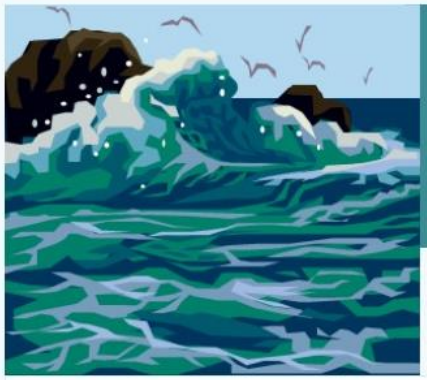
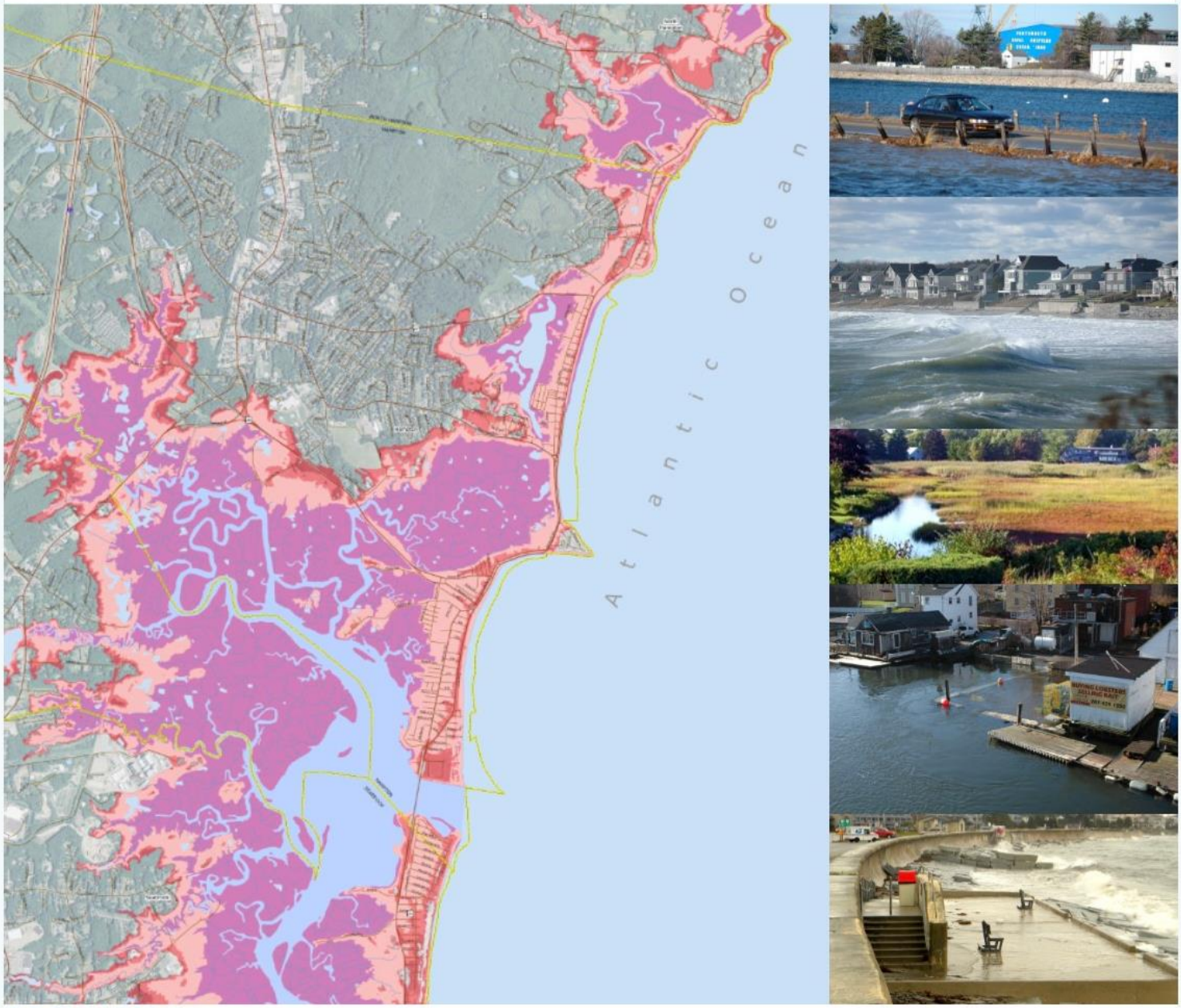


FROM TIDES TO STORMS: PREPARING FOR NEW HAMPSHIRE'S FUTURE COAST

Assessing Risk and Vulnerability of Coastal Communities to Sea Level Rise and Storm Surge

Seabrook - Hampton Falls – Hampton - North Hampton – Rye - New Castle - Portsmouth



ROCKINGHAM PLANNING COMMISSION

Prepared by Rockingham Planning Commission

September 2015

ACKNOWLEDGEMENTS

The Rockingham Planning Commission gratefully acknowledges the participation of coastal New Hampshire municipalities in the preparation of this report:

City of Portsmouth
Town of New Castle
Town of Rye
Town of North Hampton
Town of Hampton
Town of Hampton Falls
Town of Seabrook

The Tides to Storms project was enhanced by the willingness of these municipalities to support preparation of a coastal vulnerability assessment for New Hampshire. These municipalities contributed a great deal of staff hours to support this effort and their elected officials, land use boards and commissions, and volunteers participated in roundtable discussions to review maps and assessment data, and share their perspectives about how coastal hazards impact their community. We thank each municipality and their representatives for their contributions to this project.

Sincerely,

Executive Director and Staff
Rockingham Planning Commission

ROCKINGHAM PLANNING COMMISSION
156 Water Street
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Use and Applicability of this Report and Results:

The purpose of this vulnerability assessment report is to provide a broad overview of the potential risk and vulnerability of state, municipal and public assets as a result of projected changes in sea-levels and coastal storm surge. This report should be used for preliminary and general planning purposes only, not for parcel level or site specific analyses. The vulnerability assessment performed was limited by several factors including the vertical accuracy of elevation data (derived from LiDAR) and the static analysis applied to map coastal areas subject to future flooding which does not consider wave action and other coastal dynamics. Also, the identification of flood impacts to buildings and infrastructure are based upon the elevations of the land surrounding them, not the elevation of any structure itself. The changes in sea-level used as the basis of the vulnerability assessment are based on a plausible range of sea-level scenarios as depicted in the 2014 National Climate Assessment and New Hampshire Coastal Risks and Hazards Commission Science and Technical Advisory Committee 2014 report, and are not projections or estimates. The assumptions that underlie the sea-level scenarios should be reviewed on a regular basis.

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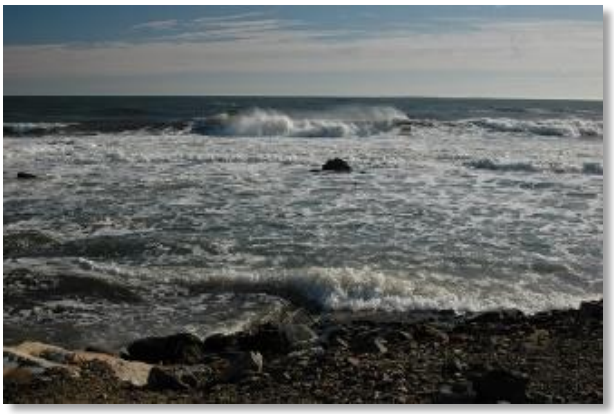
List of Maps

Assessing Risk and Vulnerability to Sea-level rise and Storm Surge: A Vulnerability Assessment of Coastal New Hampshire

I. Executive Summary

New Hampshire coastal municipalities are confronted by land use and hazard management concerns that include extreme weather events, storm surges, flooding and erosion. Concerns about issues are heightened by increases in the frequency and intensity of extreme storm events and increases in sea level.



New Hampshire coastal communities have a distinct and pressing need to address the existing and future impacts relating to climate change, particularly relating to coastal flooding from storm surge and sea-level rise. Without proactive solutions to address the expected impacts of climate change, coastal communities face a multitude of challenges to ensure the security, health and welfare of their citizens and provide for a stable and viable economic future.

In September 2015 the Rockingham Planning Commission (RPC) completed the Tides to Storms project to assess the vulnerability of coastal municipalities and public infrastructure to flooding from expected increases in storm surge and rates of sea-level rise. The project's purpose was to develop a regional scale understanding of what and where impacts from sea-level rise and storm surge will occur on New Hampshire's coast. The geographic extent of the project includes the following municipalities: Portsmouth, New Castle, Rye, North Hampton, Hampton, Hampton Falls and Seabrook. The study did not include an assessment of the specific degree of damage nor estimate monetary losses to specific sites or properties. Further depth-damage analyses of affected assets using the flood depth maps may yield some of this information in follow-up work. The data generated from this project will enable individual communities, agencies and researchers to undertake this work in the future.

In addition to the regional vulnerability assessment, an assessment report and map set were prepared for each of the seven coastal municipalities. Municipalities were provided maps and an assessment of risks to roadways and supporting transportation infrastructure, critical facilities and infrastructure, and natural resources. Flooding scenario maps were based on the 2014 National Climate Assessment, 2015 (Preliminary) Flood Insurance Rates Maps released by the Federal Emergency Management Agency (FEMA), and high resolution digital elevation data. This information was supplemented with a series of recommended actions that municipalities can take to help adapt and improve resiliency to changing conditions caused by storm surge and sea-level rise. The information and recommendations from this project should be considered for incorporation into local hazard mitigation plans. The information can also be incorporated into other state and municipal plans, policies, practices and regulatory standards.

Data sources and assumptions that underlie the flood scenarios used in this assessment are explained more fully in Section IV of this report.

SUMMARY OF VULNERABILITY ASSESSMENT RESULTS

Key findings of the coastal assessment are based on evaluation of the extent of inundation that would result under three scenarios of static sea-level rise: 1.7 feet ("intermediate-low"), 4.0 feet ("intermediate high"), and 6.3 feet ("highest") for the year 2100 and three additional scenarios that combine the static sea-level rise combined with the 100-year storm surge. In addition separate regional maps were prepared which mapped the depth of flooding associated with each scenario. An analysis was conducted to determine the intersection of inundation areas with key assets, including transportation, critical facilities (community defined) infrastructure and natural resources to evaluate the quantitative impacts of the flooding.

Table 1 provides a statistical overview of the flood impacts to specific assets and resource types from the sea-level rise and storm surge scenarios evaluated. A few of the findings discussed in more detail in the body of the report are these:

- In most instances, the greatest increase in flood impacts occurs from the transition from the intermediate low (1.7 feet) to the intermediate high (4.0) feet sea-level rise scenarios.
- The miles of local roadways impacted by flooding is at least double the miles of state roadways affected under all six flood scenarios in all seven coastal municipalities.

TABLE 1. SUMMARY OF FLOOD IMPACTS FROM SEA-LEVEL RISE AND STORM SURGE

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
Infrastructure (# of sites)	37	90	135	137	162	190
Critical Facilities (# of sites)	13	33	48	44	64	98
Roadways – Local (miles)	3.5	17.0	29.4	32.8	38.8	50.5
Roadways - State (miles)	1.6	6.6	14.1	18.7	21.8	25.6
Transportation Assets (# of sites)	35	50	68	65	78	90
Upland (acres)	1,484.6	2,602.2	3,613.5	3,473.5	4,439.0	5,298.4
Freshwater Wetlands (acres)	184.1	396.2	518.7	488.8	592.5	660.6
Tidal Wetlands (acres)	235.3	257.3	264.2	266.5	268.4	268.6
Conserved and Public Lands (acres)	492.7	717.0	873.0	882.6	1,007.0	1,131.0
Conservation Focus Areas (acres)	4,021.7	4,851.1	5,468.8	5,385.4	5,947.5	6,458.3
Wildlife Action Plan Tier I+II (acres) Tier 1 and Tier 2 habitats (acres)	1,080.7	1,600.4	1,914.7	1,864.9	2,112.0	2,309.9
100-year floodplain (acres)	8,179.5	9,361.1	9,593.2	9,639.0	9,765.8	9,818.0
500-year floodplain (acres)	8,180.6	9,368.4	9,837.6	9,879.8	10,015.3	10,069.5

Note: Upland refers to land above mean higher high water (highest tidal extent). The seven coastal region municipalities have approximately 52,751.8 acres of upland. Storm surge = 100-year / 1% chance flood event.

- The seven coastal municipalities combined have 49,266 acres of upland (land above mean higher-high water). At the lowest SLR scenario, about 3% (1484 acres) of this upland will be inundated by tides on a regular basis; at the intermediate high scenario, 5.3% (2602 acres) of upland would be affected and at the highest SLR scenario, 7.3% or 3613 acres would be affected. Upland impacts are

greater in Rye than in other communities because of the extensive low-lying areas around the marshes west of Odiorne Point.

- Over500 acres of current freshwater wetlands would be subject tidal inflows under the highest (6.3 feet) SLR scenario (non-storm surge).
- Portsmouth, Rye, Hampton and Seabrook have the greatest number of acres of conserved lands and public lands within the coastal floodplain. Although impacted by sea-level rise and coastal storm surge flooding, these undeveloped lands serve as important flood storage areas and allow space for future habitat conversation and salt marsh migration.
- Projected sea-level rise and coastal storm surge flooding are largely contained within the current 100-year floodplain with minor incursions within the 500-year floodplain in lowest lying areas.

Roadways and Transportation Assets

Route 1-A provides the vital transportation link on the immediate coast and is essential to coastal communities for access, safety, livability, recreation and for the continued viability of coastal tourist economy. With its immediate shoreline exposure, it comes as no surprise that Route 1-A is the transportation asset most vulnerable coastal flooding and disruption from sea-level rise scenarios. As shown in the project maps, the route and any connecting streets and roads are significantly affected by sea-level rise in the intermediate high and high scenarios. I-A is the backbone of the road network on the immediate coast for all of the communities (except Hampton Falls) and is essential for maintaining a function roadway system. To a great extent local responses on municipal roads will depend on State plans for improving the resilience of Route 1A and will require extensive regional coordination.

Critical Facilities and Infrastructure

Communities recognize the critical importance ensuring that emergency facilities and shelters be located in places that are secure and accessible. With existing coastal flood hazards in mind, relatively few although critical facilities are located in vulnerable locations including the Hampton Police Station and Fire Station, and the Hampton and Seabrook wastewater treatment facilities. Given the cost of making certain infrastructure and critical facilities more resilient, it is important that upgrades be budgeted as part of a long term capital improvement and included in cost estimates for new projects and facilities.

Land Use

As stated in section VI.2 General Considerations, the best way to limit the region's property and infrastructure exposure to future sea-level rise is to ensure that future development is limited in those vulnerable areas. Future land use polices that discourage further development in areas that will become vulnerable in a future 100-year storm will extend that protection and limit future losses. The adjacent upland areas that would be protected with this approach will also serve as critical flood storage in future storms and support marsh migration. Implementation strategies include land conservation/property acquisition, conservation subdivision, transfer of development rights, restoration of natural vegetation and adaptive repurpose/reuse.

Natural Resources and Environment

The coastal region is home to a wide variety of natural resources and ecosystems, including tidal and freshwater wetlands, salt marsh systems, estuarine systems, beaches, dunes, freshwater aquifers, and farm and forest land. Many of these natural areas provide significant economic value to the state and critical ecosystem services that protect assets and infrastructure, however many of these resources are also highly vulnerable to impacts from sea-level rise and storm surge. Salt marshes are particularly sensitive to changes in sea level. If marsh elevations can't keep pace with water elevations their capacity to store flood water during coastal storm events may be diminished. Many tools can be applied to protect these critical services including

land conservation and acquisition, land development regulations, zoning standards, and municipal policies and plans.

Assessed Value of Parcels

Tables 2 and 17 report the number of parcels affected by each of the six scenarios evaluated and shows the aggregated assessed value of these parcels. The extent to which the parcel and any structure or development on the parcel is affected by sea-level rise or storm related flooding was not analyzed. Affected parcels were identified based on whether the parcel was either partially or fully within the extent of the scenarios evaluated. *The data includes a number of high value parcels under state and municipal ownership.*

Between 2,800 to 5,700 parcels will be partially or wholly effected by tidal flooding, depending on the scenario, and up to 7,200 affected when storm surge is added. The data shows a 55 percent increase in the number of parcels and a $651 million dollar increase in the assessed value of parcels when comparing the 1.7 feet to the 4.0 feet sea-level rise scenario. This compares to a 32 percent increase in the number of parcels and a $659 million increase in the assessed value of parcels when comparing the 4.0 feet to the 6.3 feet sea-level rise scenario.

TABLE 2. SUMMARY OF PARCELS AND ASSESSED VALUE BY SCENARIO

Sea-Level Rise (SLR) Scenarios	Number of Parcels Affected by scenario	Aggregate Value of Effected Parcels
1.7 feet SLR	2,789	$1,298,033,374
4.0 feet SLR	4,334	$1,949,171,074
6.3 feet SLR	5,740	$2,608,930,224
1.7 feet SLR + storm surge	5,555	$2,555,831,824
4.0 feet SLR + storm surge	6,468	$2,988,594,674
6.3 feet SLR + storm surge	7,165	$3,258,843,274

Mapping shows that the three sea-level rise scenarios are for the most part contained within the current 100-year floodplain. To qualify for federal disaster relief and the National Flood Insurance Program, FEMA requires municipalities to regulate development within the 100-year floodplain. These floodplain standards are considered minimum requirements. FEMA encourages municipalities to adopt stricter floodplain standards and offers incentive programs such as the Community Rating System (CRS) which qualifies property owners to pay lower insurance premiums. CRS is a voluntary program that requires municipalities to adopt protective standards within highly vulnerable areas and take proactive actions that reduce flood risks. Creating more flood resiliency within the current 100-year floodplain may also provide flood protection against impacts from sea-level rise in the long term.

Planning Considerations

In order to effectively adapt in short-term and long–term, municipalities need help developing and implementing policies and regulations to plan for and minimize the impacts of climate induced changes. Planning for climate change can result in positive actions that improve preparedness and reduce impacts from current coastal hazards and address long-term changes that may result from climate change including sea-level rise. Communities that implement climate adaptation planning may see benefits such as:

- Enhancing preparedness and community awareness of future flood risks.
- Identifying cost-effective measures to protect and adapt to changing conditions.
- Improving resiliency of infrastructure, buildings and other community investments.
- Protecting life, property and local economies.
- Protecting coastal natural resources and the critical services they provide.
- Preserving historical assets and unique community character.

The Tides to Storms Coastal Vulnerability Assessment is a snapshot of existing conditions in coastal New Hampshire based on the current distribution of developed lands and natural landscapes and resources for the year 2015. As the developed and natural landscapes in the coastal region change, and climate parameters change, so will the degree and extent of impact from sea-level rise and coastal storm surge flooding. In order to use the latest science-based information to guide decision making, it is highly recommended that vulnerability assessments be updated as new information about emerging trends and revised projections of climate change are published.

From state and regional perspectives, the increased risk of exposure to coastal flooding from changing sea level raises a number of important issues that should be considered and addressed in state, regional and local responses to increased coastal flood risks. There are both general considerations that apply to our collective response as well as considerations that apply to the specific asset classes affected (e.g. roads, infrastructure, natural resources). These considerations are listed below and discussed in detail in Section VI.2 Regional Considerations.

Acting in uncertainty and the value of an incremental response: The most difficult circumstance under which to take action in response to a future threat is when there is uncertainty about the degree of risk from that threat. This is especially true when the threat is distant in time and the cost of responding is high. Each situation needs to be evaluated individually taking into consideration many factors.

The value of time and of acting now: Acting today may result in long term cost savings by anticipating sea level change and ensuring all current and future infrastructure investments in vulnerable areas are resilient to at least moderate sea-level rise expected over their design life.

State and regional economic considerations: Coastal New Hampshire is highly important to the region's and the state's economy. Statewide, tourism ranks as the state's second largest economic sector, and, for several communities in the coastal region, it is the largest. Much of that tourism activity is driven by access to coastal assets including beaches and the ocean.

State and municipal collaboration, coordination and planning: The state and municipalities share assets and infrastructure on the coast and as such need to align their policies, assumptions and responses to

existing and future coastal flood hazards to the greatest extent possible. Failure to coordinate such actions will increase the cost and decrease the effectiveness of planning and preparation for increased flood risk.

Creative financing mechanisms for infrastructure projects: Creating more resilient buildings and infrastructure will cost more in the short term and may accelerate the need for certain improvements. This may necessitate innovative financing approaches to make such investments workable. For example, establishing a hazard mitigation fund to enable state agencies or municipalities to purchase developed properties in high hazard locations, or in undeveloped areas.

Comprehensive shoreline management planning: A comprehensive shoreline management plan would identify both general priorities and policies for shoreline management, but also examine specific sections of coast to recommend where specific management approaches are necessary. Given the complexity of coastal property ownership, any successful shoreline management plan must be undertaken as a collaborative effort between the state, municipalities and other stakeholders.

Consistency in land development standards: Local and state land use standards should be adapted to anticipate increased flood risks associated with storm surge and sea-level rise as soon as possible so that new development will be resilient to these conditions based on comparable levels of protective standards.

Identify priority areas for restoration, protection and retreat: Developing a comprehensive shoreline management plan may me the best approach for determining priority areas for restoration, protection and retreat. It should be acknowledged that some of these priorities will likely change as future sea-level rise scenarios are refined and as conditions change as projected or altogether differently. A priority to protect some areas for the intermediate low sea-level rise scenario may prove infeasible in a higher scenario.

Continued evaluation of science based climate change projections: Over time both the range and rate of expected sea-level rise will presumably narrow as climate change projections become more certain. This in turn will allow estimates of vulnerability to become more refined. It will be important for local and state officials to periodically revisit these projections and assumptions and adjust responses accordingly.