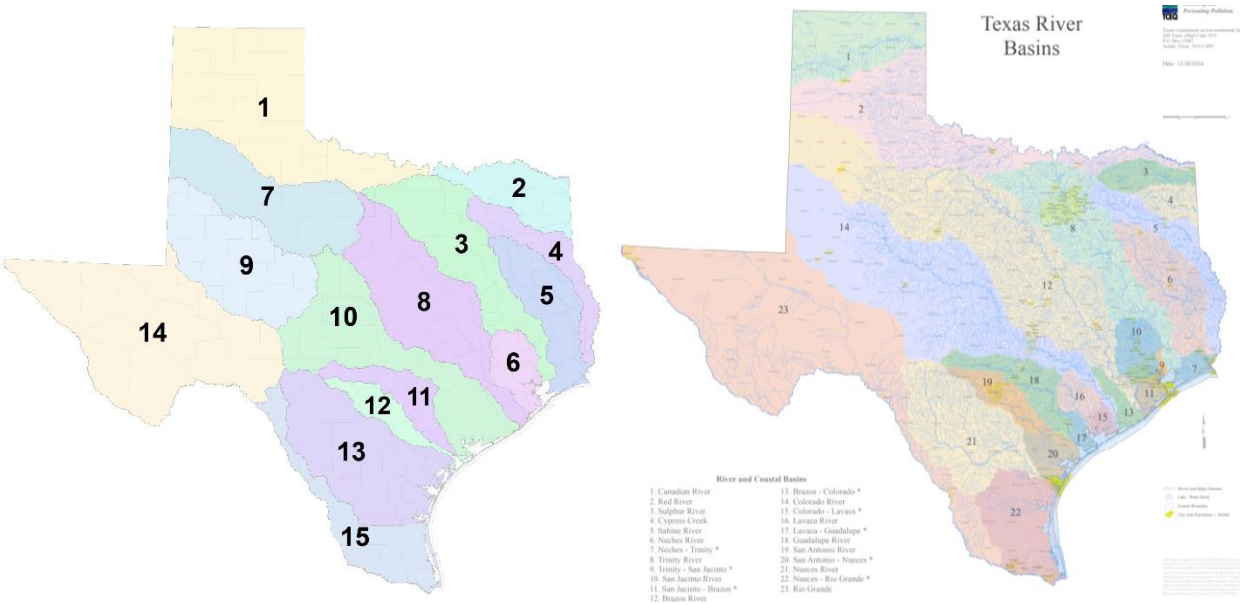

Figure 12. TWDB Regional Flood Planning Group Boundaries (left) versus major river basin boundaries (HUC 6)

The new planning process requires that all recommended flood mitigation projects be ranked in the new state flood plan, compiled from individual plans submitted by Regional Flood Planning Groups (RFPG), each representing one of the TWDB's new flood planning regions. The stated purpose of the ranking is to streamline the process used across all Texas regions to systematically address the flooding hazards with the greatest populations, properties, and critical facilities in danger from a one percent annual chance of flood. The priorities in the ranking are severity of flood risk, reduction of flood risk, and impact on life and property. The first state flood plan, created through the new planning process, is due September 1, 2024.

In the fall of 2019, Texas voters approved a constitutional amendment to create the Flood Infrastructure Fund (FIF) to assist in financing drainage, flood mitigation, and flood control projects.

In addition, the legislature appropriated funds for the TWDB to collect more flood-related data, advance its river and coastal modeling capabilities, and distribute critical flood information through an online dashboard.

3.5.1.2 Scheme of Governance

The Texas State Flood Plan is administered and overseen by the Texas Water Development Board. The TWDB has three primary responsibilities: collecting and disseminating water-related data; assisting with regional water supply and flood planning that contributes to preparing the state water plan and state flood plan; and administering cost-effective financial programs for constructing water supply, wastewater treatment, flood control, and agricultural water conservation projects.

There is a 13-member Executive Administration (see **Figure 13**), which manages the full TWDB program. A separate full-time, three-member TWDB Board is appointed by the governor and is tasked with considering loan applications from eligible applicants, awarding grants for water-related research and planning, and conducting other TWDB business, including approving the state water

plan. The TWDB Texas Water Development Board collaborates with the Texas General Land Office and the Texas Division of Emergency Management to assist communities in choosing appropriate funding for flood-related projects.

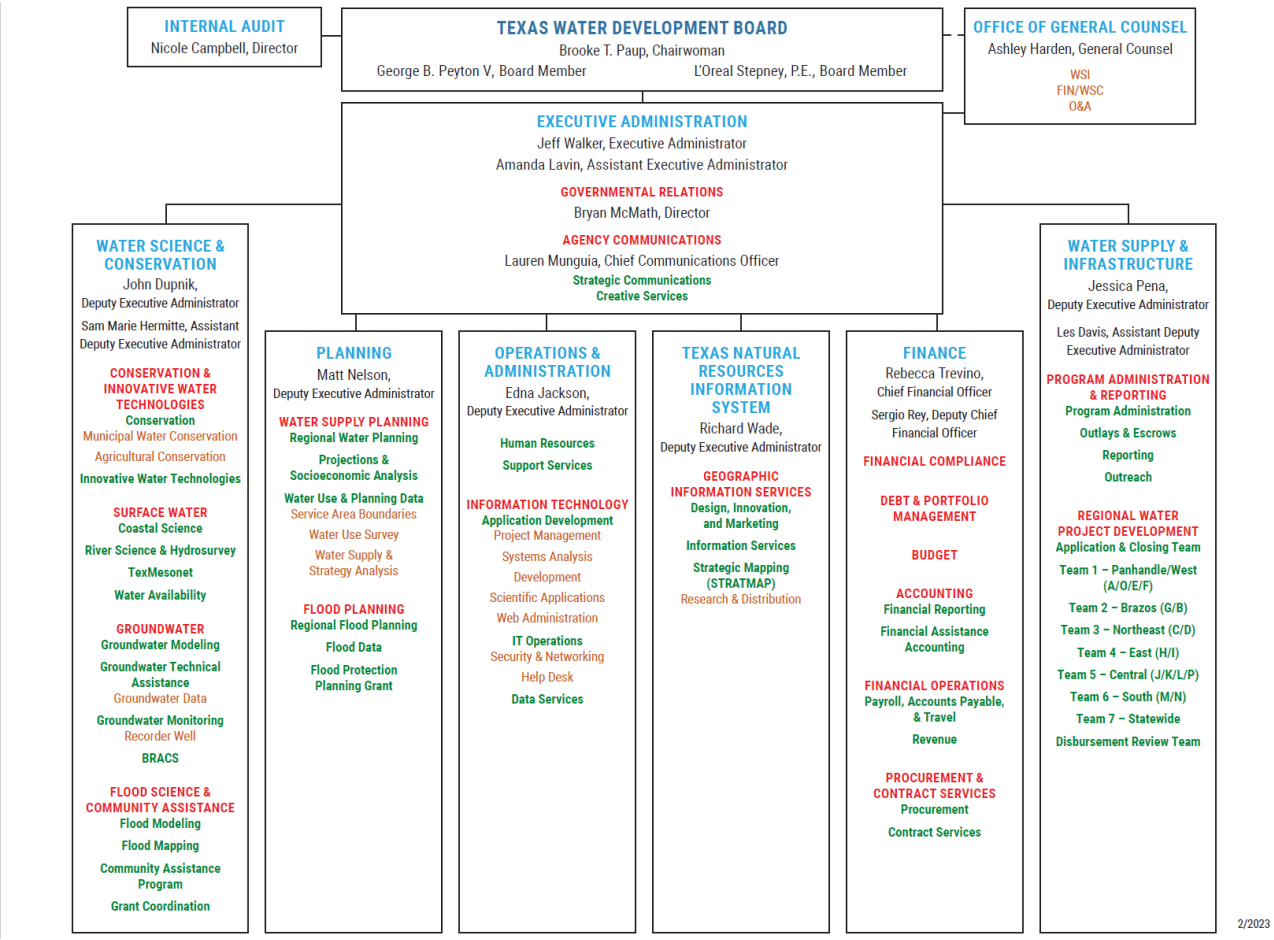

Figure 13. TWDB Organizational Chart (02/2023)

Each of the 15 RFPGs is required to have representation from diverse interest categories, including the public, counties, municipalities, industry, agriculture, environment, small business, electric-generating utilities, river authorities, water districts, water utilities, and flood districts. Furthermore, each RFPG must include seven non-voting members from specific state agencies such as the Texas Commission on Environmental Quality, General Land Office, Parks and Wildlife Department, Department of Agriculture, State Soil and Water Conservation Board, Texas Division of Emergency Management, and a dedicated TWDB staff member for ongoing support. The RFPG has the flexibility to add additional voting or non-voting positions to ensure comprehensive representation of its unique regional interests. It should also be noted that RFPGs receive funds from the TWDB to realize their regional plans and implement projects.

3.5.1.3 Datasets, Models, and Platforms for Decision Making

Two main features of the Texas flood planning program create a structure by which TWDB can define and rank proposed projects within the new state process. The first is a categorization system, and the second is a ranking criteria and weighting system.

3.5.1.3.1 FLOOD PROJECT CATEGORIZATION SYSTEM

The "2020 Flood Intended Use Plan" outlined four categories of flood-related projects for which financial assistance is needed. Loans and grants are available, depending on the activity funded and the Adjusted Median Household Income of the applicant entity. Eligible activities are organized into four categories, and each proposed project falls into one of these categories:

Category 1 – Flood protection planning for watersheds (Flood control planning before a flood event)

> Includes assessed applications based on factors like project duplication, regional vs. local scope, flood history, participation in the National Flood Insurance Program, project details, potential benefits, and the financial need of the political subdivision. Greater priority is given to counties with a median household income not exceeding 85 percent of the state median.

Category 2 – Planning, acquisition, design, construction, rehabilitation (All combinations of these)

> Encompasses planning, land acquisition, design activities, construction, rehabilitation, and implementation efforts. Applicants in this category must account for operations and maintenance costs, evaluate floodwater capture techniques, and collaborate with watershed entities.

Category 3 – Federal award matching funds

> Pertains to communities with federal awards tied to local matching funds, offering grant funds for a portion of the required federal match amount.

Category 4 - Measures immediately effective in protecting life and property

> Encompass swift, effective projects that can be implemented quickly, safeguarding life and property. Examples include warning systems, barriers, gages, and education efforts. It excludes major planning, construction, or design undertakings.

- https://www.twdb.texas.gov/financial/programs/fif/doc/2020_Flood_Intended_Use_Plan.pdf (PDF)

3.5.1.3.2 FLOOD PROJECT RANKING SYSTEM

To maintain a community priority-driven regional flood planning program, TWDB elected to use only RFPG-reported data for the ranking. RFPG-reported data refers to raw data included for each of the recommended FMPs. Criteria obtained from reported data comprise 70% of the total weight for FMPs. Only one of these criteria, “percent of structures removed from 100yr floodplain,” was calculated by TWDB using Reported Data. This criterion intends to give additional weight to projects with a more

significant impact on smaller communities. The resulting rankings are based on the reported technical merits of each RFPG-recommended Flood Management Evaluation, Flood Mitigation Project, and Flood Management Strategy.

The weighted criteria and technical merits of the ranking system include the following:

- Improvement of at-risk population structures
- Protection of transportation systems
- Farm and ranch land use rights removed from floodplains
- Nature-based solutions
- Benefit-cost ratio (FEMA's Benefit-Cost Analysis Toolkit 6.0.)
- Water supply benefits
- Severity of flooding depth
- Severity of community need
- Degree of flood risk reduction
- Flood damage reduction
- Critical facilities damage reduction
- Life and safety
- Multiple benefits
- Administrative or regulator obstacles
- Environmental benefit
- Environmental impact
- Mobility
- Regional geographic distribution

Stakeholder feedback was sought for the ranking criteria, and the specifics may remain in flux. For a complete list of proposed criteria, see the public workbook published by the TWDB.

- https://www.twdb.texas.gov/flood/planning/sfp/doc/03_Attachment1_State_Flood_Plan_Project_Ranking_Criteria_Weight.pdf (PDF)

3.5.1.3.3 APPLICATION PROCESS

Applications can be submitted for funding on an annual cycle, and the process is a two-stage application. An initial, abridged application is submitted and reviewed. Abridged applications should describe proposed projects from one of the four categories detailed above. Projects are prioritized based on the information submitted in the abridged application. Then, the TWDB invites applicants whose project prioritization and funding allocations were approved to submit a complete financial assistance application by the TWDB deadline to remain eligible for funding. The complete application asks for detailed engineering, legal, fiscal, and other items needed to make a funding recommendation based on project prioritization and a determination of funding availability. After reviewing each complete application, TWDB makes a financial assistance recommendation, which the

Board considers in a public meeting. Entities that receive financial assistance commitments have six months to close on their financing unless a cause exception is specifically recommended by the Executive Administrator and approved by the Board.

3.5.1.3.4 YEAR-ROUND SUBMITTALS

Abridged applications may be submitted for consideration at any time during the year and considered if funding is still available. However, only abridged applications received by the initial deadline are considered in the initial prioritization. The final recommendations list can be amended to include new submittals as necessary.

3.5.1.3.5 FLOOD INFORMATION CLEARINGHOUSE

The Flood Information Clearinghouse Committee enhances public funding resource utilization and helps communities identify suitable funding sources. Part of the new planning process is increased public information outreach. The TWDB, the General Land Office, and the Texas Division of Emergency Management have created Texas' comprehensive source for flood mitigation funding information for Texas communities. The website includes an online Request for Information Form that entities can submit to get feedback on what state and federal financial assistance programs could best fit their flood mitigation needs. The site also has information on current funding opportunities, general project and entity eligibility by program, upcoming flood mitigation financial assistance events, and other resources.

3.5.1.4 Program Funding

The new flood planning process is funded through state appropriations. The legislature established a new Texas Infrastructure Resilience Fund and provided funding to its Floodplain Management Account to support the development of the first state flood plan and TWDB's flood science and mapping activities. The Flood Infrastructure Fund is the main program established by the legislature to help deliver financial assistance to Texas projects recommended in the new state flood plan.

In 2019, along with the initiation of the new planning process, the legislature made a voter-approved one-time transfer of $793 million from the state's Economic Stabilization or "Rainy Day" Fund to a new flood financial assistance program, the FIF, to be administered by the TWDB. The program is designed to make the implementation of drainage and flood projects more affordable for Texas communities and meet immediate funding needs. The FIF program provides loans and grants for flood control, flood mitigation, and drainage projects. Currently, this fund has 138 active and committed projects with a total committed funding of $513,982,627 (see **Table 1**).

Table 1: FIF Funding Breakdown

Amount	Number of Projects	Commitment Type	FIF Categories	Project Classification
$3,887,186.00	1	Grant	FIF - Category 2	Buyout, FIF Structural

Amount	Number of Projects	Commitment Type	FIF Categories	Project Classification
$5,003,000.00	2	Grants/Loans	FIF - Category 2	Flood Protection
$238,240.00	3	Grants/Loans	FIF - Category 2	Non-Structural
$48,493,299.00	9	Grants/Loans	FIF – Categories 2,3	Structural Flood Control, Mitigation, & Protection
$22,043,548.00	30	Grants/Loans	FIF – Categories 1,2,3,4	Rural
$195,570,602.00	72	Grants/Loans	FIF – Categories 2	Flood Control
$238,746,752.00	87	Grants/Loans	FIF – Categories 1,2,3,4	Unassigned

FIF project details and costs can be found here.

- https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.twdb.texas.gov%2Ffinancial%2Fprograms%2Ffif%2Fdoc%2FFIFProjectReportingDashboardData.xlsx&wdOrigin=BROWSELINK

The FIF was an addition to three other existing Texas Water Development Board Flood Financial Assistance Programs:

National Flood Insurance Program (NFIP) Repetitive Loss for Texas by Community

Targets NFIP-insured structures with two or more flood losses exceeding $1,000 each in any 10-year period since 1978.

Texas Flood Mitigation Assistance grant program:

Part of FEMA's Hazard Mitigation Assistance Grant Program, the Flood Mitigation Assistance grant program provides federal funds for flood damage risk for structures that are insurable under the NFIP. Like North Carolina's Flood Mitigation Assistance program, Texas's program seeks to eliminate repeated claims under the NFIP and the dependence on taxpayer-funded federal disaster assistance for disaster recovery. It is a nationally competitive grant program and has allocated $278 million to benefit 9,700 structures in Texas since 2015, with $253.5 million coming from federal and $24.5 million from local funding. The funding has supported acquisition, drainage, elevation, and planning projects.

- https://www.arcgis.com/apps/dashboards/2493724aaf5744f98f074f13612271ed

Cooperating Technical Partners (CTP) Program

An effort launched by FEMA in 1999 to increase local involvement in developing and updating Flood Insurance Rate Maps (FIRMs), Flood Insurance Study reports, and associated geospatial data.

3.5.1.5 Program Status

The 15 regional flood planning groups (RFPGs) were designated by the TWDB in 2020. These groups each submitted their regional flood plans required by the new planning process and then submitted amended plans between January and July 2023. These 15 plans will be combined into one collaborative state flood plan delivered to the Texas Legislature for approval in September 2024. This regional flood planning process will result in Texas' first state flood plan by 2024.

3.5.1.6 Recommendations for Inclusion in the North Carolina Flood Resiliency Blueprint Process

Recommendations for a governing body to evaluate and/or approve flood mitigation projects and/or additional modeling and data needs for funding that can be applied to the Blueprint technical approach.

- Establish a two-part application process that begins with an abbreviated initial application that helps application reviewers identify high-potential projects and weed out lower-potential projects. This saves time for all parties involved and prevents everyone from completing an extensive application, even for projects where an applicant is unlikely to be approved for funding.
- Create a categorization methodology to define project types so applicants can self-define their project on the application and streamline the sorting and approval process.
- Create a percentages-based ranking system based on a predefined set of criteria that will be available to the public for all flood-related projects or activity applications.
- Allow for the project ranking criteria to go through public engagement and review prior to formal publication.
- Develop "Flood Planning Groups" based on regions, made up of representation from diverse interest categories and a dedicated NCDEQ staff member for ongoing support.
- Create a comprehensive source for flood mitigation funding information for North Carolina communities.
- Work with FEMA and North Carolina Emergency Management to use the CTP program for possible funding opportunities.

3.6 Virginia Coastal Resilience Master Plan

3.6.1.1 Background

In November 2018, Governor Ralph S. Northam issued Executive Order 24, calling for the Commonwealth of Virginia to increase its coastal resilience to sea level rise and natural hazards. The

Executive Order directed the creation of a Coastal Resilience Master Plan to coordinate coastal flood protection and adaptation projects and planning work across the various levels of government.

After two years of research, planning, and engagement, the Virginia Coastal Resilience Master Planning Framework (Framework) was released in October 2020. The Framework establishes goals, principles, and actions to guide the statewide coastal resilience strategy and serves as the foundation for the Virginia Coastal Resilience Master Plan. The Commonwealth plays the lead role in making Virginia's coast more resilient to the impacts of climate change. The Master Plan builds on the 2020 Virginia Coastal Resilience Master Planning Framework, which outlines the core principles and goals of Virginia's coastal resilience strategy. The Master Plan leveraged the combined efforts of more than two thousand stakeholders, subject matter experts, and government personnel.

In November 2020, Governor Northam issued Executive Order Number 71[15] to establish the Virginia Coastal Resilience Technical Advisory Committee to support the Chief Resilience Officer (CRO) and the Special Assistant to the Governor for Coastal Adaptation and Protection (SACAP) in developing the Master Plan, facilitating its implementation, evaluating progress, and making plan updates.

Phase One of the Virginia Coastal Resilience Master Plan (Master Plan) was released in December 2021, and Phase Two is expected to be finished in 2024. Once completed, the Master Plan will be updated every five years.

- https://www.dcr.virginia.gov/crmp/document/VirginiaCoastalResilienceMasterPlan-Summary.pdf (PDF)
- https://www.dcr.virginia.gov/crmp/plan

3.6.1.2 Program Overview

The Master Plan work is housed within the Department of Conservation and Recreation (DCR). As mandated by Executive Order Number 24,[16] the Secretary of Natural Resources serves as the CRO and leads the Master Plan efforts with support from the SACAP. While based in the DEQ, the Coastal Zone Management (CZM) Program supports the Master Plan work, and the Director of the CZM Program reports to the Secretary of Natural Resources regarding coastal adaptation and protection matters.

Stakeholder engagement captured diverse resilience perspectives from residents, local and regional officials, and other stakeholders across Virginia's coastal communities to drive regionally specific resilience priorities. Development of this Planning Framework included close coordination with coastal planning districts and regional commissions, conversations with individual localities, and significant input from scientists and an engaged group of stakeholders. A key element of their efforts was direct outreach to individual communities across the Framework's four coastal regions. The CRO

[15] Commonwealth of Virginia, Office of the Governor. Executive Order No. 27: Establishment of the Virginia Coastal Resilience Technical Advisory Committee. 16 November, 2020. https://www.dcr.virginia.gov/crmp/document/EO-71-Establishment-of-the-Virginia-Coastal-Resilience-Technical-Advisory-Committee.pdf (PDF)

[16] Commonwealth of Virginia, Office of the Governor. Executive Order No. 24: Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards. 2 November, 2018. https://www.dcr.virginia.gov/crmp/document/ED-24-Increasing-Virginias-Resilience-To-Sea-Level-Rise-And-Natural-Hazards.pdf (PDF)

and the SACAP, with assistance from state agencies, held a series of community roundtables to introduce the Virginia Coastal Resilience Master Planning Framework. The goal of the roundtables was to gather input on primary issues for citizens who live and work in vulnerable coastal areas. Combined with information collected through continuing broader public comment, these events supported the development of more detailed coastal adaptation and protection prescriptions under the Framework.

The Technical Advisory Committee (TAC) provides subject matter expertise, data, best practices, and coordination with other stakeholders. Members include state agency representatives, coastal planning districts, regional commissions/organizations, and academic advisors. The TAC consists of the following seven subcommittees to focus on roles within the Master Plan development:

- Aligning Economic Development Subcommittee
- Community Outreach Subcommittee
- Federal Installation Partnerships Subcommittee
- Finance Subcommittee
- Project Evaluation Subcommittee
- Project Identification Subcommittee
- Studies, Research, and Best Practices Subcommittee

The General Assembly codified the Virginia Coastal Resilience TAC in 2022 under § 10.1-659. Flood protection programs: coordination to assist with developing, updating, and implementing the Virginia Coastal Resilience Master Plan (CRMP).

TAC meetings, which are held at least quarterly and supported by the Department of Conservation and Recreation, SACAP, and DEQ CZM Program staff, are conducted to review updates to the Virginia Coastal Resilience Master Plan and receive updates about the progress of the Virginia Flood Protection Master Plan as the TAC can be called upon to assist DCR in its development.

Representatives from state agencies, coastal planning district commissions, regional commissions, academic advisors, and any other as-needed representatives make up the TAC membership, including:

- Executive Directors of Coastal Planning District Commissions and Regional Commissions Accomack-Northampton Planning District Commission, Crater Planning District Commission, George Washington Regional Commission, Hampton Roads Planning District Commission, Middle Peninsula Planning District Commission, Northern Neck Planning District Commission, Northern Virginia Regional Commission, Plan Richmond, Virginia
- Special Assistant to the Governor for Coastal Adaptation and Protection (SACAP)
- Director of the DCR
- Director of the Virginia Department of Emergency Management
- Director of the Virginia Department of Housing and Community Development
- Executive Director of the Virginia Resources Authority

- Director of the DEQ
- Commissioner of the Virginia Department of Transportation
- Director of the Virginia Transportation Research Council
- Commissioner of the Virginia Marine Resources Commission
- Director of the Institute for Coastal Adaptation and Resilience
- Associate Dean for Research and Advisory Services at the Virginia Institute of Marine Science
- Director of the William and Mary School of Law Coastal Policy Center
- Director of the Virginia Tech Center for Coastal Studies
- Director of the Environmental Resilience Institute at the University of Virginia
- Director of Virginia Sea Grant (Sea Grant)
- Director of Diversity, Opportunity, and Inclusion
- Chief Data Officer of the Commonwealth
- Commander of the US Army Corps of Engineers, Norfolk District
- Commander of the Navy Region Mid-Atlantic
- Representatives of the seven federally recognized tribal nations indigenous to the Commonwealth of Virginia [Chickahominy Indian Tribe, Chickahominy Tribe Eastern Division, Monacan Indian Nation, Nansemond Indian Nation, Pamunkey Indian Tribe, Rappahannock Indian Tribe, Upper Mattaponi Indian Tribe].

The Master Planning Framework also established four coastal regions to identify priority projects and strategies tailored to each region's needs. The master planning regions follow the boundaries of Virginia's eight coastal Planning District Commissions and Regional Commissions, which are established through local jurisdictional borders. Regional and local entities support data collection, engagement, planning, and project identification efforts within these regions.

- virginiacoastalresiliencemasterplan-print.pdf (PDF)

3.6.1.3 Datasets, Models, and Platforms for Decision Making

Following the creation of the Virginia Coastal Resilience Master Planning Framework, the Study Conceptual Model was developed to ensure that ensuing efforts align with and achieve the goals and objectives outlined in the Framework. The Study Conceptual Model serves to identify questions, establish a schedule, set metrics, and define any other needs before moving into the Master Plan development (see **Figure 14**).

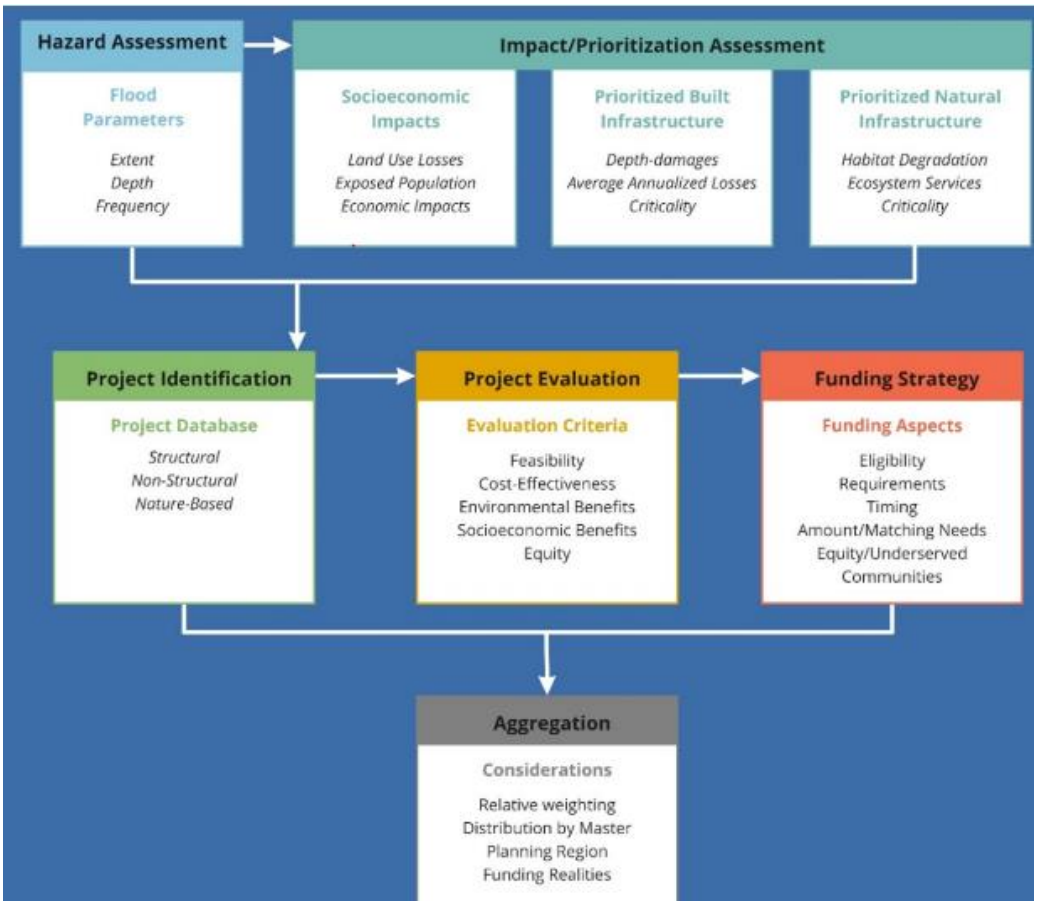

Figure 14. Virginia Study Conceptual Model Process Diagram[17]

Figure 14 highlights the key elements of the process identified by the Study Conceptual Model and the relevant metrics and evaluation criteria for each step. Access the link below to review the Virginia Coastal Resilience Master Plan Study Conceptual Model:

- https://www.dcr.virginia.gov/crmp/document/Appendix-B-Study-Conceptual-Model.pdf (PDF)

Extensive guidance was created to inform data collection, analysis, and decision-making within each step of the Master Plan process. Supplemental guidance documents include:

The Coastal Flood Hazard Framework: Uses publicly available data on known flood hazards to assess existing and future vulnerabilities.

Future Conditions Modeling Approaches: Builds on the Coastal Flood Hazard Framework to quantify existing and future conditions related to additional flood hazards, focusing on pluvial and compound flooding.

[17] Dewberry. 2021, *Virginia Coastal Resilience Master Plan, Task 2: Development of the Study Conceptual Model,* https://www.dcr.virginia.gov/crmp/document/Appendix-B-Study-Conceptual-Model.pdf. (PDF)

- Tools for modeling hydrology and hydraulics for inland hazards are listed in Appendix D of the Master Plan, as well as tools for modeling coastal hazards such as march migration and barrier islands.

Impact Assessment Methodology: Provides an overview of how physical, social, economic, and other impacts are evaluated.

Adaptation Strategies and Prioritization: Project and Capacity Building Schema, Suitability Matrix: Outlines how projects across Virginia were considered and categorized for inclusion in the prioritization process.

The CRMP Project Database was designed in alignment with the project and capacity-building classification schemas to capture and standardize the key attributes required for evaluation and prioritization. While several data collection efforts have captured some flood resilience projects and capacity-building needs, none included the full range of attributes necessary to understand and validate specific projects, and most still require verification by localities for accuracy. To address this data gap, a survey tool was developed using ESRI's Survey123 software to build and populate the CRMP Database. Participants were asked to complete a survey in alignment with the needs of the Prioritization Approach. The survey is organized into two sections: 1. Required Fields – essential attributes to characterize projects and evaluate their effectiveness. 2. Optional Fields – desirable project attributes that would help better assess the merits of a project, which could improve its chances of being funded. Capacity Building & Planning Need – participants were asked to identify ongoing or planned capacity building and planning initiatives, including a description of the effort, estimated costs, and other details.

Adaptation Strategies and Prioritization: Project Evaluation and Prioritization Approach: Outlines the project scoring and prioritization process.

Funding Analysis: Summarizes the process used to identify funding sources and to develop the online database

- https://www.dcr.virginia.gov/crmp/document/Appendix-F-Data-Product-List.pdf (PDF)
- https://www.dcr.virginia.gov/crmp/plan

3.6.1.4 Program Funding

Projects identified within the Master Plan must secure funding through eligible grant or loan sources. The Virginia Coastal Resilience Web Explorer identifies a range of federal, state, and private sources of funding opportunities relevant to the resilience strategies and projects resulting from the Master Plan (see **Figure 15**).

- https://experience.arcgis.com/experience/9e32e928ed304fa98518b71905e43085

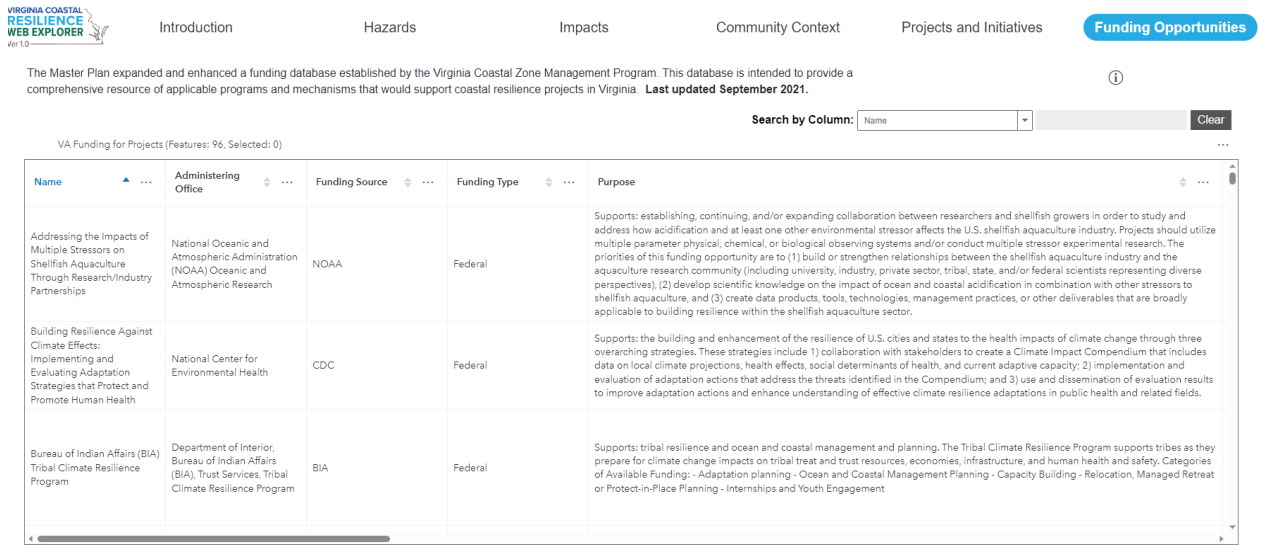

Figure 15. Sample Page Virginia Coastal Resilience Web Explorer

The Virginia Community Flood Preparedness Fund is available through the Department of Conservation and Recreation. The Fund is the main state-level funding mechanism for implementing coastal resilience projects, studies, and capacity building in low-income communities.

- https://experience.arcgis.com/experience/9e32e928ed304fa98518b71905e43085/page/Funding-Opportunities/

3.6.1.5 Program Status

The Master Plan is currently in Phase Two of its development. Recognizing the urgency of addressing coastal resilience, the Phase One Master Plan is intended to set the foundation and present preliminary findings while Phase Two is being developed.

In addition to data collection on existing conditions, Phase One of the Master Plan includes an inventory of key existing coastal resilience and capacity-building projects, organized into three categories: studies and data tools, programs, plans and policies, and technical assistance.

Phase One also identified potential funding sources and financing mechanisms to implement the various Master Plan initiatives. To consolidate all the data and information collected during the Master Plan development, the Coastal Resilience Database and Web Explorer were created as publicly accessible tools.

Phase Two will continue to build on and refine data collection efforts and project, planning, and funding recommendations.

- https://experience.arcgis.com/experience/9e32e928ed304fa98518b71905e43085/page/Introduction/

3.6.1.6 Recommendations for Inclusion in the Blueprint Process

Recommendations for a governing body to evaluate and/or approve flood mitigation projects and/or additional modeling and data needs for funding that can be applied to the Blueprint technical approach.

- Broaden the analysis and characterization of hazards by including rainfall-driven, riverine, and compound flooding in the coastal hazard and impact assessments
- Expand and improve the inventory of resilience projects by continuing to add proposed and planned projects and refining the data requested from project owners to understand the scope and benefits of projects better
- Develop and implement sustainable public planning, outreach, and engagement processes with clear objectives, time-bound tasks, defined accountability, transparent progress monitoring, and actionable evaluation.
- Revise and expand the project evaluation and prioritization approach based on the risks and impacts identified in the Technical Study's updated impact assessment and gap analyses
- Determine options and opportunities to develop adaptation and protection solutions for identified gaps in elevated risk and vulnerable areas

4 Non-Peer State Flood Resilience Programs

Additional programs located in midwestern, non-peer states have relevant information that could be applicable to the North Carolina Flood Resiliency Blueprint. The same factors used to analyze the programs within peer states were also used to attain information on the programs in the states below. Due to the topographic variations in the landlocked states below and in North Carolina, the application of a beneficial technical approach may vary compared to the core programs mentioned above.

4.1 Indiana Floodplain Information Portal

4.1.1 Background

The Indiana Department of Natural Resources Division of Water created the Indiana Floodplain Information Portal, a comprehensive, full-state floodplain map. It was designed to supplement and fill in FEMA's missing or inaccurate data. The portal is used to complete Floodplain Analysis and Regulatory Assessments on a local level (see **Figure 16**).

- https://www.in.gov/dnr/water/surface-water/indiana-floodplain-mapping/indiana-floodplain-information-portal/

There is a rich history of flood mapping and programs in Indiana. However, there is no mention of when this program was created other than the date Indiana Floodplain Information Portal 2.0 launched (January 11, 2022).

- https://indnr.maps.arcgis.com/apps/MapSeries/index.html?appid=f9d2d47776824df09051f4703153b355

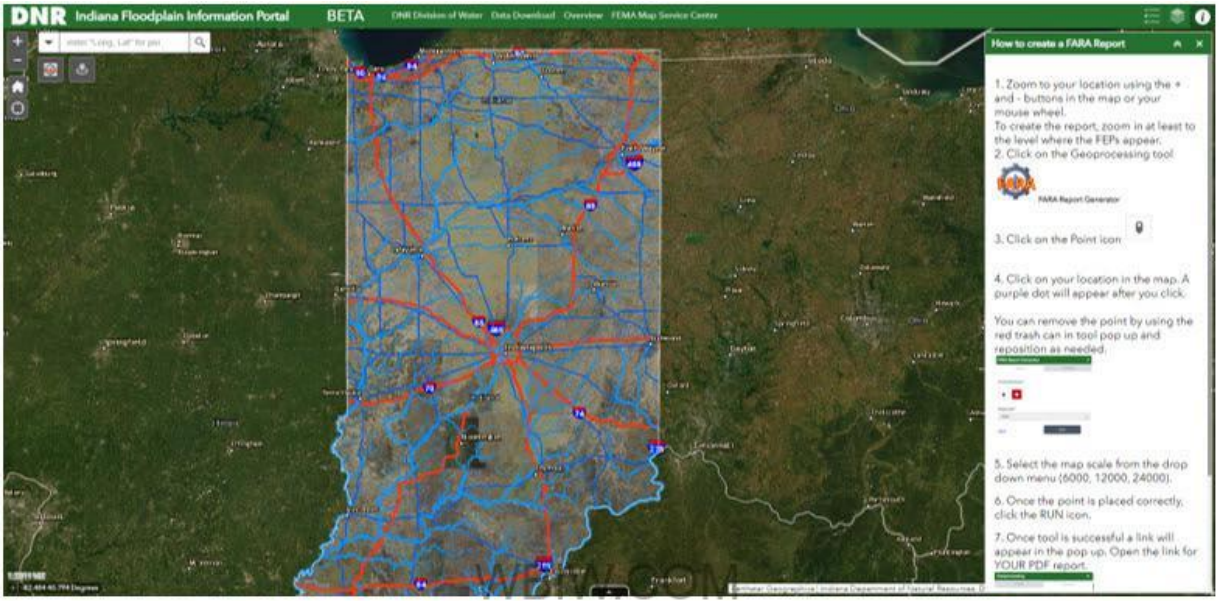

Figure 16. Indiana Department of Natural Resources Floodplain Information Portal in ArcGIS

4.1.1.1 Datasets, Models, and Platforms for Decision Making

The National Flood Insurance Program, ESRI, ArcGIS, and state-gathered data encompass the Floodplain Information Portal 2.0. The portal is a standalone project, with no hazard mitigation program mentioned as part of this effort. The Portal stays updated and is utilized by anyone in or working in Indiana.

4.1.1.2 Program Funding

The Floodplain Information Portal was created by the Indiana Department of Natural Resources, a state-level agency funded by the state. Some federal funding could be used since it combines data accumulated at the state level and NFIP data (but that is not confirmed).

4.1.1.3 Recommendations for Inclusion in Blueprint Process

Consider the type, scale, and visualization of data provided by Indiana's Floodplain Information Portal when designing Blueprint's online decision support tool.

4.2 Iowa Flood Resilience Program

4.2.1.1 Background

The Iowa Flood Resilience Program is housed within the Iowa Watershed Approach (IWA). It lives in the same space as the Iowa Flood Mitigation Projects, headed by the Director of the University of Iowa IIHR—Hydroscience & Engineering IWA Project Lead. The Flood Resilience Program focuses on Iowa's watersheds, helping residents understand the resources for living in them and encouraging resilience plans and behavior. Their goal is to prepare residents using tools, partnerships, and education to ensure the communities are as resilient as possible. The Flood Resilience Action Plan is a guidebook that is the culmination of years of planning and community engagement in an effort to reduce

flooding and increase community resilience across Iowa. These efforts were made possible by the IWA and several watershed coordinators, planners, and community organizers who completed flood mitigation and resilience projects across several watersheds.

Following a severe flood in 2008, the state of Iowa started creating flood mitigation and resiliency plans and programs to help alleviate extended damages. Between 2011 and 2013, there were eight disaster declarations in Iowa. The Iowa Watershed Approach stemmed from these flooding disasters and now works using local, state, and federal resources to try to accomplish six goals:

1. Reduce flood risk
2. Improve water quality
3. Increase resilience
4. Engage stakeholders
5. Improve quality of life
6. Develop a program that is replicable in other Midwest states

The IWA Flood Resilience Program (see **Figure 17**) provides value to Iowa watershed communities through establishing partnerships and developing tools that improve the visualization of flood resilience, benefiting future mitigation, preparedness, response, and recovery actions. The goals of the Flood Resilience Program are to:

- Measure, visualize, and communicate flood resilience resources
- Enhance flood resilience content in formal watershed plans
- Improve social resources for flood resilience

Nine district watersheds, classified as HUC-8, serve as the pilot project sites for the IWA. Each has or will form a Watershed Management Authority, develop a hydrologic assessment and watershed plan, and implement projects to reduce the magnitude of downstream flooding and improve water quality during and after flood events. Flood resilience programs are also being implemented in each watershed to help increase community resilience to future floods.

Figure 17. Main Focuses and Goals of the Iowa Flood Resilience Program

4.2.1.2 Program Status

The program is active, and with the Iowa Flood Mitigation Projects, it is accomplishing its goal of assisting the individuals living in Iowa's watersheds. As the flood resilience program has developed, Iowa has collaborated with local governments within the IWA watersheds to develop community-wide flood resilience action plans. The IWA coordinates with local governments through educational kiosks, newsletters, and fliers as well as field days at project sites, community best management practices workshops, and community-wide meetings with the targeted audiences consisting of local leaders, farmers and landowners, flood vulnerable community members, local partners, and other residents. The main objective of the flood resilience action plans is to enhance community resilience to frequent flood hazards.

4.2.1.3 Datasets, models, and platforms for decision making

The Iowa Watershed Approach Information System (IWAIS) is an interactive data visualization platform designed to support and inform decisions related to strategic best management practice (BMP) implementation and the development of community flood resilience. IWAIS is designed explicitly for the watersheds and communities participating in the Iowa Watershed Approach project funded by the US Department of Housing and Urban Development. This platform helps the IWA reduce flood risk, improve water quality, increase flood resilience, and engage stakeholders through outreach and education.

- https://iwa.iowawis.org/

IWAIS displays information on three major components: social vulnerability, flood damage estimates, and BMP mapping. This information allows users to make connections between urban and rural—upstream and downstream—watershed activities. IWAIS supports efforts to increase flood resilience within a community or at the watershed scale, to mitigate future damages, and to enhance flood preparedness, response, and recovery. IWAIS can help watershed groups prioritize potential BMPs to mitigate flooding, improve water quality, and increase flood resilience. IIHR—Hydroscience and Engineering and Iowa Flood Center (IFC) researchers at the University of Iowa developed this tool. Much of the information displayed is harvested from the IFC's Iowa Flood Information System and IIHR's Iowa Water-Quality Information System.

- http://ifis.iowafloodcenter.org/
- https://iwqis.iowawis.org/

The Iowa Watershed Approach, and in turn, the Iowa Flood Resilience Program, use partnerships with twenty-two associations, organizations, and agencies to help accomplish their goal of increased resiliency for everyone in the nine watersheds of Iowa they focus on. The Flood Resilience Program focuses on education and outreach for these communities to keep them up to date on available resources.

4.2.1.3.1 PHASE I: HYDROLOGIC ASSESSMENT

The IWA works with Watershed Management Authorities (WMAs) comprising two or more eligible political subdivisions (e.g., cities, counties, and Soil and Water Conservation Districts) to engage in watershed planning and management. The WMAs are responsible for…

- Assess and reduce flood risk;
- Assess and improve water quality;
- Monitor federal flood risk planning and activities;
- Educate residents of the watershed regarding flood risks and water quality; and
- Allocate money made available to the Authority for water quality and flood mitigation.

The IWA and WMAs select locations for the construction and implementation of projects to mitigate flood damage, improve water quality, and build community flood resilience. IIHR—Hydroscience & Engineering (IIHR) and the IFC are developing a hydrologic assessment of each watershed that will provide WMAs, local leaders, landowners, and residents with an understanding of the hydrology — the movement of water — within their watershed. This assessment will deliver valuable information to stakeholders to help guide strategic decision-making that efficiently addresses flooding and water-quality concerns. The hydrologic assessment includes a comparison of the water cycle across the watershed and an analysis of hypothetical watershed scenarios that seek to reduce flood damages, including changes to infiltration and increased water storage on the landscape. Information from the hydrologic assessment will be integrated into a comprehensive watershed resiliency plan developed with local stakeholders. The watershed resiliency plan will guide long-term watershed management initiatives and planning efforts and identify goals and objectives to meet the current and future needs of the community.

4.2.1.3.2 PHASE II: PROJECT CONSTRUCTION

Watershed Management Authorities in each watershed will identify eligible sub-watersheds to construct and implement built projects. The location, type, and number of projects in each watershed will be based on the hydrologic assessment, watershed plan, and stakeholder input. The hydrologic assessment runs simulations using two main tools: the Iowa Best Management Practices Mapping Project and the Agricultural Conservation Planning Framework. A combination of baseline data from the Mapping Project and suitability analysis provided by the Agricultural Framework provides valuable information used to evaluate the effects of conservation practice implementation. Projects range in type, including wetlands, stormwater detention basins, channel bank stabilization, riparian buffers, perennial cover, etc.

Volunteer landowners are eligible to receive cost-share assistance on constructed projects, with the remaining costs covered by the landowner or through local match. Projects are designed using Natural Resources Conservation Service specifications and guidelines and are required to have a 20-year maintenance agreement. A dense instrumentation network monitoring stream stage, precipitation, soil moisture, soil temperature, and water quality will be deployed in each watershed to track project benefits before and after implementation.

The Iowa Flood Center developed a statewide hydrologic model to inform community risks, project development, and resource allocations. Their work is accessible to everyone through the online Iowa Flood Information System. The IFC is part of the University of Iowa College of Engineering. IFC students, staff, and researchers strive to develop the most advanced tools and innovative projects to improve Iowa's flood preparedness and resiliency. The IFC also provides critical science-based information and technology to help communities better understand their flood risks and make watershed-scale decisions as part of the IWA. This includes modeling water flows and quality to answer the following questions: Where can natural infrastructure and other flood mitigation projects have the most significant impact? What types of natural infrastructure are most appropriate? And how much natural infrastructure is needed to meet environmental outcomes and risk reduction goals?

4.2.1.4 Program Funding

Various local, state, and federal funding sources support the Iowa Flood Resilience Program, with HUD's Natural Disaster Resilience Competition Funding acting as the primary contributor and subsequent sources acting as matching funds. At the watershed scale, funding varies and is distributed based on the community's needs. The University of Iowa Flood Resilience Team asked the watersheds to develop a flood resilience action plan as part of a project funded by a grant awarded to the Iowa Economic Development Authority by HUD.

In January 2016, HUD announced an award of nearly $97M to the state of Iowa for its proposal titled The Iowa Watershed Approach for Urban and Rural Resilience. The award was made under HUD's National Disaster Resilience Competition, which is designed to fund cutting-edge projects that address unmet needs from past disasters while addressing the vulnerabilities that could put Americans in harm's way during future disasters.

4.2.1.5 Recommendations for Inclusion in the North Carolina Flood Resiliency Blueprint Process

Recommendations for a governing body to evaluate and/or approve flood mitigation projects and/or additional modeling and data needs for funding that can be applied to the Blueprint technical approach.

- Use the IWAIS two-dimensional base-level engineering model structure when the Blueprint is ready to apply to other North Carolina watersheds
- Partner with organizations across North Carolina that work both in the flood mitigation industry and with larger, nationwide organizations for support and implementation
- Consider forming a dense instrumentation network for monitoring stream stages, precipitation, soil moisture, soil temperature, and water quality by leveraging existing monitoring sites and deploying new gauges in each watershed to track project benefits before and after implementation.

5 North Carolina-Specific Recommendations Across States

This section includes a set of common themes and lessons learned from the peer and non-peer state efforts reviewed in this report that will specifically help design recommendations for the Blueprint program that will allow for long-term repeatability of the decision-support tool and other program elements. The following recommendations span several topics, including, but not limited to, capacity building for municipal and state government end users, funding mechanisms, staffing, updating key data and modeling inputs, and long-term basin planning.

Recommendations	Peer and Non-Peer State Program Connection
Create programs, guidance documents, and searchable online databases within the Blueprint that focus on capacity building, technical assistance, and identifying funding to help communities implement flood resilience strategies.	Louisiana Coastal Master Plan and Watershed Initiative
Create a comprehensive website source maintained by NCDEQ for flood mitigation funding information for North Carolina communities. The site should include information on the various programs, projects, plans, and watershed regions applicable to the Blueprint process.	Louisiana Coastal Master Plan and Watershed Initiative
Engage subject matter experts to advise on regional administrative and outputs of Blueprint project action strategies.	Louisiana Coastal Master Plan and Watershed Initiative
Address underrepresented population needs and provide environmental, economic, and social co-benefits, as well as risk reduction factors, to incentivize restoration project solutions. Like the TCRMP, Blueprint should identify and prioritize areas with no organized or active stakeholders, areas with historically few flood resiliency projects, and communities identified as socially vulnerable.	Texas Coastal Resiliency Master Plan
Develop an easy-to-use tool to prioritize actions identified during the Blueprint process and support the development of the state's broader flood resilience strategy each cycle. This tool should allow any NCDEQ-approved organization	Massachusetts Integrated State Hazard Mitigation Plan and Climate Adaptation Plan

to provide input during each Blueprint production cycle.	
Create a robust stakeholder engagement program with opportunities for meaningful contributions during the Blueprint process for every cycle.	Massachusetts Integrated State Hazard Mitigation Plan and Climate Adaptation Plan
Partner with organizations across North Carolina that work in the flood mitigation industry and larger nationwide organizations for support and implementation.	Iowa Flood Resilience Program
Perform return on investment analysis in flood hazard modeling using Virginia, Iowa, Texas, and Louisiana approaches as examples/templates.	Iowa Flood Resilience Program; Virginia Coastal Resilience Master Plan; Texas State Flood Plan; and Louisiana Coastal Master Plan and Watershed Initiative

6 Appendix A – Peer/Non-Peer State Questions

6.1 Louisiana Watershed Initiative Program

- How were the nine regions delineated?
- How was stakeholder engagement done?
- How were watersheds/HUC8s selected to be together?
- Are the different funding "rounds" determined by time?
- Who can apply for funding and/or technical support?
- Are Technical Advisory Group (TAG) members appointed? How are they selected?
- Who is the TDQ team made up of?
- How was the TDQ team developed?
- What is the make-up and selection process of stakeholders, steering committees, TAGs, and watershed coalitions? How can they get on the committee?
    - Regional Capacity Building Grant Program: Short-term Regional Steering Committees vs Long-term watershed coalitions – what is the difference in makeup, function, etc.?
- For the Statewide Data and Modeling Program – are the federal partners part of a partnership agreement?
- Nature-Based Solutions Program – what level of technical assistance is available?
- How many people did it take to develop and maintain?
- What percentage of the work is performed with public versus consultant staff?
- What is the program's operational cost or at least a percentage?

6.2 Massachusetts

- How many people did it take to develop and maintain the plan?
- What percentage of the work is performed with public versus consultant staff?
- What is the cost to run the plan and program, or at least a percentage?
- How did they develop cost and capacity needs?
- What is the cost data on coastal flooding in Massachusetts?
- Is it much more than inland?
- Has it been increasing?
- Massachusetts has incorporated natural hazard mitigation and climate change adaptation into other programs. What are examples of what they are incorporating under each category? On what frequency is the plan reviewed, revised, and updated? We are looking for guidance to help us develop sustainable program recommendations.

- Inland flooding impacts resulted in an average of over $9.1 million in damages per year between 2007 and 2014, with the most vulnerable areas being those highly developed or within the floodplain. More intense and frequent downpours will result in more frequent flooding and greater areas exposed. This doesn't seem like a lot. Is this only for state facilities?

6.3 Texas

- How many people did it take to develop and maintain the program?
- What percentage of the work is performed with public versus consultant staff?
- What are the program's operational costs or at least a percentage?

6.4 South Carolina

- How many people did it take to develop and maintain the program?
- What percentage of the work is performed with public versus consultant staff?
- What are the program's operational costs or at least a percentage?

6.5 Virginia

- How many people did it take to develop and maintain the program?
- What percentage of the work is performed with public versus consultant staff?
- What are the program's operational costs or at least a percentage?
- Who decides who will be on the technical advisory committee?
- How long do they serve?
- Do they have a standing number for each stakeholder group they want to represent (e.g., academic, commerce, recreational fisheries, local government)?
- How was the CRMP Project Database designed to align with the project and capacity-building classification schemas to capture and standardize the key attributes required for evaluation and prioritization? Tell us more about where the proposed projects come from and how they are prioritized.
- How did they build capacity for the project?
- Does it have any permanently assigned staff and specific annual budget allocation?
- Was it funded by grants or GFs?

6.6 Indiana

- How many people did it take to develop and maintain the program?
- What percentage of the work is performed with public versus consultant staff?
- What are the program's operational costs or at least a percentage?

- The Floodplain Information Portal was created by the Indiana Department of Natural Resources, a state-level agency funded by the state. Some federal funding could be used since it combines data accumulated at the state level and NFIP (National Flood Insurance Program) data (but that is not confirmed).

6.7 Iowa

- What is their outreach approach?
- How long does it take them to develop a community plan? (Between 12-20 months)
- Do they use consultants or existing staff?
- What percentage of the work is performed with public versus consultant staff?
- How many staff do they have?
- What are the program's operational costs or at least a percentage?
- What is the annual funding?
- Where does it come from? (Funding comes from Iowa Watershed Approach)
- The Flood Resilience Program focuses on education and outreach for these communities to keep them updated on available resources. Is there anything else besides education occurring?
- The Iowa Flood Resilience Program is active and, with the Iowa Flood Mitigation Projects, appears to be doing well in assisting the individuals living in Iowa's watersheds. How is this measured?
- Are there any projects being implemented?
- If so, how are they identified, prioritized, chosen, and funded?