

**Preparing New Hampshire for  
Projected Storm Surge, Sea-Level Rise,  
and Extreme Precipitation**



The final report of the New Hampshire  
Coastal Risk and Hazards Commission,  
**Preparing New Hampshire for Projected Storm Surge,  
Sea-Level Rise and Extreme Precipitation,**  
is available for download on the Commission's website:  
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# NEW HAMPSHIRE COASTAL RISK AND HAZARDS COMMISSION

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<sup>1</sup> Commission Alternates and former members are listed in [Appendix B](#).

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## EXECUTIVE SUMMARY

Coastal hazards associated with storm surge, sea-level rise, and extreme precipitation events can be devastating to human health and safety, public and private structures and facilities, and the economies of coastal communities. Coastal New Hampshire was fortunate to experience minimal damage from Tropical Storm Irene in 2011 and Superstorm Sandy in 2012. Nevertheless, the impacts of these storms on neighboring states and the more extreme local impacts from storms such as the Mother’s Day storm of 2006, the Patriots’ Day storm of 2007, and Winter Storm Nemo in 2013 have reinforced our knowledge that strong storm systems are capable of causing immense damage in areas on or near the coast. New Hampshire’s coastal exposure to current and future flood risks is significant. As of 2016, the state’s 17 coastal zone municipalities are home to approximately 11 percent of the state population, host over 100,000 jobs, and generated a 2014 Gross Regional Product of approximately \$11 billion.<sup>1,2</sup>

Where and how we build and rebuild as the coastal population and economy continue to grow have critical implications for how coastal New Hampshire will withstand projected coastal hazards. Should we choose to build using the same strategies and techniques as we have in the past, we will exacerbate our exposure to these hazards by placing structures, facilities, and people directly at risk. Alternatively, if we incorporate projected flood risks into our planning, design, construction, and conservation practices today, we will greatly reduce exposure to flood hazards, resulting in saved lives and property and lower response and recovery costs.

Recognizing the need to prepare for existing and projected coastal flood hazards, in July 2013 the State Legislature enacted Senate Bill 163, introduced by Senator David Watters (District 4), which established the New Hampshire Coastal Risk and Hazards Commission to “recommend legislation, rules, and other actions to prepare for projected sea-level rise and other coastal and coastal watershed hazards such as storms, increased river flooding, and stormwater runoff, and the risks such hazards pose to municipalities and the state assets in New Hampshire.” In response to this legislative mandate, the Commission puts forward a final report and set of recommendations for state legislators, state agencies, and coastal municipalities to help these audiences better prepare for and minimize coastal risks and hazards. The report presents a summary of the best available science and vulnerability information followed by recommendations for action.

### Understanding What We Are Facing

To lay the foundation for our understanding of coastal hazards and flood risks, the Commission established a Science and Technical Advisory Panel (STAP) to review existing science and analyze historic trends and projections for the years 2050 and 2100 for storm surge, sea-level rise, and extreme precipitation in coastal New Hampshire.<sup>3</sup> Some of the key scientific findings summarized in the STAP report include:

- Global and regional sea levels have been rising for decades, though not uniformly.
- Using mean sea level in 1992 as a starting point, New Hampshire sea levels are expected to rise between 0.6 and 2.0 feet by 2050 and between 1.6 and 6.6 feet by 2100.
- Today’s extreme storm surge events will have a significantly greater inundation extent and destructive impact due to higher sea levels.
- It is likely that coastal storms will be more severe as a result of warmer oceans and other changes in climate systems, but at the time of the STAP report publication, the research continues to be uncertain about whether storm frequency will change in the future.
- Annual precipitation is expected to increase by as much as 20 percent by the end of the 21<sup>st</sup> century compared to the late 20th century, and extreme precipitation events are projected to increase in frequency and in the amount of precipitation produced.

## Understanding Our Risks and Vulnerabilities

The Commission’s report summarizes vulnerabilities to projected coastal flood hazards and how these hazards could impact different sectors of our life in the coastal region. Recent and ongoing assessments of the Atlantic Coast and Great Bay communities identify valuable assets at risk of different coastal hazards, evaluate the exposure and sensitivity of those assets to coastal hazards, and assess existing capacity for managing and reducing vulnerabilities. While additional assessments are needed to more fully understand New Hampshire’s coastal vulnerabilities, especially in the Great Bay communities and at the site-specific scale, significant progress is underway. Some key findings from regional assessments are presented in this report, focusing on vulnerabilities specific to our economy, our built landscape, our natural resources, and our heritage.

### Our Economy

A review of key indicators reinforces the growing importance of the coastal region to the economic vitality of the State. The coastal region hosts 11 percent of the state’s population, accounts for 15 percent of total state employment, and generates a disproportionate share of statewide tourism revenue as measured in Meals and Rooms tax revenue.<sup>4,5,6</sup> The Tides to Storms vulnerability assessment conducted for the seven Atlantic Coast municipalities reported that just over 7,000 parcels will be partially or wholly affected under the 6.3 feet sea-level rise<sup>ii</sup> plus storm surge scenario, putting approximately \$4.4 billion, or 35 percent, of total assessed property value at risk of flooding.<sup>7</sup> Similarly, the Climate Risk in the Seacoast (C-RiSe) vulnerability assessment conducted for the ten Great Bay municipalities suggests that nearly 1,600 parcels will be partially or wholly affected under the 6.3 feet sea-level rise plus storm surge scenario, putting over \$805 million, or 8.5 percent, of total assessed property value at risk of flooding.<sup>8</sup>

### Our Built Landscape

State and local roadways throughout the coastal region are vulnerable to flooding and damage due to storm surge, sea-level rise and extreme precipitation. In many municipalities, flooding is magnified by the combination of tidal or storm-related flooding and freshwater flooding. The Tides to Storms vulnerability assessment conducted for the seven Atlantic Coast communities reported that, under an intermediate sea-level rise scenario of 4.0 feet, 90 public infrastructure sites, 33 critical facilities, and nearly 24 miles of state and local roads could be subject to daily tidal flooding by 2100.<sup>9</sup> Under the same 4.0 feet sea-level rise scenario, the C-RiSe vulnerability assessment conducted for the ten Great Bay municipalities reported that 23 public infrastructure sites, zero critical facilities, and only one mile of state and local roads could be subject to daily tidal flooding by 2100.<sup>10</sup>

### Our Natural Resources

As reported in the 2015 Wildlife Action Plan, sea-level rise will alter the function of coastal habitats such as salt marshes and estuaries, habitat availability, and the timing of nesting and migration for seabirds.<sup>11</sup> Total habitat and species losses will likely be greater in developed areas where there is no space for natural habitats to retreat or migrate inland. Modeling results suggest that salt marshes will likely reach a tipping-point under the highest sea-level rise scenario, with 95 percent of salt marshes potentially disappearing by 2100.<sup>12</sup> In addition to long-term sea-level rise, extreme storm events can pose significant risks to coastal systems by altering hydrology, sedimentation, and land forming processes. Coastal dune sediments will be driven inland by storm surges, and dune degradation will further exacerbate the impacts of storms. As dune systems migrate landward they will compete with developed landscapes and, as a result, the remaining dunes could eventually be lost completely.

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ii The 6.3 feet sea-level rise map was developed prior to the STAP report summary and therefore used slightly different estimates for sea-level rise. The maps do not show significant difference in inundated area due to the resolution of the elevation data.

## Our Heritage

Cultural, historic, and recreational resources and amenities are vital assets in the coastal region, in part because they support the tourism industry, as well as a sense of place for New Hampshire residents and visitors alike. Regional-scale vulnerability analyses have identified some vulnerable recreational destinations, however less than 11 percent of the coastal region has been inventoried for historic architectural resources.<sup>13</sup> Much less of the coastal region has been evaluated for archaeological resources, though we know that at least 102 archaeological sites, most of which are historic Native American sites, are already situated below mean sea level.

## Understanding What We Need To Do

This report is the start of a critical and ongoing effort in the state to embrace a proactive approach that is responsive to changing conditions and societal and ecological needs. Planning for coastal hazards will evolve with research and as creative adaptation strategies are implemented here and around the country. State, municipal, and private sector responses will likely combine *defending* certain key assets and resources from loss, *accommodating* new flood extent and risk, and *retreating* from areas where the frequency or severity of impacts are too great to defend against or accommodate. The appropriateness of responses will vary by location and will change over time as flood risk and exposure changes, requiring the State and municipalities to periodically reassess their responses.

Given this uncertainty and need for flexibility, we present six guiding principles that should be applied at both state and municipal levels to plan for coastal risks and hazards, followed by our goals to achieve a resilient New Hampshire and a summary of the recommendations for action.

## Our Guiding Principles

### Act Early

By starting now, the normal cycles of reconstruction, replacement and redevelopment can gradually replace vulnerable facilities and construction not designed for future conditions, often at minimal added cost and resulting in long-term cost savings.

### Respond Incrementally

Given uncertainties about future flood risk, strategies can be implemented in increments, allowing multiple opportunities to refine and correct actions as understanding of future coastal hazards improves.

### Revisit and Revise

Actions must keep pace with observed changes and improved scientific understanding, therefore it is important that state and municipal officials periodically revisit projections and assumptions as the science becomes more certain and adjust their course of action accordingly.

### Collaborate and Coordinate

The state and municipalities share assets and infrastructure on the coast that are systematically and functionally linked and as such, they need to work together to align policies, assumptions, and responses about future coastal flood hazards.

### Incorporate Risk Tolerance in Design

The acceptable loss or damage to an asset should be considered in determining the most appropriate design standards for protection, with more critical, expensive, and long-lasting structures and facilities having low risk tolerance and lower value, easily replaced structures and facilities having higher risk tolerance.

### Make No Regrets Decisions

By preparing for future impacts from uncertain coastal hazards, often the results will be beneficial even if those future hazards turn out to be less extreme than anticipated.

## Our Goals

We present four goals intended to help achieve our vision for a resilient coastal New Hampshire. These goals form the SAIL framework: Science, Assessment, Implementation, and Legislation.

- 1. Science:** To research, understand, establish, and use best available science about current and future coastal hazards.
- 2. Assessment:** To identify our assets that are vulnerable to current and future coastal hazards and evaluate existing policies to identify ways to reduce vulnerabilities.
- 3. Implementation:** To implement strategies to enable the state and coastal communities to protect, adapt, and sustain our assets.
- 4. Legislation:** To recommend legislation that leads to actions to reduce vulnerability and adapt to current and future coastal hazards.

## Recommendation Highlights

We propose extensive and detailed recommendations and associated actions that should be implemented to prepare for projected sea-level rise and other coastal watershed hazards. Highlights from the recommendations are summarized below and form a high-level to do list for New Hampshire's state legislature, state agencies, and coastal municipalities.

- Review and evaluate the current state of climate change science in order to periodically update storm surge, sea-level rise, extreme precipitation, and other relevant climate projections; and provide planning guidance.
- Identify vulnerable state and municipal economic assets; structures and facilities; natural resources; and recreational and cultural resources at regional, municipal, and site-specific scales.
- Amend statutes, ordinances, rules and regulations, policies, programs, and plans to incorporate and consider the best available science and vulnerability information.
- Secure funding sources and develop funding mechanisms, including incentives and market-based tools, to pay for vulnerability assessments and implement climate adaptation strategies.
- Encourage businesses to create preparedness plans in order to minimize economic disruptions and ensure continuity of services to essential facilities, people, businesses, and employment centers.
- Make existing structures and facilities more resilient to flooding, acquire properties in high risk areas, and avoid exposing new structures and facilities to current and future flood risks.
- Protect and restore vulnerable natural resources, and consider how natural resources reduce the impacts of flooding in state and municipal planning efforts.
- Develop plans and implement strategies to prepare and adapt recreational and cultural resources vulnerable to climate impacts.



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